The Effect of CEO Climate Awareness on Corporate Emissions

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Abstract

This paper investigates the impact of CEOs' personal climate awareness on corporate greenhouse gas emissions, and the role of information in forming such awareness. Climate awareness of CEOs is measured by their experience of extreme weather during their impressionable years in combination with the availability of climate change information at the time. I find that high climate awareness of CEOs is associated with lower carbon intensity of their firms. The translation from extreme weather experience to climate awareness is facilitated by knowledge about climate change, thus, the emission reduction effect is driven by extreme weather experience gained *after* the science of climate change was introduced to the public. CEOs who were likely to encounter misinformation during their impressionable years tend to misinterpret their experience, such as regarding severe winter weather as counter-evidence for climate change, and generally overlooking extreme weather that is not directly related to rising temperatures. Evidence from plausibly exogenous CEO turnover events supports the emission reduction effect of CEO climate awareness to be causal. This study presents CEO personal climate awareness as a determinant of corporate emission policies and shows that such awareness can be induced by a combination of extreme weather experience and climate change information. Adding to the literature about managers' personal experience, this study emphasizes the mediating role of information in translating experience into behaviours, highlighting that one's interpretation of her experience is as important as the experience itself.

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1 Introduction

The Paris Agreement sets the goal to keep the rise of global temperature below 1.5°C, and achieving this goal relies on reaching 'net-zero' carbon emissions by mid-century. However, only a limited percentage of firms have made commitments towards the net-zero goal. In PwC's annual global CEO survey of 2021 (PwC, 2022), only 22% of respondents have made a net-zero commitment. The survey was conducted among CEOs who chose to attend the 2021 United Nations climate change conference (COP26), indicating the number is overestimated if considering the universe of firms. To meet the target set by the Paris Agreement and avoid disastrous consequences, much remains to be done in the private sector.

In this paper, I study how CEOs' personal awareness on the climate change affects companies' greenhouse gas emissions, and to what extent the formation of such awareness depends on access to information about climate change. The fast-growing literature in climate finance has identified several limitations in current environmental regulations and market mechanisms, such as the limited adoption of CSR contracting (Flammer et al., 2019; Tsang et al., 2021), practitioners' belief that asset prices on average underestimate climate risk (Krueger et al., 2020; Stroebel and Wurgler, 2021), and the geographically fragmented emission regulation (Bartram et al., 2022). These features give CEOs discretion in making environmental decisions, allowing their personal opinions to play a role.

Although CEOs' climate opinions may not be directly observable, yet we know such opinions are highly divided among the public. While over 99% of peer-reviewed scientific publications since 2012 agree on the overall negative effect of anthropogenic climate change currently underway (Lynas et al., 2021), a significant percentage of the world population does not believe the climate is changing or that this will have serious consequences. In the US, Yale University surveyed a representative sample of adults in 2021 about their climate opinions, 28% of the respondents do not believe global warming is happening, while 43% do not believe that human activities are the main reason for global warming (Howe et al., 2015)[1]. As such disagreement is likely to exist among business executives as well, I conjecture that the heterogeneity in CEOs' personal awareness of climate change may help explain the variations in their environmental

[1] Visualized data available at https://climatecommunication.yale.edu/visualizations-data/ycom-us/

decisions, ultimately leading to effects on corporate emissions.

I consider two elements that may facilitate the formation process of long-term climate awareness: climate-related extreme weather experience and information about climate change at the time of the experience. Many studies find the general public and investors raise attention to topics about climate when distinct abnormal weather events happen (e.g., Alok et al., 2020; Bergquist et al., 2019; Choi et al., 2020; Rudman et al., 2013). To further translate the short-term attention to long-term awareness and changes in behaviour, one needs to be able to causally relate her abnormal weather experience to climate change, and that requires access to climate change information which has been popularized today but may not be the case decades earlier. Combining experience and information, I measure a CEO's climate awareness by her climate-related extreme weather experience during college and the availability of climate science information at that time. I focus on the college period because it coincides with the impressionable years of individual development, a period during which people is highly susceptible to opinion and attitude changes (Krosnick and Alwin, 1989).

I collect corporate emission data from Refinitiv Asset4, CEO data from BoardEx and natural disaster data from the Spatial Hazard Events and Losses Database (SHELDUS). Due to the availability of natural disaster data, the sample is restricted to CEOs who started undergraduate studies in the U.S. in or after 1960. The final sample spans from 2003 to 2020.

I consider six types of extreme weather or natural disasters as climate-related extreme weather events: flooding, hurricane, heat, drought, wildfire and coastal events (including coastal floods, high tide, beach erosion, high seas, etc). These types of events satisfy two criteria: 1) the increasing frequency and intensity of these disasters are likely to be related to climate change, as shown by scientific studies, and 2) these events are likely to be linked to climate change in people's perception. Using this definition, I construct an indicator "Extreme weather experience" for each CEO that equals 1 if, during her college time, the county where she attended college suffered economic damage caused by the above climate-related extreme weather events, and otherwise 0.

In the baseline tests, I find that CEO's extreme weather experience is associated with lower carbon intensity, after controlling for firm financial variables and a set of fixed effects: firm fixed effects to control for time-invariant firm-level unobservables, year fixed effects to control for firm-invariant cross-section characteristics, CEO cohort fixed effects to capture time-invariant generational characteristics, CEO cohort-year fixed effects to control for time-varying generational characteristics, and industry-year fixed effects to filter out the impact of the changing environment that may be specific to each industry. On average, firms whose CEO had extreme weather experience during her impressionable years have lower Scope 1 carbon intensity by 49.72 tonnes per million dollars of sales than those whose CEO did not experience such events. The magnitude of the effect is equivalent to 13.9% of one standard deviation of Scope 1 carbon intensity in the sample. If considering a firm with average sales of $22,000$ million dollars per year, the reduction in direct emissions will be 1.09 million tonnes per year, which is 14.4% of the one standard deviation in the level of direct emissions of the sample. The baseline evidence supports the hypothesis that experiencing climate-related extreme weather events can raise climate awareness and encourage pro-environmental behaviours in the long term.

Then, I investigate whether the process of developing climate awareness from extreme weather experiences is facilitated by the understanding of climate science. First, I examine how people with and without any knowledge of climate change science respond differently to their experience. Although it is difficult to accurately pin down a person's level of knowledge, evidence suggests the 1980s is when the climate change science was first introduced to the public. First, the number of books mentioning "global warming" or "climate change" was virtually zero before the mid-1980s and grew rapidly afterwards. Second, as shown in Figure 3, the earliest poll results in climate opinions, which dates back to July 1986, show that 39% of the public has heard of the concept of greenhouse effect, which was by then strongly suspected to lead to dangerous global warming. Considering that college students may have better access to the latest science discovery than the average public, and that adding such a question to a general poll indicates significant attention to this issue, I assume that CEOs who attended college after 1980 were aware of the climate change science by the time, and those attended college before 1980 had no information. Consistent with the hypothesis that having basic knowledge of climate change helps developing climate awareness, I find that the emission reduction effect is driven by extreme weather experience occurred after 1980, while such experience gained before 1980 does not associated with lower carbon intensity. While the evidence is insufficient to tell whether a person can recollect her past experience and re-interpret after obtaining new information, it suggests even if such recollection happens, the effect is too small to impact her behaviour significantly, and this finding is in line with the theory of impressionable years, which predicts stable values and attitudes after early adulthood.

Next, to further analyse the role of information, I study whether inaccurate information affects the way in which experience shapes beliefs and behaviour. I find that in the full sample, the reduction in carbon intensity is driven by experience of "warming" extreme weather events, such as heat, wildfire and drought, while "non-warming" extreme weather events, including hurricanes, flooding and coastal events, have no significant impact on emissions. Furthermore, for experience gained between 1975 and 1990, "warming" weather events are negatively associated with carbon intensity, "non-warming" extreme weather events have no significant effect, and severe cold winter experience is associated with higher carbon intensity. To illustrate this, let us take two similar firms run by CEOs who belong to the same generation and went to college between 1975 and 1990 in the same state. If one CEO experienced "warming" extreme weather and another experienced severe cold winter, the average difference between their Scope 1 carbon intensity is 219.3 tonnes per million dollars of sales, equivalent to 60% of one standard deviation of carbon intensity in the sample. The results are consistent with the hypothesis that as "climate change" was primarily known as "global warming" until the 2000s, the phrasing creates two types of misunderstanding among the public. First, with the term stressing "warming" explicitly, people focused on signs that are directly related to rising temperatures, but largely overlooked other signs of climate change. For example, hurricanes have been found to become more frequent due to changes in the atmosphere, which is part of climate change, but since hurricanes are not direct manifestations of "warming", people who experienced hurricanes are less likely to conceive it as evidence of climate change or global warming. Second, overemphasizing the average "warming" trend led to a misunderstanding that cooler events "disprove" the theory. Therefore, some perceived extreme cold weather as evidence against global warming, potentially leading to disbelief in climate change and lower climate awareness.

I considered three alternative explanations. First, as college graduates tend to stay where they studied for work, common experiences between CEO and firms could drive the results. I rule out this explanation as including state-year fixed effects does not change the results. Second, the effect could be driven by persistent corporate environmental policies that are slow to adjust. To address this concern, I control for lagged ESG ratings and find the results are similar. Third, there may be endogenous matching between companies and CEOs on climate preference. To alleviate the concern, I examine changes in emissions around plausibly exogenous CEO turnover events caused by CEO deaths, illness or retirement, and find the results are robust. These findings support that the effect of CEO climate awareness on corporate emissions is likely to be causal.

Finally, I test whether the effect is robust when the extreme weather experience variable is constructed in alternative forms. I find the results are robust to 1) using the dollar amount of economic damage caused by those events as a continuous measure, and 2) grouping extreme weather experience into three terciles based on the value of economic damage, and I find the emission reduction effect is stronger for an extreme experience compared to a medium level experience.

Overall, the evidence shows that when a person experiences extreme weather events during her impressionable years, if she had access to information that causally relates such experience to climate change, her climate awareness is likely to increase. A high level of climate awareness developed during the impressionable years has a profound impact on behaviors. Firms run by CEOs with high climate awareness have lower carbon intensity, and evidence supports the causal relationship between CEO climate awareness and firm carbon intensity.

