The Effect of CEO Climate Impact Awareness on Corporate Carbon Emissions *

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Abstract

This paper investigates the role of CEOs' personal awareness of the economic impacts of climate change on corporate carbon emissions, and the factors that shape this awareness. I find that CEOs' experiences with climate-related extreme weather during their impressionable years are associated with significantly lower Scope 1 carbon emissions. Both the availability and quality of climate change information are crucial in shaping long-term climate awareness. Specifically, the negative correlation between extreme weather experiences and emissions is stronger when these events occur after the public dissemination of climate science. Moreover, while experiences with salient warming weather have a pronounced negative effect on emissions, severe winter weather experiences during periods of limited information and emphasis on "global warming" lead to an opposite effect. Evidence from plausibly exogenous CEO turnover events supports the causal effect of CEOs' climate awareness in reducing firm carbon intensity. This effect of climate awareness is distinct from preference or attention shifts driven by early-life or recent experiences. Overall, this study documents CEOs' personal climate awareness as a determinant of corporate carbon emissions, and emphasizes the importance of the information environment in translating personal experiences into managerial behaviors.

JEL Classifications: G30, G34, G40, Q54

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1 Introduction

The 2016 Paris Agreement aspires to limit the global temperature increase to 1.5°C above pre-industrial levels, which relies on reaching net-zero emissions by mid-century. However, less than half of S&P 500 firms have made any commitment towards this goal, and only 15% of these CEOs have their compensation linked to carbon emission targets (MacFarland et al., 2024). The lack of financial incentives for emission reduction gives CEOs significant discretion in determining their firms' carbon policies.[1] Indeed, CEOs exhibit different approaches in response to the call for sustainable transition. For example, Elon Musk explained why he founded Tesla, which has become the largest electric vehicle (EV) manufacturer, by emphasizing the urgency of climate action. In an interview, Musk stated, "The acceleration of sustainable energy is absolutely fundamental, because this is the next potential risk for humanity".[2] Conversely, Ford has been conservative in entering the EV market and set its carbon neutral goal to 2050, while its major competitor, General Motors, has pledged to achieve it by 2040. Ford's CEO, Jim Farley, humorously referred to himself as a "lifelong petrol head".[3]

As extensive literature has shown that CEO's personal beliefs and characteristics influence their managerial decisions (e.g., Cronqvist & Yu, 2017; Malmendier et al., 2011), firms' carbon management policies may also depend on CEOs' personal opinions on climate change as well. In this paper, I study how CEOs' personal awareness of the economic impacts of climate change affects their firms' carbon emissions, and what factors shape the heterogeneity in this awareness.

[1] Recent 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), the belief that asset prices on average underestimate climate risk (Krueger et al., 2020; Stroebel & Wurgler, 2021), and the geographically fragmented emission regulations (Bartram et al., 2022). These conditions grant CEOs greater latitude in making environmental decisions, allowing their personal views to influence firm policy

[2] Catherine Clifford, "Elon Musk: This is the 'why' of Tesla", *CNBC*, February 4, 2019, https://www.cnbc.com/2019/02/04/elon-musk-on-the-why-and-purpose-behind-tesla.html.

[3] Jim Farley's comments can be found in his LinkedIn post, "Confessions from a lifelong Petrol Head. I love electric vehicles and it has nothing to do with politics." June 28, 2024, https://www.linkedin.com/pulse/confessions-from-lifelong-petrol-head-i-love-electric-jim-farley-fc81e/.

Therefore, I measure a CEO's "climate impact awareness" using two key factors that likely shape this belief: their experience with climate-related extreme weather events, and the climate change information environment they were exposed to at the time. These two factors are measured during the CEO's "impressionable years", a critical period for shaping long-term values. I find that CEOs who experienced climate-related extreme weather events during their impressionable years are associated with lower Scope 1 carbon intensity at their firms. Additionally, both the availability and the quality of the climate information environment matter in shaping climate awareness. First, the impact of extreme weather experiences is primarily driven by those occurring after climate change science became public knowledge. Second, consistent with the historical framing of "global warming" rather than "climate change", the reduction in carbon intensity is most pronounced for CEOs' experience with warming-related extreme weather. In contrast, encountering severe winter weather during periods dominated by the "global warming" narrative shows an opposite effect. My results are not driven by the endogenous matching between firm and CEO preferences, and are incremental to the effect of similar experience in the CEO's formative or recent years.

While previous literature has documented that various CEO traits—such as their professional experiences, social connections, personality, and political stances—influence firms' ESG policies (Cai et al., 2022; Cronqvist & Yu, 2017; Davidson et al., 2019; Di Giuli & Kostovetsky, 2014), we still lack a direct measure of CEOs' attitudes toward climate change. This paper bridges this gap by measuring long-term climate impact awareness based on its formation process, providing a direct approach that does not rely on proxies such as gender or political preferences. Furthermore, while it is well established that CEOs' experiences have a lasting influence on their managerial styles (e.g., Bernile et al., 2017; Malmendier & Nagel, 2011), it remains unclear whether similar experiences always yield homogeneous effects or vary depending on how they are internalized.

This paper sheds light on this question by showing that extreme weather experiences lead to climate awareness and environmental friendly behaviors only when there is sufficient and accurate information linking these experiences to climate change and human activities. This highlights the critical role of the information environment in facilitating the translation of personal experiences into managerial styles.

Although CEOs' climate opinions are often not directly observable, yet we know such opinions are highly divided among the public. A significant portion of the world population doubts that the climate is changing or underestimates its potential consequences, despite over 99% of peer-reviewed scientific publications since 2012 agreeing on the overall negative effect of anthropogenic climate change currently underway (Lynas et al., 2021). In 2021, around 28% of U.S. adults do not believe global warming is happening, and 43% do not believe that human activities are the main reason for global warming (Howe et al., 2015).[4] Similar disagreement may exist among business executives, influencing CEOs' decisions on their firms' environmental policies, particularly those related to carbon emissions.

Climate change is a slow and gradual process, but public and investor attention tends to increase following distinctly abnormal weather events (e.g., Alok et al., 2020; Bergquist et al., 2019; Choi et al., 2020; Rudman et al., 2013). However, for short-term attention to develop into long-term awareness of the economic risks and impacts involved, potentially leading to lasting behavioral changes, one needs to be able to causally connect abnormal weather events to climate change and recognize the role of human activities in current anthropogenic climate change. Without adequate scientific information on climate change, extreme weather experiences may simply be attributed to bad luck, preventing the formation of logical reasoning that could

[4] The Yale Program on Climate Change Communication conducts annual surveys on a representative sample of U.S. adults about their climate opinions. Visualized data available at https://climatecommunication.yale.edu/visualizations-data/ycom-us/.

drive a shift in behavior.

While scientific understanding of climate change is widely disseminated today, this was not the case decades ago, when many current CEOs were in their impressionable years. Impressionable years, spanning from late adolescence to early adulthood, is when individuals are susceptible to changes in their social and political preferences and beliefs, which tend to stabilize afterwards (e.g., Krosnick & Alwin, 1989; Osborne et al., 2011). Therefore, CEOs' extreme weather experiences during their impressionable years may not necessarily translate into climate awareness, if the information environment they faced at the time was inadequate or inaccurate.

My hypotheses are, therefore, that (1) CEOs' climate impact awareness formed during their impressionable years has a long-lasting impact on their managerial decisions, and (2) this awareness can be shaped by both climate-extreme weather experiences and information about climate change. To empirically examine my hypotheses, I construct a sample linking CEOs' exposure to extreme weather and climate change information during their impressionable years to their firms' carbon emissions. I use corporate emission data from Refinitiv ESG, CEO data from Execucomp and BoardEx, and extreme weather hazard data from the Spatial Hazard Events and Losses Database (SHELDUS). To infer CEOs' extreme weather experiences, I consider the locations and time periods of their undergraduate studies, as most CEOs attended college during their impressionable years. Due to the availability of extreme weather data, the sample is restricted to CEOs who attended college in the U.S. after 1960. The sample consists of $3,828$ firm-year observations, including 757 unique firms with $1,007$ unique CEOs. Most CEOs in the sample spent their impressionable years in the 1970s (36.0%) and the 1980s (40.9%).

I consider six types of extreme weather as climate-related events: flooding, hurricanes, heat, drought, wildfire, and coastal events. These events satisfy two criteria: first, scientific studies suggest that the increasing frequency and intensity of these events are likely related to climate change;[5] and second, these events are likely to be perceived by the public as being related to climate change.[6] Based on this classification, I measure a CEO's exposure to climate-related extreme weather events by the total economic damages caused by these events in the county where the CEO attended college.[7]

I find that CEOs' extreme weather experiences during their impressionable years are associated with lower Scope 1 carbon intensity in their firms, after controlling for firm fixed effects, industry-year fixed effects, and CEO cohort fixed effects. On average, the extreme weather experience of a CEO is related to a 11.1% lower Scope 1 carbon intensity, equivalent to 37.9% of one standard deviation in Scope 1 carbon emissions for the average firm in the sample. Moreover, more intense experiences with extreme weather events that cause greater economic damage are associated with a stronger effect.

Next, I find evidence that the availability of climate change information helps translate extreme weather experiences into climate impact awareness. Using the frequency of "climate change" or "global warming" in printed English sources as a measure for information availability, I show that the effect of extreme weather experiences is primarily driven by those gained after the public introduction of climate science,[8] and the effect is more pronounced for experiences gained when the information availability is high. These findings suggest the formation of climate awareness is a process based on logical reasoning, which relies on interpretation and

[5]A counterexample is earthquakes, where there is no consensus supporting the direct impact of climate change on earthquakes.

[6]A counterexample is severe winter weather, which recent studies have linked its increasing frequency and intensity to climate change (Cohen et al., 2021), but it may not be conceptually linked to climate change when "global warming" was more commonly used than "climate change".

[7]Figure 5 plots the spatial distribution of annual average economic damages caused by climate-related extreme weather events during the 1960s, 1970s, 1980s, and 1990s, showing that these events affected various regions across the U.S.

[8]The introduction of climate change science to the public happened in the 1980s. First, the number of books mentioning "global warming" or "climate change" was virtually zero before the mid-1980s and grew rapidly afterwards, as shown in Figure 1. Second, as shown in Figure 2, 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 the greenhouse effect, which was by then strongly suspected to lead to dangerous global warming.

internalizing one's experience with information.[9]

Furthermore, the quality of information matters, as inaccurate or incomplete information can lead to misinterpretation of experiences. In the early stages of climate science dissemination, the term "global warming" was often emphasized over "climate change", leading to an incomplete understanding of the actual scope of climate change. In my results, I find two types of misinterpretation consistent with the overemphasis on warming. First, among climate-related extreme weather events, those that directly manifest rising temperatures, which I referred to as "warming events" (heat, wildfire, drought), drive the negative association with firm Scope 1 carbon intensity, while non-warming events have no significant impact on average. Second, when the use of "global warming" was particularly prevalent compared to "climate change", experiences of severe winter weather are associated with higher carbon intensity, in contrast to the negative effect of warming events. This suggests that overemphasizing the average "warming" may have led to a misunderstanding that cooler events "disprove" the climate change theory.[10]

However, it is possible that the association between CEO climate awareness and firm carbon intensity is driven by the endogenous matching between firms and managers, where firms appoint CEOs who are most suited to implement their optimal climate policy. To alleviate this concern, I examine changes in carbon intensity around plausibly exogenous CEO turnovers due to the incumbent CEO's death, illness or retirement. Prior literature suggests the timing of these turnovers is largely unrelated to firm performance, creating exogenous variations in the CEO-firm matching process (e.g., Dittmar & Duchin, 2016; Fee et al., 2013). I confirm that CEOs'

[9] While one may recollect extreme weather experiences and update beliefs on climate change upon receiving new information, my findings suggest such retrospective adjustments do not significantly influence managers' climate policies. This finding is consistent with the theory of impressionable years, which predicts stable values and attitudes after early adulthood.