This study can contribute to two streams of literature in finance. First, it will join the rapidly growing yet still small literature in climate finance, especially in understanding how firms overcome short-termism to address climate challenges (Hong et al., 2020; Stroebel and Wurgler, 2021). Prior research has identified several factors that influence corporate emissions, such as firm ownership, listing status and financial constraints (Akey and Appel, 2021; Azar et al., 2021; Bolton and Kacperczyk, 2021a; Shive and Forster, 2020; Xu and Kim, 2022). In the meantime, executives and board members appear to have a say in corporate social responsibility policies. For example, Iliev and Roth (2021) find that foreign CSR regulations can spillover across borders via foreign connections of directors; Di Giuli and Kostovetsky (2014) show key persons' political affiliations impact firm CSR scores; and O'Sullivan et al. (2021) find that early life traumatic experience affects CSR scores. A recent study by Garel and Petit-Romec (2022) finds that reduction in corporate greenhouse gas emissions follows hot temperature, but faces challenges in distinguishing the cofounding impact on CEOs and other roles involved in the decision-making process. My study documents that CEO's personal climate awareness as a new determinant of corporate environmental policies. Importantly, my measure disentangles climate awareness from other preferences, such as financial risk preferences or the general attitude for pro-social behaviours. This measure helps to explain the heterogeneity of corporate greenhouse gas emissions, which is a more objective measure compared to CSR ratings.

The literature about the relationship between personal experience and managerial styles is also related to my study. For example, Bernile et al. (2017) study how early life disaster experience changes one's financial risk preference; Malmendier et al. (2011) find going through the Great Depression and having military experience systematically impact CEOs' financing decisions. My study adds to them by linking early adulthood extreme weather experience to decisions on environmental issues. In addition, most of the prior literature focuses on the influence of experience on the subconscious level, for example, traumatic experiences may heighten desires for interpersonal relationships (O'Sullivan et al., 2021). My results, on the other hand, show early adulthood experience also affects behaviour on the conscious level based on logical reasoning. Moreover, for the impact via logical reasoning, information can play a vital role. For an experience to affect one's behaviour decades later, the experience must first be internalized, and the way in which this is done depends on how people perceive the experience. When there is more than one way to interpret an event, one's interpretation is influenced by the information environment, including the level of related knowledge she has, and how others, such as media, talk about the event. Exploiting the time-varying information environment about climate change science, I find that climate-related extreme weather disaster experience only translates into climate awareness and pro-environment behaviour when the individual perceives it as a sign of climate change. These findings show that experience alone may not be sufficient to determine how it will influence managerial styles, understanding how people internalize their experience and the context in which they do so is as important as considering the experience itself.

The findings of this study suggest two actions that may help tackle the climate crisis. First, to improve the scientific knowledge to cohorts of CEOs who may have been exposed to inaccurate information in their impressionable years, providing education programs with up-to-date climate science may help to correct some misunderstandings, and raise their climate awareness, even the level of awareness to which they will develop may not be as high as those developed during impressionable years. Next, stopping misinformation about climate change is crucial to achieving wider consensus. Providing scientifically proven information to the public will not only help business executives, but also the wider community who must work together in dealing with the climate crisis.

The rest of the paper is organized as follows. Section 2 discusses the measure for CEO climate awareness. Section 3 develops hypotheses for empirical tests. Section 4 introduces data sources and presents summary statistics. Section 5 presents the main empirical results and Section 6 conducts robustness tests, then Section 7 concludes.

2 Measuring climate awareness

2.1 Opinion formation during the traditional college age

Traditional college ages, sometimes called "late adolescence" or "early adulthood", is a period during which people undergo significant development in multiple aspects, including cognitive functions, psychosocial development, and attitudes and values on complex issues (Mayhew et al., 2016). It coincides with "the impressionable years" of individual development, a period during which people are highly susceptible to changes in attitudes and values (Giuliano and Spilimbergo, 2014; Krosnick and Alwin, 1989). Although it is difficult to know for sure when people form their climate opinions, evidence in psychology and education literature indicates that traditional college time may be an important period.

First, forming opinions on complex issues such as climate topics requires high levels of cognitive function as it involves logically processing mixed evidence, making reasons, making good judgement and positioning oneself. Biologically, these functions rely on the frontal lobes in our brain, which are not fully developed until early or mid-20's (Stuss, 1992; Thompson et al., 2000). Consistent with the biological studies, it is well-established that significant development in cognitive functions is observed during the traditional college age (Mayhew et al., 2016). Therefore, while people may have started thinking about climate topics much earlier in their life, the formation of a self-sustained, thorough and comprehensive opinion is more likely to be formed during the traditional college age.

Second, in many people's experience, going to college exposes them to an environment that has greater diversity than anything they have ever experienced. Youths enter a period during which they explore various alternatives of identity, form initial commitments (Marcia, 1966), and possibly make more in-depth exploration, evaluate and adjust their initial commitments (Luyckx et al., 2006). Empirically, the college age is found an important period in developing racial and sexual identity, spiritual and religious identity, gender and sexual identity, as well as self-concept and social self-concept etc (see Mayhew et al. (2016) for a review).

Overall, while individuals' climate opinions can change throughout their life, theories and evidence in biological and psychological development indicate that the traditional college age is a plausible crucial period in the formation of attitudes towards complex social issues, including climate change.

2.2 Extreme weather experience and climate change information

To quantify the unobservable climate awareness of individuals, I develop a measure based on two elements - experience and information - that may facilitate the formation process of climate awareness. First, people may doubt the occurrence of climate change due to the gradual and slow change in climate is difficult for individuals to observe (Weber, 2016). One exception that makes climate risk salient is distinct extreme weather events, such as floods and hurricanes. Although any single extreme weather event may not be a direct result of climate change, it manifests scenes that can happen if climate change worsens, thus, may conceptually raise people's attention to the climate topic. Recent evidence in psychology shows that experiencing extreme weather events stimulates more discussions about climate change on social media, increases the willingness to take action against climate change, and increases the political support for green politicians (Bergquist et al., 2019; Rudman et al., 2013; Sisco et al., 2017). Similarly, investors react to abnormal weather and natural disasters by divesting high emission companies when experiencing abnormally high temperatures, being close to a disaster zone or experiencing air pollution (Alok et al., 2020; Choi et al., 2020; Huynh et al., 2021). This line of evidence indicates CEOs who experienced extreme weather events are likely to be more aware of the climate risk, less likely to deny the occurrence of global warming, and prone to take action in response to the climate crisis.

Second, extreme weather experience can only be translated into higher climate awareness if the person can causally relate the experience to the likelihood or severity of climate change perceptually (Weber, 2016). For people who are not experts in climate science, establishing such a connection relies on the availability of public information about climate change. When people were unaware of the theory of climate change, one may simply attribute extreme weather events to back luck. When climate change was primarily known as "global warming", one may only relate events with a rising temperature to climate change, such as heatwaves, but overlook other signs that manifest in different forms, such as more frequent and destructive hurricanes. Moreover, some may perceive extreme cold winter weather as counter-evidence to the climate change science, despite scientific research has found that the warming in the Arctic is likely to be a main reason for more frequent extreme cold in the northern hemisphere (Cohen et al., 2021).

Combining experience and information, I measure a CEO's climate awareness by her climate-related extreme weather experience during college and the availability of climate science information at that time. Importantly, this measure allows me to explore temporal variations in the availability of climate change information: the greenhouse gas effect attracted scientists' attention in the 1950s, but in the meantime, the aerosol pollution made some believe that the cooling effect of pollution would dominate the warming effect of burning fossil fuels. Meanwhile, the earth went through a slight cooling period from around the 1940s to the 1970s, as shown in Figure 1, fuelling the debate between cooling- and warming-prediction supporters. In the 1970s, although the majority of researchers predicted warming instead of cooling, mainstream media exaggerated a few pieces of evidence supporting the cooling prediction (Peterson et al., 2008), leading to confusion and potential misunderstanding among the public. In the 1980s, scientists formed a consensus on the occurrence of global warming, and books regarding the issue surged, as shown in 5, giving information access to the wider public. In the 1990s, the consensus was established on a wider basis, and 84 countries signed the Kyoto Protocol in 1997. From the 1970s to the late 1990s, the public was exposed to an information environment with mixed opinions by scientists, which were further biased in media reporting. This information environment could mislead people in interpreting their extreme weather experience. For the cohort of CEOs in recent decades, understanding the impact of information is particularly relevant, because a significant portion of them spent their impressionable years during the 1970s to the 1990s.

3 Hypothesis Development

To analyse the effect of CEO climate awareness on corporate emissions, the first question is to what direction extreme weather experience affects people's attitudes towards the environment. Many recent studies in climate opinions argue that witnessing extreme weather events makes people more aware of the climate risk, exhibit higher support for environmental-friendly policies and are more willing to accept higher tax rates in order to fight against the climate crisis (Bergquist et al., 2019; Egan and Mullin, 2017; Sisco et al., 2017; Weber, 2016). For example, using Hurricane Sandy as a natural experiment, Rudman et al. (2013) find college students who expressed negative implicit attitudes towards "green" policies reverted their attitudes after experiencing hurricane, and the change is larger among those who were significantly impacted by the disaster. However, most of these recent studies focus on attitude change in the short term, it is possible that the attitude will be reverted again in the long run. Therefore, I form my first hypothesis as follows:

Hypothesis 1. *CEOs with high climate awareness, measured by extreme weather experience during their impressionable years, will make more environmental-friendly decisions.*

If evidence supports Hypothesis 1, it will suggest experience of climate-related extreme weather are on average associated with pro-environment behaviours, but it is not enough to tell whether climate awareness is the channel via which the experience influences behaviour. An alternative is that people who experienced extreme weather may be traumatized and become more risk-averse, which results in a reduction in investment when they become CEOs. However, the traumatic experience explanation is based on an instinctive response to disasters, so whether the person attributes the disaster to climate change or bad luck should not change the effect. On the contrary, the climate awareness explanation is based on conscious reasoning that logically links disaster experience to human-made climate change, therefore, the interpretation process relies on information that allows the person to draw such a causal conclusion. Hence, I form the next three hypotheses that will test the role of information in the formation of climate awareness:

Hypothesis 2. *If evidence supports Hypothesis 1, the effect should be stronger among CEOs who had information about climate change when experiencing those events.*

Hypothesis 3. *When climate change was primarily known as "global warming", The effect should be* *stronger in CEOs who experienced warming, compared to non-warming extreme weather events.*

Hypothesis 4. *When climate change was primarily known as "global warming", the effect of experiencing extreme weather that directly relates to "warming" may be opposite to the effect of experiencing extreme cold winter weather.*

Overall, testing Hypothesis 1 will establish the association between CEO extreme weather experience and corporate greenhouse gas emissions, and testing Hypothesis 2, 3 and 4 will shed light on whether the climate awareness is likely to be the channel via which CEOs' extreme weather experience affects corporate decisions.

4 Data and sample

4.1 Sample construction

I start from corporate emissions data collected from Thomson Reuters' ASSET4. Following the Greenhouse Gas Protocol, CO2 equivalent emissions can be measured in three scopes: Scope 1 emissions, which measures the direct emissions produced by establishments controlled by the firm. Scope 2 emissions are indirect emissions related to the energy consumption of the firm, such as electricity and heat. Scope 3 emissions measure the emissions caused by the operation of the firm but produced by other entities, covering a wide range from the extraction of materials, transportation and emissions associated with the use of the sold goods by end-users. The Thomson Reuters' ASSET4 reports Scope 1 emission as "CO2 Equivalents Emission Direct" in data item *En_En_ER_DP024*, Scope 2 emission as "CO2 Equivalents Emission Indirect" in data item *En_En_ER_DP025*, and Scope 3 emissions alone as "CO2e Indirect Emissions, Scope 3" in data item *En_En_ER_DP096*.

My sample includes the universe of US listed firms that 1) reported at least one emission measure in any year during the sample period of 2002 to 2020, and 2) have at least one CEO with an undergraduate degree awarded by a US institution after 1960. I exclude utilities (SIC 4900 to 4999), financial (SIC 6000 to 6999) and governmental firms (SIC 9000 to 9999) because their business activities face different regulations from others.

CEO information and education records are obtained from BoardEx. In my sample, 90% of CEOs finished their undergraduate studies at or before the age of 23, therefore, I focus on

Associate's degrees and Bachelor's degrees such that their disaster experience is measured at a similar age. Based on the graduation time, I infer the college start time by assuming that an Associate's degree takes 2 years to complete and a Bachelor's degree takes 4 years. To be able to construct the disaster measures using US natural disaster data, I require the CEO to receive at least one Bachelor's degree in the United States that started no earlier than 1960. ZIP codes of degree granting institutions are from BoardEx, the Integrated Postsecondary Education Data System of the National Centre for Education Statistics [2], and Google search as a last resort. I map ZIP codes into county FIPS using HUD USPS ZIP Code Crosswalk Files[3] managed by the US Department of Housing and Urban Development.

County level natural disaster data since 1960 is obtained from the Spatial Hazard Events and Losses Database (SHELDUS)[4] managed by Arizona State University. I define 6 types of disasters as climate-related extreme weather events: heat, wildfire, drought, hurricane, flooding and coastal hazards. For each type of hazard and each county-year pair, I use the aggregate dollar losses from crop damage and property damage in 2019 dollars.

To measure an individual CEO's exposure to natural disasters, I compute the average economic damage, defined as the sum of crop damage and property damage, over the college education period for each type of hazard. For CEOs who received multiple undergraduate degrees from institutions in different counties, I take the average over those county-year pairs.

4.2 Summary statistics

All variables are winsorized at the 1% and the 99%. The final sample includes 3,050 firm-year observations with 532 unique firms and 737 CEOs. Table 1 reports summary statistics of corporate emission measures. The average firm in my sample generates 2.542 million tonnes of direct (Scope 1) CO2 equivalent emissions per year, 0.963 million tonnes of Scope 2 emissions, and 15.919 million tonnes of Scope 3 emissions. Carbon intensity is defined as CO2 equivalent emissions (tonnes) divided by annual revenue (million dollars). The carbon intensity for the average firm is 146.008 tonnes per million dollars of revenue for direct emissions. 65.185 for Scope 2 emissions and 561.182 for Scope 3 emissions. For Scope 1 emissions, the summary statistics

[2] https://nces.ed.gov/ipeds
[3] https://www.huduser.gov/portal/datasets/usps_crosswalk.html
[4] https://cemhs.asu.edu/sheldus

of my sample are largely comparable to those of Bolton and Kacperczyk (2021a). The summary statistics for the growth rates of Scope 2 and Scope 3 emissions, and the carbon intensity of Scope 3 emissions are different from theirs. There are at least four reasons that may contribute to the difference. First, Bolton and Kacperczyk (2021a) use Trucost as the primary data source for emission data while I use Thomson Reuters' ASSET4. Second, their sample period is from 2005 to 2017 and mine is from 2002 to 2020. Third, as Scope 2 and Scope 3 emissions are not directly controlled by the firm, there may be estimation errors when reporting these two measures. Fourth, as emissions reporting is not mandatory for all firms, only a fraction of companies report Scope 3 emissions which may lead to selection bias. In the following analysis, I will focus on measures based on direct emissions as they exhibit better data quality.

To study whether and how climate-related disasters shape CEO's climate policies, I focus on hazards that satisfy the following two criteria: first, scientifically, the hazard has been related to climate change. A counterexample is earthquakes where there is no consensus supporting the direct impact of climate change on earthquakes. Second, perceptually, the hazard is likely to draw people's attention to climate risk when it occurs. For example, recent studies find extreme winter weather has become more frequent and severe due to climate change (Cohen et al., 2021), however, by the time most CEOs in my sample attended college, climate change was known as "global warming", thus, people may not be aware of climate change risk when experiencing unusual snowing and cold weather. Based on these two criteria, I define coastal events, drought, flooding, heat, hurricane and wildfire as climate-related extreme weather events. Among these six types of hazards, most are not directly fatal, resulting in a lack of variation in CEOs' experience when measured by fatalities and injuries, therefore, I will focus on economic damage in my analysis.

I create a variable *Extreme weather experience* that equals 1 for a CEO if, during her undergraduate studies, the county where she attended college suffered economic damage caused by climate-related extreme weather disasters, and otherwise 0. Alternative to this main measure, I divide CEOs into three groups based on the intensity of their experience. Specifically, CEOs whose economic damage measures are in the top tercile among the sample are in the group of "Top tercile economic damage experience", and the rest are grouped into "Middle tercile Extreme weather experience" and "Bottom tercile Extreme weather experience" accordingly. To investigate how the fact that climate change was largely known as "global warming" before the 2000s, I further divide extreme weather events into two categories: warming disasters and non-warming disasters. Warming disasters include heat, wildfire and drought, which are direct signs of rising temperatures. Non-warming disasters include flooding, hurricane and coastal hazards, which have been proved to be consequences of climate change, but may be overlooked if someone only focuses on signals of "warming". Furthermore, to investigate whether "warming" experience and "cooling" experience have different effects, I categorize CEOs' experience in severe cold winter that caused economic damages into top, middle and bottom tercile. Summary statistics of these experience measures are shown in the top part of Table 3. In my sample, 76.5% of CEOs experienced climate-related extreme weather events. The average economic damage caused by these hazards is 4.627 million dollars, measured in 2019 constant price, the standard deviation is large, suggesting substantial variation across individuals. CEOs who experienced warming disasters are much fewer, they account for 15.9% of the sample. 83% of CEOs experienced severe winter weather, but the economic damage caused by those events is as small as 0.825 million dollars per year, hence, I focus on relatively destructive severe winter weather - those of which the economic damage is among the top two-third of the CEO sample.

5 Empirical results

5.1 Baseline: The effect of CEO extreme weather experience on corporate emissions

Due to the gradual and slow nature of climate change, the climate risk is usually not salient except when abnormal weather events happen. Prior research has found multiple evidence of sentiment changes around the occurrence of natural disasters. By observing the consequence of climate change, one may raise awareness and would like to take pro-environment actions to lower the risk of future disasters. Therefore, I form Hypothesis 1 by conjecturing that the CEO's experience of climate-related extreme weather is negatively correlated with firm greenhouse gas emissions. I test the hypothesis with a fixed effect regression of corporate emission variables on the CEO's disaster experience measures:

$$Emissions_{i,t} = a_0 + a_1 CEODisasters_{i,t} + a_2 Controls_{i,t} + \mu_t + \gamma_i + \theta_{i,t} + \lambda_{i,t} + \epsilon_{i,t} \quad (1)$$

where $Emissions_{i,t}$ stands for a generic emission measure of firm i in year t, it can be $log(emissions)$, growth rate of emissions or carbon intensity, and can be measured at different scopes of emissions. In the following analysis, I focus on Scope 1 (Direct) emissions due to higher data quality. $CEODisasters_{i,t}$ is the dummy variable that measures CEO's experience of climate-related extreme weather events associated with firm i at time t. $Controls_{i,t}$ includes a set of firm characteristics that reflects the financial position the CEO faced when making environmental decisions. In my baseline regression, I include $TotalAssets_{t-1}$, $Book-to-market_{t-1}$, RoE_{t-1}, PPE_{t-1} as a measure for asset tangibility, $BookLeverage_{t-1}$ computed as book debt divided by book assets, $Tobin'sQ_{t-1}$ to control for investment opportunity that the CEO faced at the beginning of year t. Three fixed effects are included in the model: μ_t stands for year fixed effects that control for the growing pressure on environmental issues imposed by the public and regulators. γ_i are firm fixed effects that allow me to explore how a specific firm behave differently when running by CEOs with different disaster experience. $\theta_{i,t}$ represents CEO cohort fixed effect measured by the birth year of CEO, filtering out the common characteristics shared by the same generation of CEOs. $\lambda_{i,t}$ stands for industry-year fixed effects controlling for the changing dynamics within each industry, using the 2-digit NAICS industry classification.