[10] Besides the phrasing of "global warming", there are other factors that may have contributed to the inaccurate information environment in this period. First, 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 developing consensus, instead, they exaggerated a few research predicting cooling (Peterson et al., 2008). Second, the earth experienced a slight decrease in surface temperature during the 1970s, as shown in Figure A1, casting doubt on the occurrence of climatic change.

personal climate awareness, induced by extreme weather experiences, causally reduces firms' Scope 1 carbon intensity.

Additionally, the effect of extreme weather experiences during impressionable years remains significant after controlling for similar experiences during formative years—defined as childhood and early adolescence[11]—as well as experiences in the recent year, suggesting that the climate awareness formed during impressionable years is distinct from pro-social attitudes developed during earlier life (O'Sullivan et al., 2021) or from short-term attention shifts due to recent abnormal weather (Garel & Petit-Romec, 2022).

Finally, I rule out the possibility that shared extreme weather experiences between the CEO and the firm drive these results. I also document that CEOs with extreme weather experiences are more likely to adopt other environmental initiatives, such as reporting environmental expenditures, making environmental investments, and taking adopting restoration initiatives. Furthermore, I find no evidence that CEOs' extreme weather experiences are associated with worse firm performance, as measured by sales and its growth rate, profitability, and Tobin's q.

Overall, my findings show that firms led by CEOs with higher climate awareness have lower Scope 1 carbon intensity. This awareness of economic impacts of climate change, formed during their impressionable years, is induced by experiences of climate-related extreme weather and cemented by scientific information about climate change through logical reasoning. This awareness is distinct from subconscious attitude changes driven by early-life experiences or short-term attention shifts triggered by recent experiences.

My paper contributes to the growing literature on corporate carbon emissions. Prior research has identified several factors influencing corporate emissions, such as firm ownership, listing status and financial constraints (e.g., Akey & Appel, 2021; Azar et al., 2021; Bolton & Kacperczyk,

[11]Bernile et al. (2017) define formative years at the period between ages 5 and 15, and I use the same definition to measure formative year extreme weather experiences.

2021; Shive & Forster, 2020; Xu & Kim, 2022). Additionally, CEOs' personal traits, experiences, and beliefs have been linked to their environmental policies. For instance, Di Giuli and Kostovetsky (2014) show that firms with Democratic-leaning CEOs have higher environmental scores. Cronqvist and Yu (2017) document that female socialization from the CEO's family environment improves their firms' environmental performance.[12] My paper adds to this literature by showing that a CEO's long-term climate impact awareness has a tangible impact on the firm's carbon emissions. Using measures rooted in the formation process of climate awareness during impressionable years, I am able to disentangle this awareness from short-term climate attention or general pro-social attitudes, and link it to firm outcomes specifically about carbon emissions.

I also contribute to the literature that connects personal experiences to managerial styles. For example, Bernile et al. (2017) find that CEOs' natural disaster experiences during their formative years affect their financial risk preferences. Malmendier et al. (2011) find that having lived through the Great Depression and having military experience systematically impact CEOs' financing decisions. O'Sullivan et al. (2021) show that managers' traumatic early-life experiences increase CEOs' desires for interpersonal relationships, resulting in better social performance of their firms. My study complements this body of work by introducing a new factor—information—that influences how experiences translate into managerial styles. For belief updates that require logical reasoning, the availability and quality of the information environment can significantly alter how individuals perceive, interpret, and internalize their experiences. Exploiting the time-varying information environment about climate change science, I show that climate-related extreme weather experiences only translate into climate awareness and pro-environment behavior when individuals recognize these events as signs of climate change.

[12] In a related paper, Garel and Petit-Romec (2022) document that a firm's recent exposure to abnormally high temperature is associated with lower carbon intensity. My paper differs by distinguishing the CEO's experience from the firm's experience, focusing on climate awareness formed during the CEO's impressionable years, which tends to be more stable over the long term, rather than short-term attention shifts.

My study emphasizes that experience alone may not be sufficient to determine its impact on managerial styles; understanding how experiences are internalized, and the context in which they are interpreted, are equally important.

A policy implication of this study is that combating misinformation about climate change is crucial for building broader consensus. Providing scientifically proven information to the public will not only benefit 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 conceptualized the formation of climate impact awareness. Section 3 describes the data. Section 4 examines the relationship between corporate carbon intensity and CEOs' extreme weather experiences during their impressionable years. Section 5 explores the role of information in shaping climate awareness. Section 6 performed robustness analyses. Section 7 concludes.

2 Conceptualizing climate impact awareness

In recent years, firms have faced increasing pressure to consider stakeholder interests. In this study, I distinguish the awareness of climate change as a direct force with potentially large economic impacts, from general attitudes towards "doing good". Hence, this study measures the establishment of "climate impact awareness" as awareness of its economic impacts, created during a CEO's impressionable years by a combination of extreme weather events and access to adequate information.

2.1 Opinion formation during impressionable years

The impressionable years, typically from late adolescence to early adulthood, represent a period when individuals are especially receptive to changes in attitudes and values (Giuliano &

Spilimbergo, 2014; Krosnick & Alwin, 1989). This phase coincides with traditional college years, during which significant development occurs across various domains, including cognitive functions, psychosocial growth, and the formation of values on complex issues (Mayhew et al., 2016). Evidence from psychology and education literature highlights the importance of this period in shaping climate opinions.

First, forming opinions on complex issues, such as climate change, requires the logical ability to process conflicting evidence, make reasoned judgments, and position oneself on the issue. Biologically, these advanced cognitive functions depend on the development of the brain's frontal lobes, which are not fully developed until early or mid-20's (Stuss, 1992; Thompson et al., 2000). Consistent with these 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 individuals may begin thinking about climate change earlier in life, the formation of a self-sustained and comprehensive opinion is more likely to occur during the impressionable years.

Second, attending college often exposes individuals to a more diverse environment than they have previously encountered. During this time, young adults engage in identity exploration, make initial commitments, and, in some cases, reassess and refine these commitments (Luyckx et al., 2006; Marcia, 1966). Empirical evidence shows that the college years are crucial for developing racial identity, spiritual and religious identity, gender and sexual identity, as well as self-concept and social identity (see Mayhew et al., 2016, for a review.).

Third, political opinions, which are often closely linked to climate opinions in the U.S., also tend to solidify during the impressionable years. Individuals are more open to shifts in political values during this period, after which these values generally stabilize (Osborne et al., 2011). This suggests that climate opinions and political values are likely co-formed during these impressionable years.

Overall, theories and evidence from biological and psychological development indicate that the impressionable years, which often coincide with traditional college years, is a crucial period for forming attitudes toward complex social issues, including climate change.

2.2 Extreme weather experience and climate change information

Literature has documented that attention to climate change increases when distinctly extreme weather events happen. However, most of this research implicitly assumes that people understand the causal relationship between extreme weather and climate change, which is likely true for recent events but may not have been the case before the 1980s because the information space was confusing.

Regarding the impact of experiencing extreme weather events, people may doubt that climate change is taking place because the gradual and slow change in climate is difficult for individuals to observe (Weber, 2016). One exception that makes climate risk salient is extreme weather events, such as floods and hurricanes. Although no single extreme weather event may be directly attributed to climate change, it manifests scenes that will worsen if climate change proceeds apace, thus, conceptually raising people's attention to the climate topic. Recent evidence in psychology shows that experiencing extreme weather 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, there is evidence that investors divest from high-emission companies when experiencing abnormally high temperatures, being close to natural disaster zones, or experiencing air pollution (Alok et al., 2020; Choi et al., 2020; Huynh et al., 2022). This evidence suggests that CEOs who have experienced extreme weather events are more likely to be aware of climate risks, less likely to deny the occurrence of global warming, and more prone to take action in response to the climate crisis.

Regarding the importance of information, extreme weather experiences can translate into higher climate impact awareness if individuals can causally relate these events to climate change logically (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 suffering damages from extreme weather events to back luck. When climate change was primarily known as "global warming", one may only relate events with a rising temperature, such as heatwaves, to climate change, 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 theory, although increased Arctic meltwater has been found as the likeliest reason for more frequent extreme cold in the northern hemisphere (Cohen et al., 2021).

Through the 1960s to the 2000s, there exist significant temporal variations in the information generally available about climate change. The greenhouse gas effect attracted scientists' attention in the 1950s, but at the time, aerosol pollution made some believe that its cooling effect would dominate the warming effect of burning fossil fuels. Indeed, the Earth went through a slight cooling period from around the 1940s to the 1970s, as shown in Figure A1, 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 1, giving information access to the public. In the 1990s, the consensus was established on a wider basis with 84 countries signed the Kyoto Protocol in 1997.

Overall, 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 when 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 their impressionable years were during the 1970s to the 1990s.

3 Data and sample

3.1 Sample construction

The main sample is constructed by merging corporate carbon emissions data from Refinitiv ESG, CEO information from Execucomp, CEO education details from BoardEx, extreme weather records from the Spatial Hazard Events and Losses Database (SHELDUS), and firm financial data from CRSP/Compustat Merged (CCM). Since Refinitiv data begins in 2002, my sample period spans from 2002 to 2023.

I start from all U.S.-listed and U.S.-headquartered firms covered in the CCM database. Next, I combine it with corporate carbon emissions data from Refinitiv ESG. Following the Greenhouse Gas Protocol, CO_2 equivalent emissions can be measured in three scopes. Scope 1 emissions measure the direct emissions produced by establishments controlled by the firm. Scope 2 emissions are indirect emissions related to the firm's energy consumption, 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 of activities from the extraction of materials, transportation and emissions associated with the use of the sold goods by end-users. To be included in the sample, a firm must report its Scope 1 emissions for the given year. I focus on Scope 1 emissions because firms are directly liable for them (e.g. under California's cap-and-trade or the EU's emission trading scheme). Additionally, this scope has higher data availability and is the most consistently reported across different emissions data providers (Bolton & Kacperczyk, 2021). I exclude utilities (SIC 4900 to 4999), financial (SIC 6000 to 6999) and governmental firms (SIC 9000 to 9999) from my analyses because their business activities are subject to different regulations.

I then identify the CEO for each firm-year observation in the sample using Execucomp, supplemented by BoardEx. I infer the county where the CEO spent their impression years using the location of their attended college.[13] In my sample, 90% of CEOs finished their undergraduate studies by the age of 23, therefore, I focus on Associate's and Bachelor's degrees such that extreme weather experiences are measured during late adolescence and early adulthood. Based on graduation dates provided by BoardEx, I estimate the start of college education by assuming that an Associate's degree takes 2 years and a Bachelor's degree takes 4 years.

Next, I obtain U.S. county-level extreme weather data from SHELDUS. For each county-year, I measure the impact of extreme weather events by the economic damage they caused, defined as the sum of dollar losses from crop damage and property damage, adjusted to 2019 dollars. As the coverage of SHELDUS begins in 1960, the sample is restricted to CEOs who attended college in the U.S. on or after 1960.

To measure a CEO's extreme weather experience during their impressionable years, I calculate the economic damages caused by climate-related extreme weather events during their college years in the county where they attended college. For CEOs who received multiple degrees from institutions in multiple counties, I take the average over those county-year pairs. The climate-

[13] BoardEx provides addresses, including ZIP codes, for most universities and colleges covered in its executive and director education database. I supplement missing data using the Integrated Postsecondary Education Data System from the National Center for Education Statistics, with Google searches as a last resort. I then map ZIP codes into county-level FIPS using HUD USPS ZIP Code Crosswalk Files managed by the US Department of Housing and Urban Development.

related extreme weather events include six types of hazards: heat, wildfire, drought, hurricane, flooding and coastal hazards. These hazards are chosen because they are likely to satisfy the following two criteria: first, scientific studies have linked the hazard to climate change; and second, they are likely to perceptually draw attention to climate risks. For example, recent studies find extreme winter weather has become more frequent and severe due to climate change (Cohen et al., 2021). However, during the impressionable years of most CEOs in this sample, the term "global warming" was more commonly used than "climate change". Thus, experiencing unusual snowing and cold weather may not have raised concerns about climate change at that time.[14] Additionally, to distinguish extreme weather events that directly manifest rising temperatures from the rest, I divided climate-related extreme weather events into two groups: warming extreme weather, including heat, wildfire, and drought; and non-warming extreme weather, including hurricane, flooding, and coastal hazards.

After linking the above data sources, the final sample for the period 2002-2023 includes $3,828$ firm-year observations from 757 unique firms and $1,007$ unique CEOs.

3.2 Summary statistics

Panel A of Table 1 reports summary statistics for corporate carbon emissions. All variables are winsorized at the 1% and 99% levels. My primary measure for corporate emissions is carbon intensity, the metric commonly used by practitioners, defined as the ratio of CO_2 equivalent emissions (tonnes) to annual revenue (million dollars). On average, firms in the sample produce 2.108 million tonnes of Scope 1 carbon emissions per year, and the average Scope 1 carbon intensity is 148.477 tonnes per million dollars of revenue. For completeness, I also report Scope 2 and Scope 3 emissions, although fewer firms report these two scopes.

[14] 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 instead use economic damage to measure extreme weather experiences.

Panel B of Table 1 presents CEOs' extreme weather experience during impressionable years at the firm-year level. *Extreme weather experience (mil$)* is the average annual economic damage caused by climate-related extreme weather events during a CEO's college years in the county where they attended college. *Extreme weather experience (0/1)* is an indicator that equals 1 if *Extreme weather experience (mil$)* is greater than zero. In my sample, 82.3% of CEOs experienced climate-related extreme weather events during their impressionable years, and those events caused an average economic damage of 1.609 million dollars (in 2019 dollars) per year. 15.6% of CEOs experienced warming extreme weather, which caused an average economic damage of 0.330 million dollars per year, while 80.9% of CEOs experienced non-warming extreme weather that caused an average of 1.179 million dollars of economic losses. Additionally, 88.4% of CEOs had severe winter experiences during their impressionable years, with an associated economic damage of 0.501 million dollars per year. Appendix Table A1 provides summary statistics on the CEO-level, which are largely similar to the firm-year level data. It also reports the distribution of CEO birth and education cohorts. The birth year of CEOs ranges from the 1930s to the 1990s, with 33.9% born in the 1950s and 43.9% in the 1960s. In terms of education time, 36.0% of CEOs started college in the 1970s, and 40.9% started in the 1980s. Figure 3 plots the histogram of CEO birth years and Figure 4 for the education start years, both on the CEO level. Appendix Table A2 reports summary statistics for financial variables, board characteristics and other CEO demographic characteristics on the firm-year level.

4 CEO extreme weather experience and corporate carbon emissions

Due to the gradual and slow nature of climate change, climate risks are often not salient except when abnormal weather events happen. By observing the consequences of these events, one may become more aware of climate risks and take pro-environmental actions to contribute to efforts aimed at mitigating climate change. Therefore, I begin with estimating the following OLS model to examine the relationship between the CEOs' experiences of climate-related extreme weather events and their firms' Scope 1 carbon intensity:

$$\text{Log Intensity}_{i,t} = b_0 + b_1\text{CEO Disasters}_{i,t} + b_2\boldsymbol{X}_{i,t-1} + \text{Fixed Effects} + \epsilon_{i,t}, \tag{1}$$

where Log $\text{Intensity}_{i,t}$ is the natural logarithm of Scope 1 carbon intensity for firm i in year t. CEO $\text{Disasters}_{i,t}$ is an indicator that equals 1 if the CEO of firm i in year t experienced climate-related extreme weather during impressionable years (*Extreme weather experience (0/1)*). $\boldsymbol{X}_{i,t-1}$ is a set of one-year lagged control variables. These include financial variables consisting of firm size, ROA, book-to-market ratios, leverage, PPE, Tobin's q; board characteristics, including board size, the percentage of independent directors, the gender mix of the board, whether the CEO is also the board chair, and the percentage ownership of institutional investors; and CEO demographic characteristics, including age and gender.

To account for time-invariant, firm-specific unobservables that may be related to both the CEO's climate awareness and the firm's carbon emissions, such as corporate culture, I include firm fixed effects in all specifications. Year fixed effects are included to control for time-specific factors, such as the attention to corporate environmental practices. A potential concern of using year fixed effects is that different industries may have different year-level characteristics, and a firm's environmental practices are highly industry-specific. To address this, some specifications replace year fixed effects with Fama-French 12-industry-year fixed effects, allowing for varying year fixed effects across industries. In addition, CEO cohort fixed effects are used to filter out the common characteristics shared by the same generation of CEOs, such as the general frequency of extreme weather events, or common experiences with other major events. In some specifications, I also include education state fixed effects to account for unobservable factors related to the state where the CEO spent their impressionable years, such as the spatial heterogeneity in the likelihood of extreme weather events.

Table 2 presents the results, where the dependent variable is the logarithm of Scope 1 carbon intensity, and the variable of interest is the indicator for whether the CEO experienced climate-related extreme weather during impressionable years. I report the coefficients of control variables in this table, which are not displayed in other tables with similar regression specifications for brevity. The coefficients reported in the table are multiplied by 100 for enhanced readability. Across various combinations of fixed effects, the coefficient for CEO extreme weather experience remains significantly negative, indicating that CEOs who experienced climate-related extreme weather during their impression years are associated with significantly lower Scope 1 carbon intensity at their firms. The effect is both statistically and economically significant. For example, the result in Column (7) shows that, when controlling for firm, industry-year, and CEO cohort fixed effects, a firm with a CEO who experienced extreme weather events during her impressionable years produces, on average, a 11.1% lower Scope 1 carbon intensity. Given that the sample's average Scope 1 carbon intensity is 148.477 tonnes per million dollars of sales, and the sample average sales are $17,261.774$ million dollars, the magnitude of the effect translates into an average reduction in Scope 1 carbon emissions by $11.1\% \times 148.477 \times 17,261.774 = 284,490.382$ tonnes per year, equivalent to $2.845/7.513 = 37.9\%$ of one standard deviation of Scope 1 carbon emissions in the sample. Overall, these baseline results show a statistically and economically significant negative association between CEOs' extreme weather experiences during their impressionable years and their firms' Scope 1 carbon intensity, even after controlling for a range of fixed effects and firm and CEO characteristics.

Next, I examine whether the effect of extreme weather experiences varies based on the intensity of those experiences. It is plausible that more severe extreme weather events, which cause greater damage, are more likely to capture attention and lead to stronger climate impact awareness. Alternatively, the impact of experience intensity may be non-linear. For instance, similar to the effect of early-life natural disasters on financial risk preference, as documented in Bernile et al. (2017), those who witnessed the most severe extreme weather may be willing to take pro-environmental actions, while those who experienced moderate extreme weather events may downplay the impact of climate change and resist taking climate action.

I use the following measures for the intensity of extreme weather experiences: *Log economic damage of extreme weather*, which is the logarithm of 1 plus the dollar amount of economic damages (in millions of 2019 dollars), and indicators for the amount of economic damages relative to the sample distribution. For the latter, I follow the approach in Bernile et al. (2017) to distinguish the more intensive events from the rest. I construct an indicator, *Highest 50% (30%, 20%) extreme weather intensity (0/1)*, which equals 1 if the economic damage of the CEO's extreme weather experience is among the top 50% (30%, 20%) of the sample, and *Below 50% (30%, 20%) extreme weather intensity (0/1)*, which equals 1 if the CEO experienced extreme weather events but the economic damage is not within the top 50% (30%, 20%) of the sample.

Table 3 presents the results. Column (1) shows that the intensity of the CEO's extreme weather experience, as measured by economic damage, is significantly and negatively associated with the firm's Scope 1 carbon emissions. Columns (2) to (4) further confirm that the negative correlation between the firm's carbon intensity and the CEO's extreme weather experience is primarily driven by more severe weather events. For example, the results in column (3) show that, on average, a firm whose CEO experienced extreme weather within the top 30% in terms of intensity has 23.0% lower Scope 1 carbon intensity than a firm whose CEO did not experience extreme weather during their impressionable years, and this effect is statistically significant at the 1% level. CEOs who experienced less intense extreme weather still show a negative correlation with

Scope 1 carbon intensity, but the effect is smaller in magnitude (16%) and less statistically significant (10%). Overall, the above results show that the intensity of the CEO's extreme weather experience is negatively associated with the firm's Scope 1 carbon intensity, with more intense experiences leading to a stronger effect.

5 The role of information in shaping climate awareness

While the above section established a negative association between a CEO's extreme weather experiences during impression years and the firm's Scope 1 carbon intensity, it remains unclear whether these experiences alone are sufficient to shape climate awareness. Since climate impact awareness is a belief grounded in logical reasoning, the question arises: if simply experiencing climate-related extreme weather, without knowledge of climate science, leads to pro-environmental behaviors, is it truly *climate impact awareness*? Or is it more likely a subconscious change in risk preferences or social attitudes, as documented in studies such as Bernile et al. (2017) and O'Sullivan et al. (2021)? Conversely, if extreme weather experiences during impressionable years genuinely shape long-lasting climate impact awareness, then the availability of information linking climate change to such events should play a critical role in translating these experiences into climate impact awareness. Hence, in this section, I exploit the history of climate change science development and investigate the mediating role of information in transforming extreme weather experiences into climate awareness and subsequent pro-environmental behaviors.