Table 4 presents results from the baseline regression where the dependent variables are carbon intensity of direct emissions in Columns (1) to (4), the natural logarithm of direct emissions in Column (6), and the annual growth rate of direct emissions in Column (7). Firm fixed effects and year fixed effects are included in all specifications. CEO cohort fixed effects are controlled at the birth year level in Columns (2), (4), (5), (6) and (7). In Column (4), CEO cohort fixed effects are additionally controlled as the decade in which the CEO started her undergraduate studies (i.e., the 1960s, 1970s, 1980s, 1990s and 2000s), absorbing the potential time-varying environment that CEOs were exposed to during college. In Column (3), I replace indicators for CEO generation with CEO age and the squared term of age to allow for a non-linear pattern associated with age. In Column (5), I also control for CEO cohort-year fixed effects which allows the cohort effect to be time-varying, and this accounts for the case where the earlier generations of CEOs who did not have opportunities to learn knowledge about climate change at school may still become more climate-aware later in their life as the science develops, but their average attitudes may be different from other generations. All standard errors are clustered at the firm level.

Columns (1) to (5) of Table 4 provide evidence that CEO's extreme weather experience has a significant impact on corporate carbon intensity. Specifically, Column (2) shows that, when controlling for firm, year and CEO cohort fixed effects, compared to firms run by CEOs without extreme weather experience, having a CEO with extreme weather experience lowers Scope 1 carbon intensity by 49.72 tonnes per million dollars of sales, the coefficient is statistically significant at 99% and also economically considerable: the reduction in carbon intensity is equivalent to 13.7% of one standard deviation of carbon intensity in the sample. Considering an average firm with annual sales of 21,959 million dollars, the reduction in direct emissions is $21,959 \times 49.72 = 1.091$ million tonnes, equivalent to about 14.4% of one standard deviation of direct emissions in the sample. The explanatory power of the model and the results are similar when adding the education start time fixed effects in Column (4), using the second-order polynomial of age in Column (3), or controlling for CEO cohort-year fixed effects in Column (5). Columns (6) and (7) find no significant relation between CEO extreme weather experience the logarithm of direct emissions or the growth rate of direct emissions.

5.2 Availability of information and awareness of climate change science

In this section, I investigate the mediating role of information and how it facilitates the translation from extreme weather experience to climate awareness and subsequent pro-environmental behaviours. As shown in 2, the terms "climate change" and "global warming" started to appear frequently in books in the 1980s, giving the public access to information about climate change science. If the effect captured in the baseline regression is indeed induced by climate awareness, then without the basic knowledge of climate change, a person who experienced extreme weather should not be able to relate her experience to the climate crisis, and thus, not likely to develop climate awareness in her perception. However, if what the experience induced is a general change at the subconscious level, then the effect will not depend on information. Additionally, although it is possible for someone to recollect her past experience, recent events usually have a stronger influence on human minds compared to distant events, so even a person is able to recall her past experience after learned the idea of climate change, the impact of such memory should be smaller than an otherwise similar recent experience. Assuming that college students after 1980 would have at least some information about climate change (or global warming), I interact an after-1980 dummy variable with the extreme weather experience variable, as shown in the following equation:

$$Emissions_{i,t} = a_0 + a_1 CEODisasters_{i,t} + a_2 CEODisasters_{i,t} \times After1980_{i,t} + a_3 Controls_{i,t} + \mu_t + \gamma_i + \theta_{i,t} + \lambda_{i,t} + \epsilon_{i,t} \quad (2)$$

where $After1980_{i,t}$ equals 1 if the CEO of firm i at time t entered college in or after 1980, and otherwise 0. μ_t, γ_i, $\theta_{i,t}$ and $\lambda_{i,t}$ control for time fixed effects, firm fixed effects, CEO cohort (education decade) fixed effects and industry-year fixed effects, respectively. I also split the sample into CEOs educated before and after 1980 and perform a similar analysis without the interaction term.

Table 5 presents the results and provides support for Hypothesis 2. Columns (1) to (3) show the effect found in Table 4 is driven by CEOs who had extreme weather experience after 1980. When looking at the full sample, as shown in Column (1), having extreme weather experience alone does not lead to lower carbon intensity, but if the experience occurred after 1980, such experience is associated with lower carbon intensity. For two otherwise similar CEOs who both had extreme weather experience, but one was before 1980 and another was after 1980, the difference in the Scope 1 carbon intensity of their firm could be as large as 130 tonnes per million dollars of sales, roughly 35% of one standard deviation of carbon intensity in the sample. In the subsample of CEOs who went to college before 1980, as shown in Columns (2), there is no significant difference in the carbon intensity of firms run by CEOs with different extreme weather experiences. But in the subsample of CEOs that went to college after 1980, those who had extreme weather experience are associated with lower carbon intensity by 44.26 tonnes per million dollars of sales, roughly 12% of one standard deviation. Using the logarithm of Scope 1 emissions as the dependent variable in Columns (4) to (6), extreme weather experience are associated with fewer emissions by roughly 51% among CEOs who went to college after 1980, but the effect is not significant for CEOs educated before 1980, consistent with findings in carbon intensity.

Results of Table 5 show that the effect of extreme weather experience depends on the availability of proper information. In other words, whether extreme weather experience can translate into climate awareness hinges on whether the CEO was able to perceptually link the event to climate change at the time of the event. While the results cannot fully rule out the possibility of recollecting experience and gaining climate awareness later on, Columns (1) and (2) suggest this effect is not significant enough to be detected. The fact that extreme weather experience must be combined with information to impact managerial behaviours indicates the effect is not an instinctive reaction, instead, it is a process involving interpreting and making reasons for one's experience.

5.3 Inaccurate information and misinterpretation: the different effects of warming, non-warming disasters and severe winter weather

When climate change science was first introduced to the public in the 1980s, the information passed on to the public looked different from today's consensus. First, the term used primarily was "global warming" instead of "climate change". Second, in the 1970s, although more and more scientists started to predict the warming effect from greenhouse gas would dominate the cooling effect of aerosol pollution, the mainstream media coverage did not reflect this gradually developing consensus, instead, they exaggerated a few research predicting cooling (Peterson et al., 2008). Meanwhile, the earth experienced a slight decrease in surface temperature during the 1970s, as shown in Figure 1. The phrasing of "global warming" and the reporting of cool weather together expose the public to an inaccurate information environment that may cause at least two types of misunderstandings. First, as the phrase "global warming" highlights "warming", some believe everything must warm for the entire science to be real, therefore, reporting that emphasizes cooling and experience associated with extremely cold winter may lead to climate change denial. Second, some may only take weather related to high temperatures as evidence supporting the theory of global warming, but overlook other types of extreme weather that manifest in different forms. To test Hypothesis 3 and Hypothesis 4, I divide the six types of climate-related extreme weather into two categories: heat, wildfire, and drought are classified as "warming disasters" as they are likely to be associated with the warming effect conceptually, and the other three (flooding, coastal events and hurricane) are "non-warming disasters". Furthermore, I construct variables for experiences of severe winter weather based on the economic damage caused by those events. Equation 3 is the regression equation:

$$Emissions_{i,t} = a_0 + a_1 CEODisasters_{i,t} + a_2 Controls_{i,t} + \mu_t + \gamma_i + \theta_{i,t} + \lambda_{i,t} + \eta_{i,t} + \epsilon_{i,t} \quad (3)$$

where $CEODisasters_{i,t}$ are variables for CEO experience in different types of disasters, $Controls_{i,t}$ are the set of control variables identical to those in Equation 1. μ_t, γ_i, $\theta_{i,t}$ and $\lambda_{i,t}$ control for time fixed effects, firm fixed effects, CEO cohort (birth decade) fixed effects and industry-year fixed effects, respectively. Since warming disasters and severe winter weather are distributed unevenly across states, I additionally control for fixed effects for the state where the CEO attended college, denoted by $\eta_{i,t}$.

Table 6 report the results. In Column (1), I try to disentangle the effect of warming disasters, non-warming disasters and severe winter weather in the full sample. The results show that only experience in warming disasters predicts lower Scope 1 carbon intensity, and the effect size is comparable to that in the baseline tests. Next, I focus on the sample of CEOs who started their college from 1975 to 1995, a period during which evidence about global warming was mixed, and the public lacked consistent scientific information about the matter. In Column (2), I perform the baseline regression with the addition education state fixed effects on the subsample of CEOs educated during 1975 to 1995, and find a similar result that climate-related extreme weather experience is negatively associated with carbon intensity. In Column (3), I repeat the regression in Column (1) on the subsample of 1975 to 1995. The result shows the negative effect of warming disaster experience on carbon intensity is particularly strong, and non-warming extreme weather experience has no such effect. In addition, experience of severe winter weather which damage is among the top one-third of the sample is significantly positively related to carbon intensity. Consider two similar firms run by CEOs who belong to the same generation and both went to college between 1975 and 1995 in the same state, with the exception that one experienced warming disasters and another experienced destructive winter weather, the average difference between their carbon intensity is 223 tonnes per million dollars of sales, roughly 61% of one standard deviation of carbon intensity in the sample.

In general, Table 6 show that experience of extreme weather events that are conceptually linked to "global warming" are more likely to translate into climate awareness and subsequent pro-environment decisions, compared to other climate-related extreme weather events of which the relation to global warming was not manifested directly. When the public information about climate change was not consistent and potentially inaccurate, the effect of such misunderstanding is particularly large. A caveat to the analysis of misunderstanding is that it may not apply to the future generation of CEOs. With the development of climate change science, scientists and mainstream media are no longer overlooking no-warming signals of climate change, thus, the younger generation is less likely to suffer from inaccurate information. However, because there are limited numbers of CEOs who were educated after 1990, the current sample is unable to test the change of effect of non-warming disasters.

6 Robustness Tests

6.1 CEO-Firm matching on climate preferences

In the past two decades, there were rapid changes in regulations and public pressures on climate policies on firms, which may alter the optimal environmental policy for companies over time. Given the time-varying optimal policy, firms may prefer different types of CEOs at different times, and this within-in firm heterogeneity is not captured by firm fixed effects, resulting in the possibility that the effect captured by my measure is in fact driven by the endogenous matching between CEO and firm.

With the caveat that CEO assignment is naturally a matching process, I try to alleviate the endogeneity concern by examining changes in corporate emissions around plausibly exogenous CEO turnover. I use an open-source database for CEO turnover events of S&P 1500 firms by Gentry et al. (2021) (Version 2021.08.31), which classifies CEOs' departing reasons into eight categories: CEO death, CEO illness, dismissed for job performance, dismissed for personal issues, CEO retirement, CEO seeking new opportunities, other reasons and unclear reasons. Among these eight categories, CEO turnover due to the death, illness or retirement of the incumbent CEOs is usually considered as largely exogenous by prior literature. To the extent that the timing of these CEO turnovers is largely exogenous and the available candidate pool is limited, these turnover events create exogenous variations in the CEO assignment process. Therefore, I constructed a subsample of outgoing CEOs and incoming CEOs involved in plausibly exogenous CEO turnovers. To be included in the subsample, I require there are at least 2 years of observations both before and after the turnover year, which leaves me 51 CEO turnover events, among which 19 cases involve changes in CEOs' extreme weather experience if measured by the binary variable "Extreme weather experience (1/0)", and 30 cases involve changes if measured by the tercile of economic damage caused by extreme weather events.

Table 7 shows the results. Compared with the baseline result, the effects of extreme weather experience, as well as the terciles associated with the economic damage of extreme weather experience, have similar statistical significance to those in Table 4 and Table 10. The magnitude of coefficients is larger, potentially caused by the limited size of the subsample. The result provides support for the causal relationship between CEO extreme weather experience and corporate carbon intensity.

6.2 Distinguishing the effect of firm location

A potential endogeneity that may bias the baseline regression arises from companies' choices of locations. Specifically, there are two possible channels. First, Bound et al. (2004) document a mild but positive association between the number of degree recipients in a state and the long-term education rate of the state's population, revealing graduates' tendency to stay in the area where they studied after graduation. A firm whose CEO is a graduate from the same state may have experienced the same climate natural disaster as its CEO, and such experience can have an impact on the firm's emission policy via non-CEO channels, such as local investors' ESG taste, local customers' preferences, local regulations or local energy supply. Second, firms' locations could affect their access to financing, and thus the availability of resources that can be devoted to emission management. Bartram et al. (2022) and Xu and Kim (2022) show that financially constrained firms behave differently from unconstrained firms in terms of carbon emissions and toxic release. Meanwhile, Dougal et al. (2021) find that "glamour" cities, typically featured with pleasant weather and high education rate, host headquarters of firms with higher stock market valuations on average, and provide more IPO opportunities for young firms. This evidence suggests firms' emission decisions may differ systematically across cities, as firms located in superior locations may enjoy better external financing opportunities and be able to allocate more resources to environmental policies.

To alleviate this concern, I incorporate corporate headquarter state-year fixed effects to the baseline regression, filtering out omitted variable that affects firms headquartered in the same state simultaneously. Table 8 shows results that are similar to the baseline regression with slightly larger coefficients. Specifically, Column (2) suggests that after controlling for firm, year, CEO cohort, firm headquarter state-year and industry-year fixed effects as well as the standard set of controls, compared to a CEO with no extreme weather experience, those went through such disasters do translate the experience into higher climate awareness, reflecting in a lower carbon intensity by 69.02 tonnes per million dollars of sales, equivalent to 19% of one standard deviation in the distribution of carbon intensity.

6.3 The persistence of corporate environmental policies

While previous results have shown a robust relationship between CEO climate experience, information and corporate emissions, it is possible that the stickiness of ESG policies drives the results. Therefore, I include 1-year lagged Refinitiv ESG ratings and sub-ratings of each category as control variables. If the coefficient of the variable of interest remains unchanged, it will alleviate two concerns. First, the stickiness of environmental policy may reflect the preferences of other stakeholders, such as shareholders, of the firm. To the extent that other stakeholders of the firm usually do not change much from time to time, controlling for past ESG ratings allows me to disentangle the change made by the CEO from the potentially long-lasting impact of others that are already in place. Second, the environmental policy itself, no matter made by who, has inertia and is sticky, which means corporate emissions do not solely reflect the decision of the current CEO, instead, it may be a cumulative result of previous decisions that made by other managers.

Column (1) of Table 9 controls for the 1-year lagged Refinitiv Overall ESG score, Column (2) controls for the 1-year lagged Environmental score, and Column (3) includes all three sub-scores for Environment, Social and Governance. Results suggest past ESG ratings do not explain the effect of extreme weather experience on corporate emissions. The coefficients of extreme weather experience are robust in these three specifications, and the magnitudes are similar to the baseline regressions. This finding shows that CEOs do change environmental policy based on their personal climate awareness, and the effect is incremental to any policy in place. As past ESG ratings at least partially reflect the long-term preference of other stakeholders, this finding confirms the change in carbon intensity is indeed driven by CEOs instead of other parties who can also influence corporate policies.

6.4 Alternative measures of extreme weather experience

In the baseline specification, CEO extreme weather experience is coded as a binary variable, in this section, I test two alternative forms of the measure. First, I use a continuous variable representing the logarithm of the value of economic damages caused by extreme weather a CEO experienced. As shown in Columns (1) and (2) of Table 10, a CEO whose extreme weather experience caused greater economic damage to the county where she studied will make more environmental-friendly emission decisions. In particular, when controlling for firm, year, CEO cohort and industry-year fixed effects, as the specification in Column (2), a 1% increase in the economic damage associated with a CEO's extreme weather experience is associated with a drop in carbon intensity of the firm by 10.20 tonnes per million dollars of sales, which is roughly 2.8% of one standard deviation of carbon intensity of the sample. The results suggest that extreme weather experience, as a measure for climate awareness, can be constructed as a continuous variable which allows for more heterogeneity across individuals and finer analysis on how climate awareness impacts people's behaviours. The second alternative measure is dividing CEOs into three groups: those who experienced extreme weather events of which the economic damage is among the top one-third of the sample are defined as having "Top tercile Extreme weather experience", the middle one third as having "Middle tercile Extreme weather experience" and the bottom one third as having "Bottom tercile Extreme weather experience". Using the bottom tercile as the base group, Columns (3) and (4) of Table 10 show that both top tercile and middle tercile experience leads to lower carbon intensity, and the effect is stronger for the top tercile experience, this is probably due to more salient demonstration of the consequence of climate change can induce stronger climate awareness.

7 Conclusion

The paper examines the effect of CEO climate awareness on corporate greenhouse gas emissions. Two elements that facilitate the formation of climate awareness are considered: climate-related extreme weather experience and the availability of information about climate change at the time of the experience. With support from the theory of impressionable years, I focus on experience gained during CEOs' college, a period that is critical in opinion formation. I find that firms whose CEO experienced climate-related extreme weather have lower Scope 1 carbon intensity, suggesting that such experience may increase climate awareness and encourages pro-environment decisions. Furthermore, having information that allows people to properly interpret their experience is as important as the experience itself. For CEOs who are unlikely to know the science of climate change when they experienced climate-related extreme weather, such experience does not translate into higher climate awareness and more environmental-friendly decisions. For CEOs who may misunderstand the term "global warming", only extreme weather that was directly related to rising temperatures makes them reduce their corporate emissions, and experiencing severely cold winter leads them to increase greenhouse gas emissions. Robustness tests rule out alternative explanations and suggest the reduction effect of CEO climate awareness on corporate greenhouse gas emissions is likely to be causal.

The study finds CEO climate awareness as a new determinant of corporate greenhouse gas emissions. In addition, it shows that such awareness is shaped by experience and information together. For experience in climate-related extreme weather to translate into climate awareness and environmental-friendly behaviours, the person needs information that allows her to interpret the experience as causally related to climate change. This finding is particularly relevant for CEOs in the recent decades as a significant percentage of them may have been misled by inaccurate climate change information during their impressionable years. The paper also points to the importance of stopping misinformation in the effort of tackling the climate crisis.

There are a few directions that I may pursue with further analysis. First, does compensation differ between high-awareness and low-awareness CEOs? Is hiring a high-awareness a cheap way to implement pro-environmental policy? Second, how do CEOs cut carbon intensity? Lower carbon intensity indicates a transition towards low-carbon-high-price products. Do CEOs dispose assets to achieve that? Third, do the announcement returns of CEO appointments differ based on the new CEO's climate awareness. Fourth, as the current sample is mainly restricted by the limited data in corporate emissions. If data is available, it would be interesting to test on CEOs who went to college after the 1990s, who may have more accurate information of climate change during their impressionable years.

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Tables and Figures

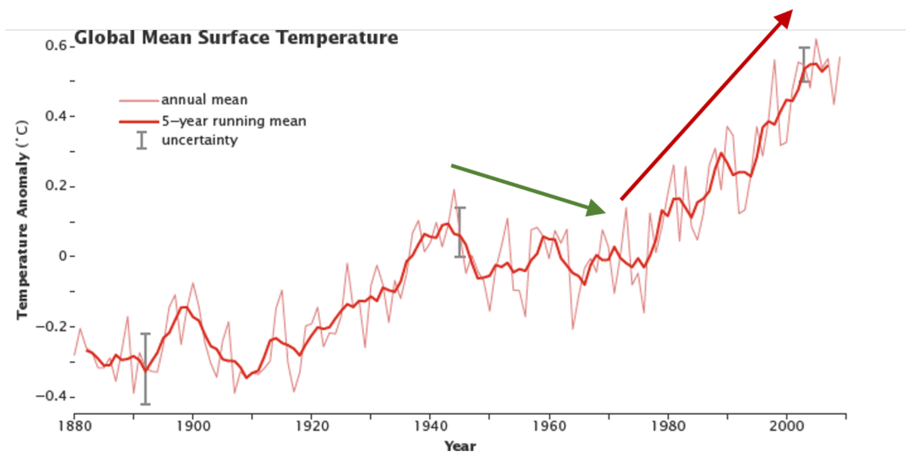

Figure 1. Global average surface temperatures (source: NASA)