5.1 The availability of information

I begin by examining whether access to information on climate change helps convert extreme weather experiences into climate awareness that impacts one's behaviors. To gauge the availability of climate change information to the general public, I use data from Google Ngram, specifically, the frequency of a given string among the corpse of n-grams that appear in printed books written in English and published in a particular year. A higher value means a higher frequency that this string is being used in printed sources, making it more likely that the general public has read of this concept. In Figure 1, I plot the frequencies of the terms "climate change" and "global warming" in English books published between 1960 and 2022. Notably, these phrases were almost non-existent before the 1980s. Since then, their usage has increased rapidly, reflecting the growing public access to climate change science. Therefore, I use two measures to capture the availability of climate change information: *Frequency of climate change words*, which is the sum of Google Ngram frequencies for "climate change" and "global warming" among all English books published in a given year; and *Education started after 1980 (0/1)*, which is an indicator that equals 1 if a CEO began college education in or after 1980, when climate change information became available to the general public.

I estimate the following model to examine the impact of information availability:

$$\begin{aligned}\text{Log Intensity}_{i,t} = b_0 + b_1\text{CEO Disasters}_{i,t} + b_2\text{CEO Disasters}_{i,t} \times \text{Information availability}_{i,t} \\ + b_3\text{Information availability}_{i,t} + b_4\boldsymbol{X}_{i,t-1} + \text{Fixed Effects} + \epsilon_{i,t}, \quad (2)\end{aligned}$$

where Information availability$_{i,t}$ is either *Frequency of climate change words* or *Education started after 1980 (0/1)*, corresponds to the access to climate change information during the impressionable years for the CEO of firm i in year t. I employ the same set of controls as in Equation 1, and include firm fixed effects, industry-year fixed effects, and CEO cohort fixed effects in all specifications. For the CEO cohort fixed effects, I use the decade of the CEO's birth year rather than their education time because the latter is highly correlated with the information availability measure.

Columns (1) and (2) of Table 4 report the results of Equation 2. These results show that the negative relationship between CEOs' extreme weather experience and firms' Scope 1 carbon intensity is driven by high information availability. Furthermore, I split the sample into CEOs who spent their impressionable years during periods of high and low information availability. High information availability is defined using two approaches: first, by word frequency, where the total frequency of "climate change" and "global warming" exceeds the sample median ($= 3.90 \times 10^{-8}\%$); and second, by decades, where high information availability corresponds to years on or after 1980. Columns (3) and (4) ((5) and (6)) report the results of Equation 1 for CEOs whose impressionable years occurred during periods of high (low) information availability. The results show that CEOs' extreme weather experiences are associated with lower carbon intensity only when they had access to climate change information during their impressionable years.

The above results suggest that the impact of extreme weather experiences depends on the availability of relevant information. In other words, whether extreme weather experiences can translate into climate awareness hinges on whether the CEO was able to logically link the event to climate change at the time of the event. Additionally, these results imply that while it is possible that CEOs who lacked climate change information during their impressionable years may later recall these experiences and develop climate awareness upon receiving new information, this effect is not strong enough to be detected and is not comparable to the impact of experiencing extreme weather with proper information available at the time. The fact that extreme weather experience must be paired with relevant information to influence managerial behaviors suggests that the process is not instinctive but involves interpreting and reasoning about the experience.

5.2 The quality of information

If information indeed plays a role in shaping extreme weather experiences into climate awareness, then inaccurate or incomplete information may lead to misinterpretation of these experiences, resulting in different behaviors. This possibility is particularly relevant for CEOs in the sample, as the information available to the public when climate change science was first introduced in the 1980s differed from today's consensus. First, as shown in Figure 1, the term "global warming" appeared more frequently than "climate change" until the latter began to catch up in the 2000s. Second, during the 1970s, while more scientists began predicting that the warming effects of greenhouse gases would outweigh the cooling effects of aerosol pollution, mainstream media coverage often did not reflect this emerging consensus. Instead, the media exaggerated a few studies predicting global cooling (Peterson et al., 2008). Meanwhile, the Earth experienced a slight decrease in surface temperature during the 1970s, as shown in Figure A1.

The phrasing of "global warming" and the reporting of cool weather together exposed the public to an inaccurate information environment that may lead to two types of misinterpretation of extreme weather experiences. First, as the phrase "global warming" highlights warming, one may only view extreme weather events directly related to higher temperatures as evidence supporting the theory of global warming, while overlooking other types of extreme weather that manifest in different forms. Second, one may believe everything must warm for the entire climate science to be real, therefore, media emphasis on cooling or experiences of extremely cold winters may foster climate change denial.

I divide the six types of climate-related extreme weather into two categories: "warming weather", which includes heat, wildfire, and droughts that directly manifest rising temperatures and are likely to be conceptually linked to warming; and "non-warming weather", which includes flooding, coastal events, and hurricanes. Additionally, I construct measures for experiences of severe winter weather based on the economic damage caused by those events.

I then replace the CEO experience measure in Equation 1 with indicators for experiences of warming weather, non-warming weather, and severe winter weather. Alongside firm fixed effects and industry-year fixed effects, I also include education state-year fixed effects to control for the spatial differences in the occurrence of different types of extreme weather.

Columns (1) and (2) of Table 5 show that the negative association between extreme weather experiences and firm carbon intensity is primarily driven by experiences of warming events, whereas non-warming events and severe winter events do not have significant effects. This evidence supports the existence of the first type of misinterpretation that people overlook signs of climate change that do not manifest as rising temperatures.

To further examine whether warming and severe winter experiences may be interpreted in opposing ways, I focus on CEOs who spent their impressionable years during periods of heightened misinformation. I use two definitions to identify these periods. First, I employ the ratio of the frequency of "global warming" to the frequency of "climate change" in printed books; the higher the ratio, the stronger the emphasis on "warming". Then I define years when this ratio exceeds the sample median as high misinformation periods. Second, I define the 1980s and the 1990s as periods of high misinformation, capturing the early stage of climate change science communication.

Columns (3) and (4) of Table 5 present the results of estimating Equation 1 for CEOs whose impressionable years occurred during high misinformation periods. The findings show that experiences of warming extreme weather are strongly and significantly associated with lower carbon intensity, while experiences of severe winter weather are significantly associated with higher carbon intensity. This supports the second type of misinterpretation, where cold weather is viewed as evidence against the occurrence of climate change.

The results in this section suggest that the quality of information matters in translating extreme weather experiences into climate awareness. Historically, as “global warming” was more commonly referenced than “climate change”, extreme weather events conceptually linked to warming were more likely to shape climate awareness, whereas experiences of severe cold weather had the opposite effect, hindering the formation of climate awareness. I acknowledge that these findings on misinterpretation may not apply to future generations of CEOs, because with the development of climate change science, and as scientists and mainstream media now more accurately represent both warming and non-warming signals of climate change, future generations are less likely to encounter low-quality information.

6 Robustness Tests

6.1 CEO-Firm matching on climate preferences

A CEO’s experience during their impressionable years is unlikely to directly relate to the firm’s performance because the realization of these two variables is usually decades apart. In my sample, the average CEO age is 57, while the extreme weather experiences are measured during their late adolescence to early adulthood. However, there remains a concern that CEOs and firms may be endogenously matched based on their preferences for climate policies. Specifically, a firm whose optimal climate policy is to reduce carbon intensity may choose a CEO with strong climate impact awareness who is best suited to implement such policies. While my analyses include firm fixed effects, these may not fully account for a firm’s climate preferences if those preferences change over time. Given the rapid changes in regulations and public pressures surrounding corporate carbon emissions, it is likely that a firm’s optimal climate policy evolves during my sample period, potentially contributing to the negative association between CEO extreme weather experiences and firm carbon intensity being driven by endogenous CEO-firm matching.

With the caveat that CEO assignment is naturally a matching process, I alleviate this endogeneity concern by examining changes in firm carbon intensity around plausibly exogenous CEO turnover events. I use an open-source database of CEO turnover events constructed by Gentry et al. (2021),[15] which classifies CEO departures into nine categories: CEO death, CEO illness, dismissed for job performance, dismissed for legal violations or concerns, CEO retirement, CEO seeking new opportunities, other reasons, missing reasons or Execucomp errors. Among these categories, CEO turnover due to the death, illness, or retirement of the incumbent CEO is typically considered less related to firm performance and thus plausibly exogenous to the firm (e.g., Dittmar & Duchin, 2016; Fee et al., 2013). To the extent that the timing of these CEO turnovers is largely exogenous and the pool of available candidates is limited, these turnover events create exogenous variation in the CEO assignment process.

I use a subsample of firm-year observations surrounding plausibly exogenous CEO turnover events, requiring at least two years of observations both before and after the turnover year. This subsample includes 63 CEO turnover events, among which 22 cases involve type changes in CEOs' extreme weather experience if measured by the binary variable "Extreme weather experience (0/1)". Given the relatively small variation in this binary variable, I also use the dollar value of economic damage from extreme weather experiences, and the relative intensity of such experiences in my analysis.

Table 6 shows the results. The effect of the CEO's extreme weather experience on firm Scope 1 carbon intensity remains significantly negative across different measures, with magnitudes similar to the full sample results in Table 2 and Table 3. This evidence supports that a CEO's extreme weather experience causally contributes to lower Scope 1 carbon intensity, with more

[15] This database has been updated to include turnover events after the publication of Gentry et al. (2021). For this paper, I use Version 09Nov2023, which covers turnover events identified from Execucomp up to May 2023.

intense experiences having a stronger effect.

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 of 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. (2022) 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 into the baseline regression, filtering out omitted variable that affects firms headquartered in the same state simultaneously. Table 7 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 Formative year experiences and recent experiences

Prior literature has shown that CEOs' experiences during their formative years and in recent years can influence their managerial decisions, including environmental decisions (Garel & Petit-Romec, 2022; O'Sullivan et al., 2021). This raises the possibility that my results may be driven by correlations between experiences at different stages of life. To address this concern, I control for climate-related extreme weather experiences during CEOs' formative years and the most recent year, and then reestimate the effect of extreme weather experiences during impressionable years on firm carbon intensity. Following Bernile et al. (2017), I define formative years as the period between ages 5 to 15, and assume the CEO remained in her birth county during this time. I manually collected CEO birthplace data from online sources, such as Wikipedia and CEOs' interviews. Due to missing data on CEO birthplaces and the restriction to CEOs who spent their formative years after 1960—the earliest year for which SHELDUS data is available—my sample size is reduced for this analysis.

Table 8 presents the results. After controlling for the economic damage related to early-life and the most recent year's experiences with climate-related extreme weather, I find that the negative effect of extreme weather experiences during impressionable years largely remains unchanged. Columns (2) to (5) show a significant negative association between intensive extreme weather experiences during CEOs' impressionable years and firm Scope 1 carbon intensity, while the effects of early-life and recent experiences are not statistically significant and smaller in magnitude. Although the coefficient for the indicator of extreme weather experiences during impressionable years is insignificant in column (1), it remains negative, consistent with the baseline results.