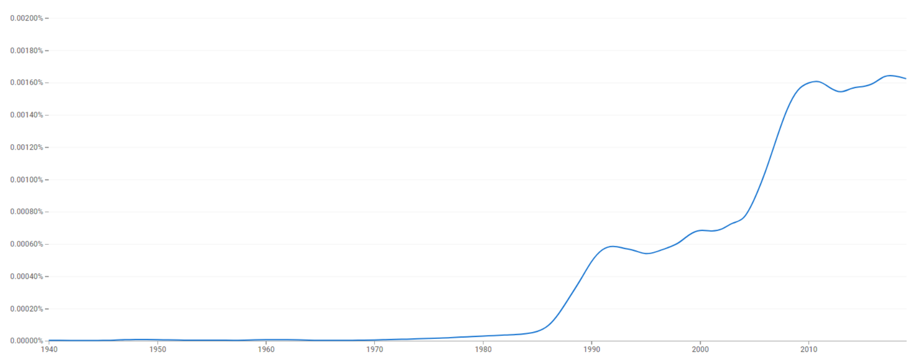

Figure 2. The frequency of "climate change" and "glocal warming" in books written in English (source: Google Ngram)

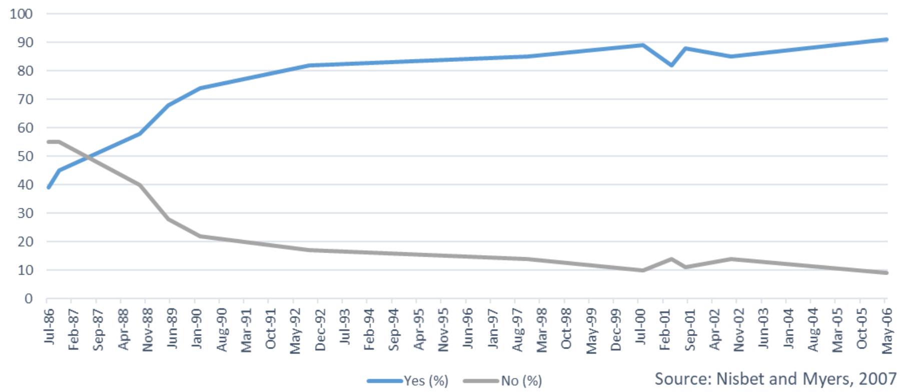

Figure 3. Poll results: percentage of Americans that are awareness of global warming as a problem in the US

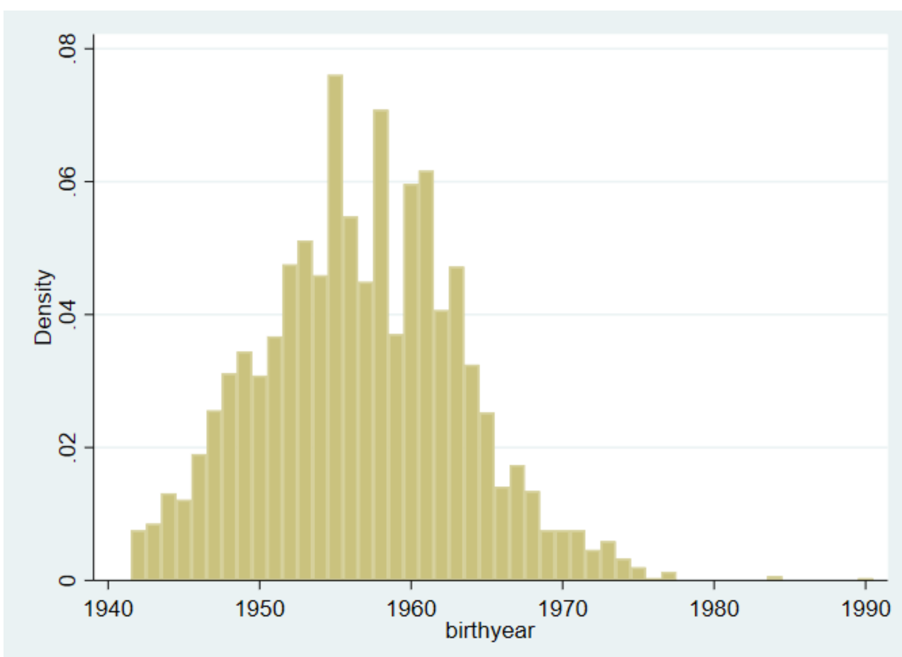

Figure 4. Histogram of CEO birth year

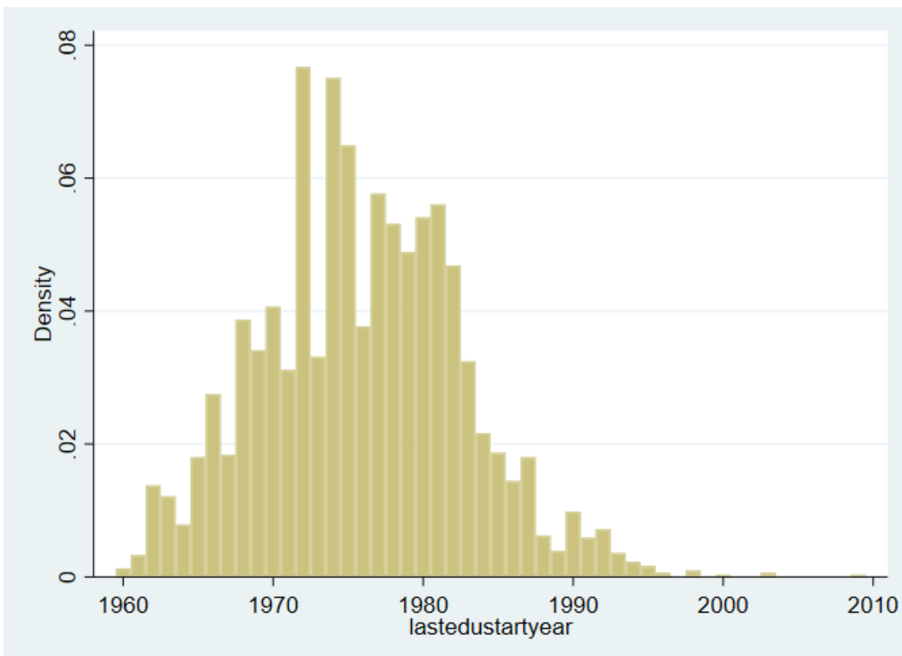

Figure 5. Histogram of CEO college education start year

Table 1. Summary statistics of corporate emissions

This table shows summary statistics of corporate greenhouse gas emissions measures and Refinitiv ESG scores. Firm-level emission data is from Refinitiv Asset4. The sample spans from 2003 to 2020 including all firm-year observations that have non-missing value in at least one scope of emission, and have a CEO received undergraduate education in the United States after 1960. Direct (or Scope 1) emissions are emissions produced directly by facilities controlled by the firm. Scope 2 emissions are indirect emissions related to energy consumption of the firm, such as electricity and heat. Scope 3 emissions are emissions caused by the operation of the firm but produced by other entities. Carbon intensity is measured by emission divided by the annual revenue. ESG scores are from Refinitiv Asset4. All continuous variables are winsorized at 1% at each side.

	Count	Mean	Median	Std.dev	Q1	Q3
Direct emissions (million tonnes)	2539	2.542	0.167	7.596	0.029	0.904
Log(Direct emissions)	2539	11.982	12.024	2.715	10.280	13.714
Carbon Intensity Direct emissions	2539	146.008	15.293	363.076	4.065	87.682
Growth rate of Direct emissions	1964	0.506	0.000	16.305	-0.073	0.089
Scope 2 emissions (million tonnes)	2489	0.963	0.279	1.900	0.076	0.915
Log(Scope 2 emissions)	2489	12.421	12.539	1.833	11.241	13.727
Carbon Intensity Scope 2 emissions	2489	65.185	26.449	154.366	12.826	58.559
Growth rate of Scope 2 emissions	1926	0.139	-0.012	4.783	-0.081	0.049
Scope 3 emissions (million tonnes)	1307	15.919	0.145	58.644	0.028	2.461
Log(Scope 3 emissions)	1307	12.388	11.881	3.298	10.252	14.716
Carbon Intensity Scope 3 emissions	1307	561.182	15.585	2449.748	3.267	166.181
Growth rate of Scope 3 emissions	972	21.884	0.019	406.737	-0.087	0.201
Total emissions (million tonnes)	1241	21.423	1.145	70.001	0.220	9.145
Log(Total emissions)	1241	14.212	13.951	2.385	12.303	16.029
Carbon Intensity Total emissions	1241	745.269	85.499	2659.726	31.707	497.661
Growth rate of Total emissions	920	0.378	0.000	3.237	-0.064	0.085
Overall ESG score	3050	0.808	0.893	0.193	0.746	0.941
Environmental score	3050	0.754	0.856	0.225	0.645	0.925
Corporate governance score	3050	0.832	0.876	0.137	0.786	0.928
Social score	3050	0.722	0.794	0.219	0.594	0.899

Table 2. Summary statistics of corporate financials

This table presents summary statistics of corporate financial information for observations where the Scope 1 emission is not missing. $Log(1 + TotalAssets)$ is the natural logarithm of 1 plus total assets (in million dollars). $Sales$ is the annual revenue in million dollars. $Leverage$ is book value of debt divided by book value of assets. $Tobin'sQ$ is computed as total assets plus common equity liquidation value minus the book value of common equity, then divided by total assets. RoE is return on equity. $Log(1 + PPE)$ is the natural logarithm of 1 plus net PPE (in million dollars). All variables are winsorzed at 1% each side.

	Count	Mean	Median	Std.dev	Q1	Q3
Log(1+Total assets)	2539	9.419	9.407	1.328	8.471	10.309
Sales (mil$)	2539	23731.074	8570.000	40513.830	3653.000	21848.000
Leverage	2375	0.241	0.221	0.119	0.151	0.309
Tobin's q	2539	2.057	1.720	1.105	1.322	2.435
RoE	2539	0.030	0.050	0.132	0.028	0.071
Log(1+PPE)	2539	7.843	7.739	1.645	6.660	9.077

Table 3. Summary statistics of CEO experience and characteristics

This table presents summary statistics of CEO extreme weather experience and other characteristics of the 737 unique CEOs in the sample. 6 types of natural disasters are defined as climate-related extreme weather events: coastal events, drought, wildfire, heat, hurricane and flooding. *Extreme weather experience* equals 1 if, during a CEO's undergraduate studies, the county where she attended college suffered economic damage resulted from the above events, and otherwise 0. *Top (Middle) tercile extreme weather experience* equals 1 if the total economic damage of these events is at the top (middle) one third of all CEOs in the sample, and otherwise 0. *Economic damage experience* is the total economic damage (corp damage and property damage) caused by these events, measured in million dollars at 2019 constant price. *Warming disaster experience* uses a narrower definition of climate-related disasters: drought, wildfire, and heat; and the measures equals 1 if a CEO experienced economic damage caused by these three disasters during her college. *Top (Middle) tercile non-warming disaster experience* equals 1 if the total economic damage of non-warming disasters is at the top (middle) one third of all CEOs in the sample, and otherwise 0. *Severe winter weather experience* equals 1 if during college, a CEO experienced severe winter weather that caused economic damage, and otherwise 0. *Top (Middle) tercile severe winter experience* equals 1 if the economic damage caused by severe winter weather experienced by the CEO is at the top (middle) one third of all CEOs in the sample, and otherwise 0. The bottom panel shows the distribution of CEOs' birth year, education year and gender in the sample.

	Count	Mean	Median	Std.dev	Q1	Q3
Extreme weather experience (1/0)	737	0.765	1	0.424	1	1
Top tercile Extreme weather experience (1/0)	737	0.331	0	0.471	0	1
Middle tercile Extreme weather experience (1/0)	737	0.334	0	0.472	0	1
Economic damage experience (mil$)	737	4.627	.142	13.363	.001	2.275
Warming disasters experience (1/0)	737	0.159	0	0.366	0	0
Non-warming disaster experiece (1/0)	737	0.746	1	0.435	0	1
Top tercile non-warming disaster experience (1/0)	737	0.332	0	0.471	0	1
Middle tercile non-warming disaster experience (1/0)	737	0.332	0	0.471	0	1
Severe winter weather experience (1/0)	737	0.840	1	0.367	1	1
Top tercile severe winter experience (1/0)	737	0.332	0	0.471	0	1
Middle tercile severe winter experience (1/0)	737	0.334	0	0.472	0	1
Born in 1940s	737	0.155	0	0.362	0	0
Born in 1950s	737	0.433	0	0.496	0	1
Born in 1960s	737	0.354	0	0.479	0	1
Born in 1970s	737	0.056	0	0.229	0	0
Born in 1980s	737	0.001	0	0.037	0	0
Born in 1990s	737	0.001	0	0.037	0	0
Undergraduate started in 1960s	737	0.176	0	0.381	0	0
Undergraduate started in 1970s	737	0.450	0	0.498	0	1
Undergraduate started in 1980s	737	0.319	0	0.466	0	1
Undergraduate started in 1990s	737	0.050	0	0.219	0	0
Undergraduate started in 2000s	737	0.004	0	0.064	0	0
Male	737	0.940	1	0.237	1	1

Table 4. Baseline: The effect of CEO extreme weather experience on corporate emissions

This table reports fixed effect regressions about the effect of CEO extreme weather experience on corporate greenhouse gas emissions. The dependent variable in Column (1) to (5) is Scope 1 carbon intensity. The dependent variable in Column (6) is the logarithm of Scope 1 emissions. The dependent variable in Column (7) is the Growth rate of Scope 1 emissions. *Extreme weather experience* equals 1 if a CEO experienced economic damage caused by extreme weather during college, and otherwise 0. The standard set of control variables includes one year lagged log total assets, RoE, book-to-market ratio, leverage, log PPE and Tobin's q. Column (3) also includes CEO age and CEO age squared. All specifications includes firm fixed effects, year fixed effects and industry-year fixed effects using 2-digit NAICS industry classifications. Column (2), (4) and (5) include CEO cohort fixed effects, measured by CEO birth years. Column (4) additionally includes CEO cohort fixed effects measured by the decade in which the CEO started college. Column (5) additionally includes birth decade - year fixed effects. All standard errors are clustered at the firm level.

	Carbon Intensity Direct emissions					Log(Direct emissions)	Growth rate Direct emissions
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Extreme weather experience (1/0)	-42.96**	-49.72***	-45.19**	-49.62***	-48.12***	0.0464	-0.440
	(-2.21)	(-2.84)	(-2.24)	(-2.88)	(-2.73)	(0.79)	(-0.64)
L.Log(1+Total assets)	-51.25***	-45.46***	-47.78***	-42.96***	-45.28***	0.467***	-1.202
	(-2.89)	(-2.82)	(-2.77)	(-2.72)	(-2.95)	(4.05)	(-0.87)
L.RoE	-2.790	-4.113	-3.609	-4.160	-3.862	0.0390	-0.0681
	(-0.25)	(-0.46)	(-0.33)	(-0.46)	(-0.42)	(0.61)	(-0.46)
L.Book-to-Market	-7.125	-3.257	-7.929	-3.151	-3.593	-0.0124	0.0883
	(-0.46)	(-0.22)	(-0.51)	(-0.21)	(-0.24)	(-0.17)	(0.25)
L.Leverage	-139.4*	-154.8**	-141.6*	-151.9**	-138.9**	0.358	-1.731
	(-1.86)	(-2.03)	(-1.89)	(-2.00)	(-2.02)	(0.92)	(-0.49)
L.Log(1+PPE)	-3.840	0.358	-5.395	-2.065	-1.597	0.0726	-0.951
	(-0.35)	(0.03)	(-0.46)	(-0.18)	(-0.13)	(0.64)	(-0.60)
L.Tobin's q	-4.925*	-3.252	-5.107*	-2.859	-3.678	0.0488	-0.728
	(-1.92)	(-1.12)	(-1.95)	(-0.97)	(-1.19)	(1.18)	(-1.31)
CEO age			17.79				
			(1.22)				
(CEO age)^2			-0.165				
			(-1.27)				
Constant	782.5***	745.8***	294.0	830.1***	576.3***	7.396***	22.11
	(3.91)	(4.24)	(0.75)	(4.43)	(3.31)	(9.29)	(0.94)
N	1924	1924	1924	1924	1924	1924	1830
Adjusted R-sq	0.306	0.351	0.310	0.352	0.359	0.178	-0.0553
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort (birthyear) FE	No	Yes	No	Yes	Yes	Yes	Yes
Cohort (education time) FE	No	No	No	Yes	No	No	No
Cohort-Year FE	No	No	No	No	Yes	No	No

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5. Availability of information and the effect of extreme weather experience

This table presents fixed effect regressions results when controlling for the availability of information about climate change, using 1980 as the cutoff point when the science was first introduced to the public. The dependent variable of Column (1) to (3) is carbon intensity of direct emissions. The dependent variable of Column (4) to (6) is the natural logarithm of direct emissions. *Extreme weather experience* equals 1 if a CEO experienced economic damage caused by climate-related extreme weather disasters during college, and otherwise 0. *Undergraduate started after 1980* equals 1 if the CEO started her undergraduate studies in or after 1980, and otherwise 0. The standard set of control variables includes one year lagged log total assets, RoE, book-to-market ratio, leverage, log PPE and Tobin's q. All specifications includes firm fixed effects, year fixed effects, CEO cohort fixed effects and industry-year fixed effects. Column (1) and Column (4) are results from the full sample regression. Column (2) and Column (5) are results from the subsample of CEOs educated before 1980, while Column (3) and Column (6) are results from the sample of CEOs educated after 1980. Standard errors are clustered at the firm level.

	Carbon Intensity Direct emissions			Log(Direct emissions)		
	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Before 1980	After 1980	Full sample	Before 1980	After 1980
Extreme weather experience (1/0)	-15.91	-13.69	-44.26***	0.0762	-0.0586	-0.512***
	(-1.02)	(-0.72)	(-5.38)	(0.94)	(-0.72)	(-2.90)
Extreme weather experience (1/0)=1 × Undergraduate started after 1980=1	-130.0**			-0.153		
	(-2.07)			(-0.66)		
L.Log(1+Total assets)	-46.10***	-47.22**	-14.67	0.483***	0.534***	0.218
	(-2.94)	(-2.22)	(-0.79)	(4.11)	(3.89)	(0.96)
L.Book-to-Market	-5.976	-11.03	7.303	-0.0316	0.0661	-0.282
	(-0.42)	(-0.64)	(0.22)	(-0.44)	(0.98)	(-1.62)
L.RoE	-5.467	-10.10	-30.50	0.0711	0.000369	0.122
	(-0.54)	(-0.92)	(-0.86)	(1.29)	(0.00)	(1.30)
L.Leverage	-148.8*	-166.6	-50.62	0.462	0.824**	-1.174
	(-1.94)	(-1.37)	(-0.81)	(1.10)	(2.03)	(-1.07)
L.Log(1+PPE)	-2.231	3.487	-19.66	0.0678	-0.0170	0.148
	(-0.21)	(0.19)	(-1.32)	(0.58)	(-0.12)	(0.73)
L.Tobin's q	-3.862	-4.345	-5.903	0.0421	0.0830**	-0.117
	(-1.48)	(-1.07)	(-1.30)	(1.11)	(2.35)	(-1.29)
Constant	871.2***	690.9***	474.0*	6.506***	6.813***	9.480***
	(4.43)	(3.13)	(1.84)	(8.28)	(7.60)	(6.98)
N	1924	1333	591	1924	1333	591
Adjusted R-sq	0.327	0.228	0.321	0.143	0.169	0.0990
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort (Education decade) FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6. The effect of warming and cooling experience

This table compares the different effects of experiencing warming, non-warming disasters and severe winter weather. The dependent variable is carbon intensity of direct emissions. Column (1) use the full sample. Column2 (2) and (3) uses a subsample of CEOs who began undergraduate studies during 1975 to 1995, a period featured with inaccurate information about climate change. Heat, wildfire and drought are defined as warming disasters. Hurricane, flooding and coastal events are defined as non-warming disasters. *Warming disaster experience* equals 1 if the CEO experienced any warming disaster during undergraduate, and otherwise 0. *Top (Middle) tercile non-warming disaster experience* equals 1 if the total economic damage of non-warming disasters is at the top (middle) one third of all CEOs in the sample, and otherwise 0. *Top (Middle) tercile severe winter experience* equals 1 if the economic damage caused by severe winter weather that a CEO experienced during college is among the top (middle) tercile of the distribution of economic damage of the sample. Firm, year, CEO birth decade, education state and industry-year fixed effects are included in all tests. Standard errors are clustered at the firm level.