6.4 Firm performance

In this section, I examine whether CEOs with higher climate awareness achieve lower Scope 1 carbon intensity at the cost of firm performance. Specifically, I test the correlation between CEOs' extreme weather experiences during impressionable years and their firms' performance, measured by the level of sales, the growth rate of sales, Tobin's q, and ROA. I replace the dependent variable in Equation 1 with each of these performance measures.

Table 9 shows the results. I find no evidence that CEOs' extreme weather experiences are associated with worse firm performance. In fact, column (1) shows that such experience is associated with significantly higher sales. These results suggest that CEOs do not cut production to reduce carbon emissions, instead, they focus on improving carbon efficiency, consistent with the emphasis on carbon intensity in current investment practices.

6.5 Other environmental initiatives

CEOs' climate awareness may extend beyond carbon emissions for two reasons. First, increased attention to climate issues may lead to a broader concern for environmental matters. Second, for firms that cannot reduce their carbon intensity in the short term, potentially due to financial or technological constraints, CEOs may still signal their environmental commitment through other initiatives. Therefore, in this section, I examine the relationship between CEOs' extreme weather experiences during their impressionable years and other firm-level environmental practices.

Table 10 shows that CEOs with extreme weather experiences are associated with higher likelihood to adopt other environmental initiatives, including reporting environmental expenditures of their firms, making environmental investments, and engaging in environmental restoration initiatives. These findings suggest that climate awareness is likely correspond with a broader interest in managing environmental externalities and enhancing the firm's ESG practices. A caveat to these results is that these actions may be more symbolic, and their real impact may not be as evident as reductions in carbon intensity.

7 Conclusion

This paper examines the effect of CEOs' personal climate awareness on corporate carbon emissions. Long-term climate awareness is likely to form during one's impressionable years when she experiences climate-related extreme weather experiences, and the information environment at the time allows her to causally relate the experience to climate change.

I find that firms whose CEO experienced climate-related extreme weather have lower Scope 1 carbon intensity. Both the availability and the quality of climate change science at the time of the experience are crucial in the formation of climate awareness. First, only experiences gained after the introduction of climate change science are related to lower Scope 1 carbon intensity, suggesting the lack of information can hinder the translation from extreme weather experiences to climate awareness. Second, consistent with the phrasing of "global warming", experiences of extreme weather that directly manifest a rising global average temperature have the most pronounced effect on firm carbon intensity, and experiences of extreme cold winters can have the opposite effect when misinformation is particularly severe. I show that the effect of climate awareness formed during impression years is distinct from and incremental to the effect of similar experiences during CEOs' earlier lives and more recent years. Exploring plausibly exogenous

CEO turnover events, I confirm that high CEO climate awareness has a causal impact on reducing firm Scope 1 carbon intensity.

In summary, this study finds CEOs' climate awareness as a new determinant of corporate carbon emissions. Such awareness is shaped during CEOs' impressionable years by a combination of climate-related extreme weather experiences and information that causally links these events to the phenomenon of climate change. I highlight that information plays a vital role in transforming experiences into managerial styles. Insufficient or inaccurate information can distort the interpretation of experiences, leading to different outcomes. These findings are particularly relevant for CEOs who served in recent decades as a significant percentage of them may have encountered 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.

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Tables and Figures

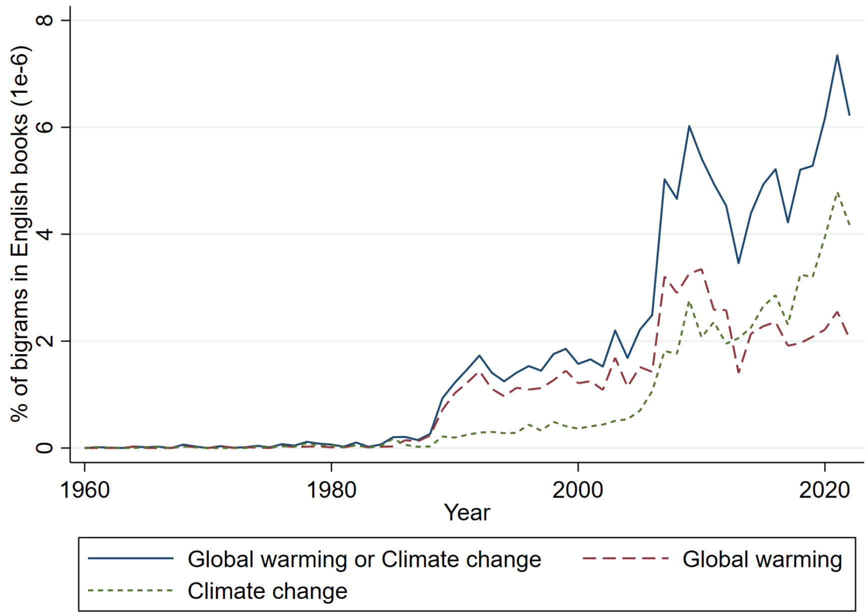


Figure 1. Frequency of “climate change” and “global warming” in English-language books (Data source: Google Ngram)

This figure shows the frequency of climate-related terms in printed English-language books published from 1960 to 2021. The red long-dashed line represents the frequency of the phrase "global warming" among all bigrams in the corpus of printed books published in each year. The green short-dashed line represents the frequency of the phrase "climate change." The blue solid line shows the total frequency of both phrases combined.

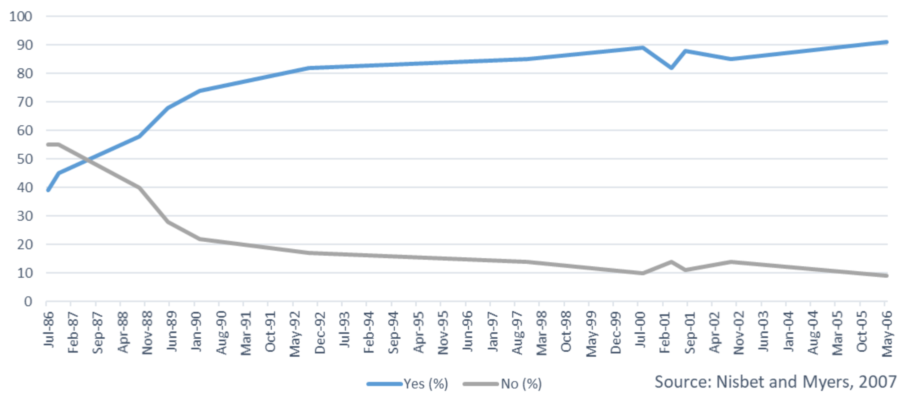


Figure 2. Poll results: percentage of Americans that are aware of global warming as a problem in the US

This figure plots the responses to the question, ”Have you heard or read anything about the ‘greenhouse effect,’ or not?” from polls conducted in the U.S. between 1986 and 2006. The data is compiled by Nisbet and Myers (2007) from various polls.

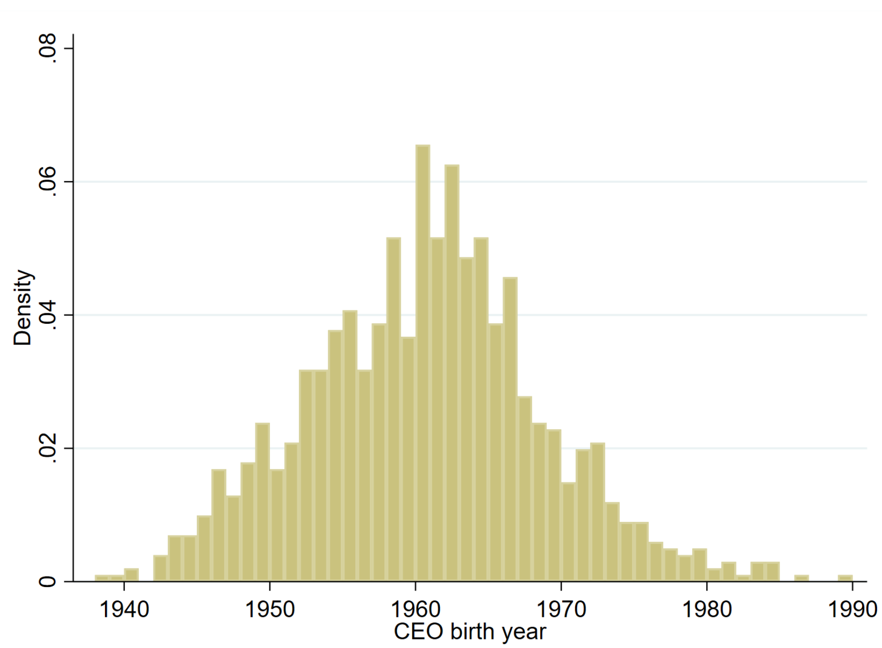


Figure 3. Histogram of CEO birth year

This figure shows the distribution of CEO birth years in the sample.

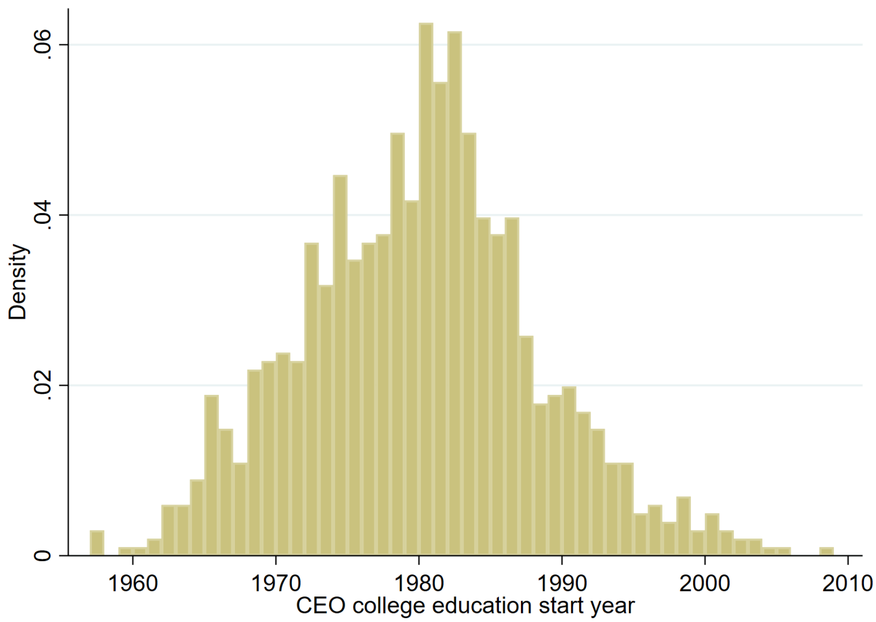
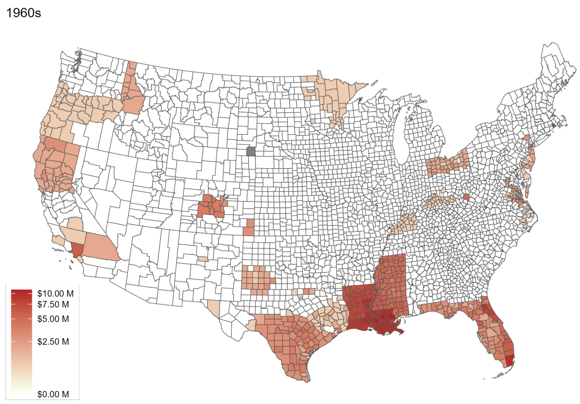
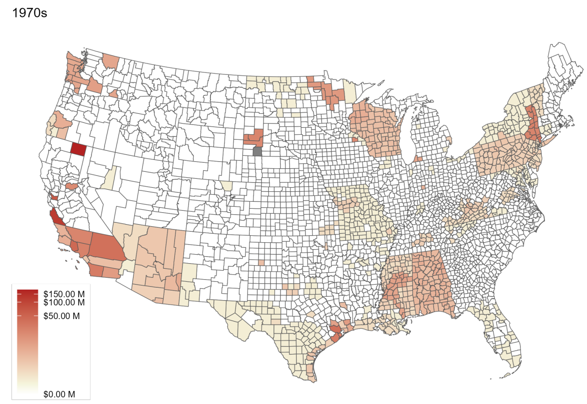


Figure 4. Histogram of CEO college education start year

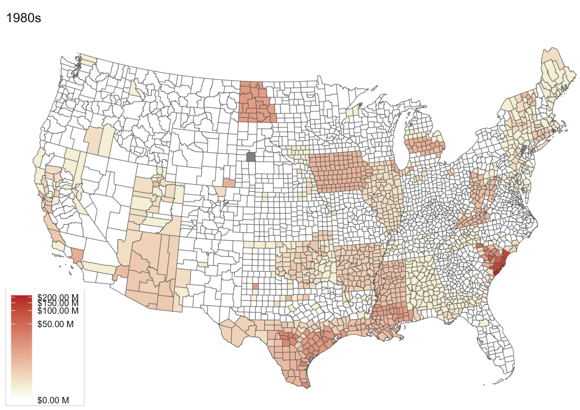
This figure shows the distribution of the starting years of CEOs' college education in the sample.



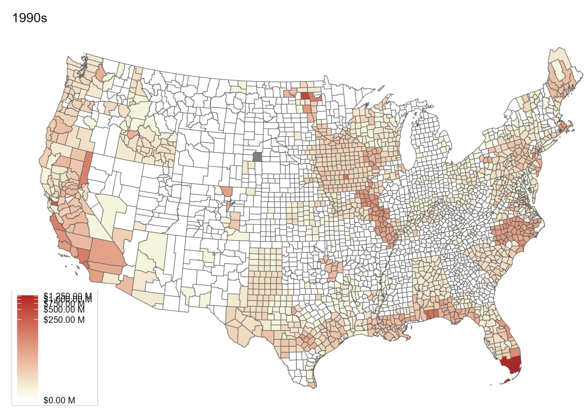
(a) 1960s



(b) 1970s



(c) 1980s



(d) 1990s

Figure 5. Spatial distribution of annual average economic damages from climate-related extreme weather events

This figure shows the spatial distribution of annual average economic damages caused by climate-related extreme weather events at the U.S. county level across four decades, from the 1960s to the 1990s. Climate-related extreme weather events include heat, wildfires, droughts, flooding, hurricanes, and coastal hazards. Economic damage represents the total economic losses from crop damage and property damage. Darker colors indicate larger economic damages.

Table 1. Summary statistics

This table reports summary statistics of key variables in the sample over the period 2002-2023. Panel A presents measures for corporate carbon emissions. *Scope 1 (2, 3) emissions (10^6 tonnes)* is the amount of Scope 1 (2, 3) carbon emissions produced by a firm in a given year. 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. *Scope 1 (2, 3) carbon intensity* is the amount of Scope 1 (2, 3) carbon emissions produced by a firm in a given year, measured in tonnes, divided by the firm's revenue of the year, measured by million dollars. Panel B presents variables of CEOs' extreme weather experiences on the firm-year level. *Extreme weather experience (0/1)* equals 1 if the CEO experienced climate-related extreme weather events that caused economic damage during impressionable years. *Extreme weather experience (mil$)* is the amount of economic damage caused by the climate-related extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions. Climate-related extreme weather events include heat, wildfire, droughts, hurricanes, coastal events, and flooding. *Warming extreme weather experience (0/1)* equals 1 if the CEO experienced warming extreme weather events that caused economic damage during impressionable years. *Warming extreme weather experience (mil$)* is the amount of economic damage caused by the warming extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions. Warming extreme weather events include heat, wildfire, and droughts. *Non-warming extreme weather experience (0/1)* equals 1 if the CEO experienced non-warming extreme weather events that caused economic damage during impressionable years. *Non-warming extreme weather experience (mil$)* is the amount of economic damage caused by the non-warming extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions. Non-warming extreme weather events include hurricanes, coastal events, and flooding. *Winter extreme weather experience (0/1)* equals 1 if the CEO experienced severe winter weather events that caused economic damage during impressionable years. *Winter extreme weather experience (mil$)* is the amount of economic damage caused by the severe winter weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions.

	Count	Mean	SD	p25	Median	p75
Panel A: Corporate carbon emissions						
Scope 1 emissions (10^6 tonnes)	3,828	2.108	7.513	0.014	0.088	0.565
Scope 2 emissions (10^6 tonnes)	3,681	0.634	1.321	0.037	0.142	0.585
Scope 3 emissions (10^6 tonnes)	1,937	16.292	58.591	0.035	0.257	3.841
Scope 1 carbon intensity	3,828	148.477	430.897	2.435	11.907	78.142
Scope 2 carbon intensity	3,681	51.980	102.594	8.044	19.855	50.133
Scope 3 carbon intensity	1,937	992.445	3903.849	5.475	34.592	312.762
Panel B: CEOs' extreme weather experience (firm-year level)						
Extreme weather experience (0/1)	3,828	0.823	0.382	1.000	1.000	1.000
Extreme weather experience (mil$)	3,828	1.609	3.986	0.003	0.078	1.100
Warming extreme weather experience (0/1)	3,828	0.156	0.363	0.000	0.000	0.000
Warming extreme weather experience (mil$)	3,828	0.330	2.148	0.000	0.000	0.000
Non-warming extreme weather experience (0/1)	3,828	0.809	0.393	1.000	1.000	1.000
Non-warming extreme experience (mil$)	3,828	1.179	2.821	0.001	0.049	0.719
Winter extreme weather experience (0/1)	3,828	0.884	0.320	1.000	1.000	1.000
Winter extreme weather experience (mil$)	3,828	0.501	1.517	0.003	0.027	0.170

Table 2. The effect of CEO extreme weather experience on corporate emissions

This table examines the relationship between the CEO's extreme weather experiences during impressionable years and the firm's Scope 1 carbon intensity. The dependent variable is the logarithm of the firm's Scope 1 carbon intensity. The variable of interest is *Extreme weather experience (0/1)*, which equals 1 if the CEO experienced climate-related extreme weather events that caused economic damage during impressionable years. Firm fixed effects are included in all columns. Different combinations of year fixed effects, Fama-French-12-industry-year fixed effects, CEO education state fixed effects, and CEO cohort fixed effects are included in different columns. Standard errors are clustered at the firm level. T-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log Scope 1 carbon intensity							
Extreme weather experience (0/1)	-0.133*	-0.131*	-0.137**	-0.135**	-0.109*	-0.119	-0.111**	-0.120*
	(-1.883)	(-1.732)	(-2.093)	(-2.021)	(-1.820)	(-1.619)	(-2.016)	(-1.888)
Firm size	-0.122	-0.105	-0.115	-0.095	-0.090	-0.088	-0.086	-0.083
	(-1.514)	(-1.376)	(-1.482)	(-1.289)	(-1.143)	(-1.158)	(-1.126)	(-1.109)
ROA	0.175	0.164	0.206	0.213	0.358	0.308	0.375	0.349
	(0.664)	(0.612)	(0.788)	(0.801)	(1.294)	(1.086)	(1.382)	(1.249)
Book-to-market ratio	0.025	0.015	0.019	0.010	0.020	0.015	0.011	0.007
	(0.359)	(0.223)	(0.278)	(0.146)	(0.286)	(0.213)	(0.159)	(0.099)
Leverage	0.090	0.100	0.042	0.043	0.387	0.289	0.341	0.231
	(0.198)	(0.249)	(0.094)	(0.108)	(0.935)	(0.751)	(0.839)	(0.615)
PPE	0.937	0.692	0.909	0.647	0.796	0.722	0.722	0.624
	(1.478)	(1.169)	(1.418)	(1.094)	(1.274)	(1.185)	(1.130)	(1.021)
Tobin's q	-0.084***	-0.079***	-0.088***	-0.081***	-0.070**	-0.065**	-0.075**	-0.069**
	(-2.756)	(-2.978)	(-2.931)	(-3.158)	(-2.337)	(-2.350)	(-2.553)	(-2.552)
Board size	-0.002	0.004	-0.001	0.003	0.000	0.003	0.002	0.003
	(-0.142)	(0.291)	(-0.097)	(0.197)	(0.022)	(0.249)	(0.129)	(0.215)
Board independence	0.728	0.604	0.724	0.632	0.621	0.559	0.609	0.548
	(1.474)	(1.207)	(1.452)	(1.250)	(1.097)	(0.970)	(1.076)	(0.938)
Board gender ratio	0.232	0.239	0.272	0.303	0.141	0.200	0.172	0.231
	(0.683)	(0.784)	(0.805)	(0.991)	(0.392)	(0.627)	(0.483)	(0.724)
CEO is chair (0/1)	0.002	-0.003	-0.005	-0.015	0.022	0.014	0.014	0.003
	(0.064)	(-0.083)	(-0.143)	(-0.401)	(0.551)	(0.372)	(0.361)	(0.073)
CEO age	-0.005	-0.006	0.000	-0.004	-0.005	-0.005	0.002	-0.004
	(-1.032)	(-1.109)	(0.037)	(-0.473)	(-0.940)	(-1.000)	(0.176)	(-0.418)
Male CEO (0/1)	-0.065	0.013	-0.088	-0.045	0.024	0.042	-0.005	-0.019
	(-0.709)	(0.097)	(-0.970)	(-0.359)	(0.312)	(0.346)	(-0.064)	(-0.173)
Institutional ownership	0.188*	0.198*	0.179*	0.190*	0.208	0.220*	0.204	0.214*
	(1.754)	(1.891)	(1.650)	(1.859)	(1.624)	(1.768)	(1.567)	(1.738)
N	3,828	3,828	3,828	3,828	3,828	3,828	3,828	3,828
Within adjusted R^2	0.022	0.016	0.021	0.014	0.013	0.011	0.013	0.010
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	No	No	No	No
Industry-year FE	No	No	No	No	Yes	Yes	Yes	Yes
Education state FE	No	Yes	No	Yes	No	Yes	No	Yes
Cohort (edu. time) FE	No	No	Yes	Yes	No	No	Yes	Yes