	Carbon Intensity Direct emissions		
	Full sample	1975 - 1995	
	(1)	(2)	(3)
Extreme weather experience (1/0)		-118.0***	
		(-3.10)	
Warming disaster experience (1/0)	-40.21*		-121.7**
	(-1.81)		(-2.27)
Top tertile non-warming disaster experience (1/0)	-7.734		30.30
	(-0.51)		(0.72)
Middle tertile non-warming disaster experience (1/0)	-13.31		30.51
	(-0.74)		(0.95)
Top tertile severe winter experience (1/0)	1.808		102.5**
	(0.13)		(2.25)
Middle tertile severe winter experience (1/0)	11.71		153.0
	(0.93)		(1.10)
L.Log(1+Total assets)	-40.83**	-27.67*	-27.97*
	(-2.52)	(-1.76)	(-1.78)
L.Book-to-Market	-6.400	-3.821	0.914
	(-0.38)	(-0.18)	(0.04)
L.Leverage	-159.0*	-95.84	-90.18
	(-1.80)	(-1.37)	(-1.26)
L.RoE	-25.87	-19.48	-16.09
	(-0.82)	(-0.63)	(-0.51)
L.Log(1+PPE)	-0.382	0.912	-0.428
	(-0.03)	(0.06)	(-0.03)
L.Tobin's q	-4.950	-7.095**	-6.066*
	(-1.58)	(-2.08)	(-1.69)
Constant	720.9***	814.0***	187.0
	(4.02)	(4.06)	(0.83)
N	1808	1053	1053
Adjusted R-sq	0.401	0.311	0.312
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Education state FE	Yes	Yes	Yes
Cohort (birth decade) FE	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7. Changes in corporate emissions around exogenous CEO turnover events

This table examines a subsample of observations around plausibly exogenous CEO turnover events due to the death, illness and retirement of the incumbent CEO. Data of CEO departure reasons is from Gentry et al. (2021). The subsample only includes firm-year observations of the departing CEO and the incoming CEO involved in such turnover events, and requires at least two years of observations both before and after the turnover year. The sample selection criteria leads to 51 unique turnover events. The dependent variable is carbon intensity of direct emissions. All columns includes the turnover event fixed effects, year fixed effects, CEO cohort fixed effects and industry-year fixed effects. Standard errors are clustered at the turnover events level.

	Carbon Intensity Direct emissions			
	(1)	(2)	(3)	(4)
Extreme weather experience (1/0)	-82.24***	-72.25*		
	(-2.76)	(-1.86)		
Top tercile extreme weather experience (1/0)			-120.1***	-110.5***
			(-2.82)	(-2.81)
Middle tercile extreme weather experience (1/0)			-107.1**	-85.73**
			(-2.60)	(-2.25)
L.Log(1+Total assets)	-100.5**	-98.66**	-102.3**	-115.3**
	(-2.21)	(-2.02)	(-2.46)	(-2.11)
L.Leverage	-495.5	-487.3**	-449.5	-401.5**
	(-1.49)	(-2.31)	(-1.58)	(-2.19)
L.Tobin's q	5.296	3.006	-8.707	-20.49
	(0.62)	(0.21)	(-0.97)	(-1.58)
L.Book-to-Market	93.53***	29.47	67.71**	4.863
	(4.60)	(0.79)	(2.55)	(0.10)
L.RoE	-298.7***	-16.94	-257.9**	-22.56
	(-2.96)	(-0.16)	(-2.44)	(-0.23)
L.Log(1+PPE)	-4.143	-31.65	17.25	4.264
	(-0.18)	(-0.91)	(0.86)	(0.14)
Constant	1309.0**	1489.5**	1205.6***	1421.2**
	(2.61)	(2.67)	(2.75)	(2.66)
N	336	336	336	336
Adujsted R-sq	0.365	0.594	0.401	0.614
Year FE	Yes	Yes	Yes	Yes
Turnover event FE	Yes	Yes	Yes	Yes
Cohort (birth decade) FE	Yes	Yes	Yes	Yes
Indusry-Year FE	No	Yes	No	Yes

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8. The effect of CEO experience when controlling for corporate location

This table adds firm headquarter state-year fixed effects to the baseline specification. The dependent variable is carbon intensity of direct emissions. The standard set of control variables includes one year lagged log total assets, RoE, book-to-market ratio, leverage, log PPE and Tobin's q. All columns include firm fixed effects, year fixed effects, firm headquarter state-year fixed effects and cohort fixed effects, and Column (2) additionally includes industry-year fixed effects. Standard errors are clustered at the firm level.

	Carbon Intensity Direct emissions	
	(1)	(2)
Extreme weather experience (1/0)	-62.69***	-69.02***
	(-2.96)	(-2.93)
L.Log(1+Total assets)	-79.96***	-39.94**
	(-3.44)	(-1.99)
L.RoE	-24.97**	-6.324
	(-2.25)	(-0.55)
L.Book-to-Market	11.24	1.087
	(0.59)	(0.07)
L.Leverage	-243.4**	-123.5*
	(-2.29)	(-1.76)
L.Log(1+PPE)	10.02	-5.543
	(0.69)	(-0.38)
L.Tobin's q	-14.85***	-7.943**
	(-2.86)	(-1.99)
Constant	1035.6***	725.5***
	(4.36)	(3.93)
N	1838	1838
Adjusted R-sq	0.275	0.381
Year FE	Yes	Yes
Firm FE	Yes	Yes
Cohort (birthyear) FE	Yes	Yes
Firm HQ state-year FE	Yes	Yes
Industry-Year FE	No	Yes

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9. The effect of CEO awareness when controlling for past ESG ratings

This table adds 1-year lagged firm Refinitiv ESG scores to the baseline model. The dependent variable of all columns is carbon intensity of direct emissions. *Extreme weather experience* equals 1 if during a CEO's undergraduate studies, the county where she attended university suffered economic damage resulted from climate-related extreme weather events, and otherwise 0. The standard set of control variables includes one year lagged Log(1+Total Assets), RoE, Book-to-market ratio, Leverage, Log(1+PPE) and Tobin's q. All columns includes firm fixed effects, year fixed effects, CEO cohort fixed effects and industry-year fixed effects. Standard errors are clustered at the firm level.

	Carbon Intensity Direct emissions		
	(1)	(2)	(3)
Extreme weather experience (1/0)	-50.12***	-49.69***	-49.20***
	(-2.87)	(-2.83)	(-2.82)
L.Overall ESG score	24.27		
	(0.93)		
L.Environmental score		12.62	16.54
		(0.67)	(1.07)
L.Corporate governance score			-21.86
			(-0.60)
L.Social score			5.667
			(0.23)
L.Log(1+Total assets)	-46.38***	-46.17***	-45.29***
	(-2.86)	(-2.83)	(-2.74)
L.Book-to-Market	-2.764	-3.337	-3.373
	(-0.19)	(-0.23)	(-0.23)
L.RoE	-4.751	-4.226	-4.166
	(-0.53)	(-0.47)	(-0.47)
L.Leverage	-152.4**	-155.1**	-155.1**
	(-2.00)	(-2.04)	(-2.01)
L.Tobin's q	-3.256	-3.286	-3.476
	(-1.12)	(-1.13)	(-1.19)
L.Log(1+PPE)	-0.0657	0.0560	-0.552
	(-0.01)	(0.01)	(-0.05)
Constant	732.1***	743.8***	752.9***
	(4.20)	(4.23)	(4.30)
N	1924	1924	1924
Adjusted R-sq	0.351	0.351	0.350
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Cohort (birthyear) FE	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10. Alternative measures of climate awareness

This table tests alternative forms for CEO extreme weather experience measures. In Column (1) and (2), CEO climate awareness are measured by the natural logarithm of 1 plus the economic damaged caused by extreme weather (in million dollars at 2019 constant price) a CEO experienced during undergraduate. In Column (3) and (4), *Top (Middle) tercile extreme weather experience* equals 1 if the total economic damage caused by climate-realted extreme weather disasters that a CEO experienced is in the top (middle) one third of the sample, and otherwise 0; The dependent variable of all columns is carbon intensity of direct emissions. The standard set of control variables includes one year lagged Log(1+Total Assets), RoE, Book-to-market ratio, Leverage, Log(1+PPE) and Tobin's q. All columns includes firm fixed effects, year fixed effects and CEO cohort fixed effects. Column (2) and (4) also include industry-year fixed effects. Standard errors are clustered at the firm level.

	Carbon Intensity Direct emissions			
	(1)	(2)	(3)	(4)
log(1+Economic damage by extreme weather(mil$))	-11.80*	-10.20*		
	(-1.72)	(-1.87)		
Top tercile Extreme weather experience (1/0)			-39.56**	-31.67*
			(-1.97)	(-1.78)
Middle tercile Extreme weather experience (1/0)			-32.44*	-26.81
			(-1.76)	(-1.49)
L.Log(1+Total assets)	-55.49***	-45.66***	-56.42***	-46.28***
	(-2.93)	(-2.90)	(-3.01)	(-2.87)
L.RoE	-36.61***	-2.861	-36.13***	-2.957
	(-3.10)	(-0.32)	(-3.11)	(-0.33)
L.Book-to-Market	13.56	-2.753	11.16	-4.840
	(0.75)	(-0.19)	(0.62)	(-0.33)
L.Leverage	-248.5*	-156.6**	-250.1**	-157.8**
	(-1.96)	(-2.04)	(-1.99)	(-2.07)
L.Log(1+PPE)	15.89	-0.817	17.67	0.312
	(1.26)	(-0.07)	(1.42)	(0.03)
L.Tobin's q	-2.422	-4.043	-2.789	-4.232
	(-0.75)	(-1.42)	(-0.87)	(-1.46)
Constant	677.5***	728.4***	692.7***	742.2***
	(4.21)	(4.31)	(4.32)	(4.21)
N	1924	1924	1924	1924
Adjusted R-sq	0.160	0.340	0.165	0.342
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Cohort (birthyear) FE	Yes	Yes	Yes	Yes
Industry-Year FE	No	Yes	No	Yes

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$