Table 3. The intensity of CEO extreme weather experience and corporate emissions

This table examines the relationship between the intensity of the CEO's extreme weather experiences during impressionable years and the firm's Scope 1 carbon intensity. The dependent variable is the logarithm of the firm's Scope 1 carbon intensity. The variable of interest in column (1) is *Log economic damage of extreme weather*, which is the logarithm of 1 plus the economic damage caused by the climate-related extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions. The variables of interest in columns (2) to (4) are indicators for the relative intensity of the CEO's extreme weather experiences. *Highest 50% (30%, 20%) extreme weather intensity (0/1)* equals 1 if the economic damage of the CEO's extreme weather experience is among the top 50% (30%, 20%) of the sample, and *Below 50% (30%, 20%) extreme weather intensity (0/1)*, which equals 1 if the CEO experienced extreme weather events but the economic damage is not within the top 50% (30%, 20%) of the sample. I employ the same set of one-year lagged financial variables and board characteristics as control variables as presented in Table 2: firm size, ROA, book-to-market ratio, leverage, PPE, Tobin's q, board size, board independence, board gender ratio, combined CEO-chair, institutional ownership; and the same set of CEO characteristics: age and gender. Firm fixed effects, Fama-French-12-industry-year fixed effects, and CEO cohort fixed effects are included in all columns. Standard errors are clustered at the firm level. The coefficients reported for *Log economic damage of extreme weather* is multiplied by 100. T-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	Log Scope 1 carbon intensity			
Log economic damage of extreme weather	-8.776*			
	(-1.900)			
Highest 50% extreme weather intensity (0/1)		-0.121*		
		(-1.683)		
Below 50% extreme weather intensity (0/1)		-0.101		
		(-1.491)		
Highest 30% extreme weather experience (0/1)			-0.230***	
			(-2.755)	
Below 30% extreme weather experience (0/1)			-0.160*	
			(-1.920)	
Highest 20% extreme weather experience (0/1)				-0.198**
				(-2.287)
Below 20% extreme weather experience (0/1)				-0.081
				(-1.379)
N	3,828	3,828	3,828	3,828
Within adjusted R^2	0.013	0.012	0.018	0.014
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Cohort (edu. time) FE	Yes	Yes	Yes	Yes

Table 4. Availability of information and the effect of extreme weather experiences

This table examines the mediating role of the availability of information in the relationship between the intensity of the CEO's extreme weather experiences during impressionable years and the firm's Scope 1 carbon intensity. The dependent variable is the logarithm of the firm's Scope 1 carbon intensity. There are two measures for information availability: *Frequency of climate change words* is the sum of Google Ngram frequencies for "climate change" and "global warming" among all English books published in a given year. *Education started after 1980 (0/1)* is an indicator that equals 1 if a CEO began college education in or after 1980, when climate change information became available to the general public. The measure for CEOs' extreme weather experiences is *Extreme weather experience (0/1)*, which equals 1 if the CEO experienced climate-related extreme weather events that caused economic damage during impressionable years. Columns (1) and (2) use the full sample, whereas columns (3) and (4) use the subsample where the CEOs spent their impressionable years during periods of high information availability, and columns (5) and (6) use the subsample where the CEOs spent their impressionable years during periods of low information availability. In columns (3) and (5), information availability is defined by the frequency of climate words in books published in a given year, and high (low) availability periods include years where the total frequency of "climate change" and "global warming" exceeds (below) the sample median ($= 3.90 \times 10^{-8}$%). In columns (4) and (6), information availability is defined by decades, and high (low) availability periods include years on or after (before) 1980. I employ the same set of one-year lagged financial variables and board characteristics as control variables as presented in Table 2: firm size, ROA, book-to-market ratio, leverage, PPE, Tobin's q, board size, board independence, board gender ratio, combined CEO-chair, institutional ownership; and the same set of CEO characteristics: age and gender. Firm fixed effects, Fama-French-12-industry-year fixed effects, and CEO cohort fixed effects are included in all columns. Standard errors are clustered at the firm level. T-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Log Scope 1 carbon intensity					
	Full sample		High availability		Low availability	
			By word freq.	By decades	By word freq.	By decades
	(1)	(2)	(3)	(4)	(5)	(6)
Extreme weather experience (0/1)	-0.062	0.002	-0.290*	-0.444***	-0.072	0.110
	(-1.003)	(0.032)	(-1.887)	(-3.409)	(-0.739)	(1.188)
Frequency of climate change words	0.013					
	(0.428)					
Extreme weather experience (0/1) × Frequency of climate change words	-0.045*					
	(-1.690)					
Edu. started after 1980		0.400**				
		(2.514)				
Extreme weather experience (0/1) × Edu. started after 1980		-0.313**				
		(-2.199)				
N	3,828	3,828	1,703	1,710	2,125	2,118
Within adjusted R^2	0.014	0.016	0.017	0.038	0.012	0.004
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort (birth time) FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 5. Quality of information and the effect of extreme weather experiences

This table examines the role of the information quality in the relationship between the intensity of the CEO's extreme weather experiences during impressionable years and the firm's Scope 1 carbon intensity. The dependent variable is the logarithm of the firm's Scope 1 carbon intensity. The variables of interest are *Warming extreme weather experience (0/1)*, an indicator that equals 1 if the CEO experienced warming extreme weather events that caused economic damage during impressionable years; *Non-warming extreme weather experience (0/1)*, an indicator that equals 1 if the CEO experienced non-warming extreme weather events that caused economic damage during impressionable years; and *Winter extreme weather experience (0/1)*, an indicator that equals 1 if the CEO experienced severe winter weather events that caused economic damage during impressionable years. Columns (1) and (2) use the full sample. Columns (3) and (4) use the subsample where the CEOs spent their impressionable years during periods of low information quality (i.e., high misinformation). I use two definitions to define periods of high misinformation. Column (4) employs the ratio of the frequency of "global warming" to the frequency of "climate change" in printed English books published in a given year, and high misinformation periods include years when this ratio exceeds the sample median as high misinformation periods. Column (3) employs a decade-based definition, where the 1980s and the 1990s as periods of high misinformation. I employ the same set of one-year lagged financial variables and board characteristics as control variables as presented in Table 2: firm size, ROA, book-to-market ratio, leverage, PPE, Tobin's q, board size, board independence, board gender ratio, combined CEO-chair, institutional ownership; and the same set of CEO characteristics: age and gender. Firm fixed effects, Fama-French-12-industry-year fixed effects, and CEO education state-education time fixed effects are included in all columns. Standard errors are clustered at the firm level. T-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Log Scope 1 carbon intensity			
	Full sample		High misinfo.	
			By decades	By word freq.
	(1)	(2)	(3)	(4)
Warming extreme weather experience (0/1)	-0.179*	-0.179*	-0.869***	-0.752***
	(-1.790)	(-1.743)	(-3.952)	(-4.564)
Non-warming extreme weather experience (0/1)	-0.087	-0.086	0.303	0.182
	(-1.151)	(-1.095)	(1.465)	(0.779)
Winter extreme weather experience (0/1)		-0.008	0.520**	0.484*
		(-0.064)	(2.016)	(1.932)
N	3,828	3,828	1,678	1,924
Within adjusted R^2	0.014	0.013	0.030	0.035
Controls FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Edu state-time FE	Yes	Yes	Yes	Yes

Table 6. Emissions around Plausibly exogenous CEO turnover events

This table employs a subsample of observations surrounding plausibly exogenous CEO turnover events and examines the relationship between the CEO's extreme weather experiences during impressionable years and the firm's Scope 1 carbon intensity in this subsample. These CEO turnovers are triggered by the death, illness, or retirement of the incumbent CEO, using reasons classified by Gentry et al. (2021). The subsample includes 63 CEO turnover events. The dependent variable is the logarithm of the firm's Scope 1 carbon intensity. The variable of interest are measures of CEOs' extreme weather experinces. *Extreme weather experience (0/1)* is an indicator variable that equals 1 if the CEO experienced climate-related extreme weather events that caused economic damage during impressionable years. *Log economic damage of extreme weather* is the logarithm of 1 plus the economic damage caused by the climate-related extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions. *Highest 50% (30%, 20%) extreme weather intensity (0/1)* is an indicator that equals 1 if the economic damage of the CEO's extreme weather experience is among the top 50% (30%, 20%) of the sample, and *Below 50% (30%, 20%) extreme weather intensity (0/1)* is an indicator that equals 1 if the CEO experienced extreme weather events but the economic damage is not within the top 50% (30%, 20%) of the sample. I employ the same set of one-year lagged financial variables and board characteristics as control variables as presented in Table 2: firm size, ROA, book-to-market ratio, leverage, PPE, Tobin's q, board size, board independence, board gender ratio, combined CEO-chair, institutional ownership; and the same set of CEO characteristics: age and gender. Turnover event fixed effects, Fama-French-12-industry-year fixed effects, and CEO cohort fixed effects are included in all columns. Standard errors are clustered at the firm level. The coefficients reported for *Log economic damage of extreme weather* is multiplied by 100. *T*-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Log Scope 1 carbon intensity				
	(1)	(2)	(3)	(4)	(5)
Extreme weather experience (0/1)	-0.162*				
	(-1.679)				
Log economic damage of extreme weather		-12.125*			
		(-1.827)			
Highest 50% extreme weather intensity (0/1)			-0.236**		
			(-2.336)		
Lowest 50% extreme weather intensity (0/1)			-0.088		
			(-0.794)		
Highest 30% extreme weather experience (0/1)				-0.202*	
				(-1.994)	
Below 30% extreme weather experience (0/1)				-0.016	
				(-0.159)	
Highest 20% extreme weather experience (0/1)					-0.246**
					(-2.156)
Below 20% extreme weather experience (0/1)					-0.097
					(-1.024)
N	554	554	554	554	554
Within adjusted R^2	0.052	0.052	0.056	0.057	0.058
Controls	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
Cohort (birth time) FE	Yes	Yes	Yes	Yes	Yes
Turnover event FE	Yes	Yes	Yes	Yes	Yes

Table 7. The effect of CEO experience when controlling for corporate location

This table examines the relationship between the CEO's extreme weather experiences during impressionable years and the firm's Scope 1 carbon intensity when controlling for the location of firm headquarters. The definitions of the dependent variable, independent variables, and control variables are the same as those in Table 2 and Table 3. In both panels, I control for firm fixed effects, Fama-French-12-industry-year fixed effects, CEO cohort fixed effects, and firm headquarters state-year fixed effects in all columns. In Panel A, I use the full sample. In Panel B, I use the subsample of observations where the CEO's college education was in a state different from the firm's headquarter. Standard errors are clustered at the firm level. The coefficients reported for *Log economic damage of extreme weather* is multiplied by 100. *T*-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Log Scope 1 carbon emissions				
	(1)	(2)	(3)	(4)	(5)
Panel A: Full sample					
Extreme weather experience (0/1)	-0.128**				
	(-2.112)				
Log economic damage of extreme weather		-9.943*			
		(-1.962)			
Highest 50% extreme weather intensity (0/1)			-0.162**		
			(-2.126)		
Lowest 50% extreme weather intensity (0/1)			-0.087		
			(-1.245)		
Highest 30% extreme weather experience (0/1)				-0.240**	
				(-2.543)	
Below 30% extreme weather experience (0/1)				-0.151**	
				(-2.055)	
Highest 20% extreme weather experience (0/1)					-0.227**
					(-2.322)
Below 20% extreme weather experience (0/1)					-0.081
					(-1.207)
N	3,828	3,828	3,828	3,828	3,828
Within adjusted R^2	0.010	0.011	0.011	0.015	0.013
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
HQ state-year FE	Yes	Yes	Yes	Yes	Yes
Cohort (edu. time) FE	Yes	Yes	Yes	Yes	Yes
Panel B: CEOs educated in a state different from the firm's headquarters state					
Extreme weather experience (0/1)	-0.215***				
	(-2.993)				
Log economic damage of extreme weather		-15.594**			
		(-2.347)			
Highest 50% extreme weather intensity (0/1)			-0.255**		
			(-2.422)		
Lowest 50% extreme weather intensity (0/1)			-0.188**		
			(-2.126)		
Highest 30% extreme weather experience (0/1)				-0.340**	
				(-2.399)	
Below 30% extreme weather experience (0/1)				-0.262***	
				(-2.687)	
Highest 20% extreme weather experience (0/1)					-0.313**
					(-2.273)
Below 20% extreme weather experience (0/1)					-0.191**
					(-2.550)
N	3,032	3,032	3,032	3,032	3,032
Within adjusted R^2	0.014	0.013	0.014	0.020	0.015
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
HQ state-year FE	Yes	Yes	Yes	Yes	Yes
Cohort (edu. time) FE	Yes	Yes	Yes	Yes	Yes

Table 8. Controlling for early life and recent extreme weather experiences

This table examines the relationship between the CEO's extreme weather experiences during impressionable years and the firm's Scope 1 carbon intensity after controlling for the CEOs' early-life and recent extreme weather experiences. The definitions of the dependent variable and variables of interest are the same as those in Table 2 and Table 3. *Early life log economic damage of extreme weather* is the logarithm of 1 plus the economic damage caused by the climate-related extreme weather events CEOs experienced between ages 5 to 15 in their birth counties, measured in 2019 dollars in millions. *Recent log economic damage of extreme weather* is the one-year lagged logarithm of 1 plus the economic damage caused by the climate-related extreme weather events that occurred in the firm headquarters county, measured in 2019 dollars. I employ the same set of one-year lagged financial variables and board characteristics as control variables as presented in Table 2. Firm fixed effects, Fama-French-12-industry-year fixed effects, and CEO cohort fixed effects are included in all columns. Standard errors are clustered at the firm level. The coefficients reported for *Log economic damage of extreme weather* is multiplied by 100. *T*-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
	Log Scope 1 carbon intensity				
Extreme weather experience (0/1)	-0.041				
	(-0.494)				
Log economic damage of extreme weather		-12.613**			
		(-1.971)			
Highest 50% extreme weather intensity (0/1)			-0.164*		
			(-1.756)		
Lowest 50% extreme weather intensity (0/1)			0.077		
			(1.011)		
Highest 30% extreme weather experience (0/1)				-0.183*	
				(-1.873)	
Below 30% extreme weather experience (0/1)				0.081	
				(1.108)	
Highest 20% extreme weather experience (0/1)					-0.255**
					(-2.407)
Below 20% extreme weather experience (0/1)					0.056
					(0.793)
Early life log economic damage of extreme weather	0.001	0.005	0.004	0.003	0.003
	(0.192)	(0.719)	(0.650)	(0.444)	(0.453)
Recent log economic damage of extreme weather	-0.002	-0.002	-0.002	-0.002	-0.003
	(-1.087)	(-1.179)	(-1.094)	(-1.169)	(-1.287)
N	1,688	1,688	1,688	1,688	1,688
Within adjusted R^2	0.032	0.037	0.041	0.042	0.045
Firm FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
Cohort (edu. time) FE	Yes	Yes	Yes	Yes	Yes

Table 9. Firm performance and CEOs' extreme weather experiences

This table examines the relationship between the CEO's extreme weather experiences during impressionable years and the firm's financial performance. The dependent variable for each column is the logarithm of sales, the growth rate of sales, Tobin's q, and ROA, respectively. The variable of interest is *Extreme weather experience (0/1)*, which equals 1 if the CEO experienced climate-related extreme weather events that caused economic damage during impressionable years. I employ the same set of one-year lagged financial variables and board characteristics as control variables as presented in Table 2. Firm fixed effects, Fama-French-12-industry-year fixed effects, and CEO cohort fixed effects are included in all columns. Standard errors are clustered at the firm level. T-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1) Log sales	(2) Sales growth	(3) Tobin's q	(4) ROA
Extreme weather experience (0/1)	0.089***	-0.011	-0.037	-0.003
	(2.830)	(-0.738)	(-0.751)	(-0.521)
N	3,828	3,828	3,828	3,828
Within adjusted R^2	0.505	0.042	0.294	0.143
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Cohort (edu. time) FE	Yes	Yes	Yes	Yes

Table 10. Other environmental initiatives and CEOs' extreme weather experiences

This table examines the relationship between the CEO's extreme weather experiences during impressionable years and the implementation of firm-level environmental practices. The variable of interest is *Extreme weather experience (0/1)*, which equals 1 if the CEO experienced climate-related extreme weather events that caused economic damage during impressionable years. The dependent variable for column (1) is *Report environmental expenses (0/1)*, an indicator that equals 1 if the firm reports its environmental expenditures or if the firm reports that it makes proactive environmental investments. The dependent variable for column (2) is *Make environmental investments (0/1)*, an indicator that equals 1 if the firm reports on making proactive environmental investments or expenditures. The dependent variable in column (3) is *Restoration initiatives (0/1)*, an indicator that equals 1 if the firm reports or provides information on company-generated initiatives to restore the environment. I employ the same set of one-year lagged financial variables and board characteristics as control variables as presented in Table 2. Firm fixed effects, Fama-French-12-industry-year fixed effects, and CEO cohort fixed effects are included in all columns. Standard errors are clustered at the firm level. *T*-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1) Report env. exp.	(2) Make env. invt.	(3) Restoration
Extreme weather experience (0/1)	0.097**	0.101**	0.074*
	(2.290)	(2.252)	(1.685)
N	3,158	3,774	3,782
Within adjusted R^2	0.033	0.027	0.014
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes
Cohort (edu. time) FE	Yes	Yes	Yes

Appendix

A Tables and figures

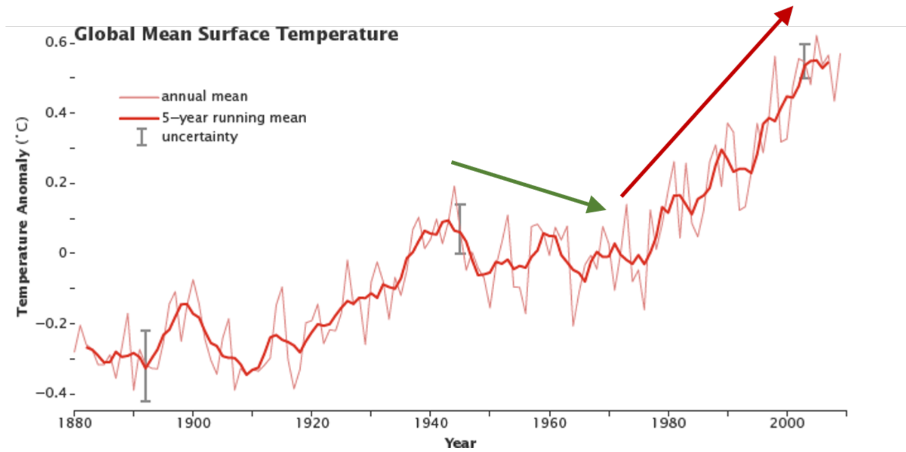


Figure A1. Global average surface temperatures (Source: NASA)

This figure illustrates the evolution of Earth's surface temperatures from the 1880s to the 2000s. The light red line represents the annual average temperatures, while the dark red line shows the 5-year rolling average.

Table A1. Summary statistics of CEOs' extreme weather experience on the CEO level

This table reports summary statistics on measures of CEOs' extreme weather experiences and their cohort on the CEO level. *Extreme weather experience (0/1)* equals 1 if the CEO experienced climate-related extreme weather events that caused economic damage during impressionable years. *Extreme weather experience (mil$)* is the amount of economic damage caused by the climate-related extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions. Climate-related extreme weather events include heat, wildfire, droughts, hurricanes, coastal events, and flooding. *Warming extreme weather experience (0/1)* equals 1 if the CEO experienced warming extreme weather events that caused economic damage during impressionable years. *Warming extreme weather experience (mil$)* is the amount of economic damage caused by the warming extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions. Warming extreme weather events include heat, wildfire, and droughts. *Non-warming extreme weather experience (0/1)* equals 1 if the CEO experienced non-warming extreme weather events that caused economic damage during impressionable years. *Non-warming extreme weather experience (mil$)* is the amount of economic damage caused by the non-warming extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions. Non-warming extreme weather events include hurricanes, coastal events, and flooding. *Winter extreme weather experience (0/1)* equals 1 if the CEO experienced severe winter weather events that caused economic damage during impressionable years. *Winter extreme weather experience (mil$)* is the amount of economic damage caused by the severe winter weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions. *Born in 1930s (0/1)* equals 1 if the CEO was born in the 1930s. Similar variables are defined for CEOs born in other decades. *Education in 1960s (0/1)* equals 1 if the CEO's college education started in the 1960s. Similar variables are defined for CEOs who had their college education in other decades.

	Count	Mean	SD	p25	Median	p75
Extreme weather experience (0/1)	1,007	0.826	0.379	1.000	1.000	1.000
Extreme weather experience (mil$)	1,007	1.648	4.108	0.003	0.101	1.135
Warming extreme weather experience (0/1)	1,007	0.173	0.378	0.000	0.000	0.000
Warming extreme weather experience (mil$)	1,007	0.416	2.394	0.000	0.000	0.000
Non-warming extreme weather experience (0/1)	1,007	0.810	0.392	1.000	1.000	1.000
Non-warming extreme experience (mil$)	1,007	1.114	2.676	0.001	0.058	0.719
Winter extreme weather experience (0/1)	1,007	0.886	0.318	1.000	1.000	1.000
Winter extreme weather experience (mil$)	1,007	0.526	1.572	0.003	0.032	0.217
Born in 1930s (0/1)	1,007	0.002	0.045	0.000	0.000	0.000
Born in 1940s (0/1)	1,007	0.101	0.302	0.000	0.000	0.000
Born in 1950s (0/1)	1,007	0.339	0.473	0.000	0.000	1.000
Born in 1960s (0/1)	1,007	0.439	0.497	0.000	0.000	1.000
Born in 1970s (0/1)	1,007	0.105	0.307	0.000	0.000	0.000
Born in 1980s (0/1)	1,007	0.013	0.113	0.000	0.000	0.000
Born in 1990s (0/1)	1,007	0.001	0.032	0.000	0.000	0.000
Education in 1960s (0/1)	1,007	0.113	0.317	0.000	0.000	0.000
Education in 1970s (0/1)	1,007	0.360	0.480	0.000	0.000	1.000
Education in 1980s (0/1)	1,007	0.409	0.492	0.000	0.000	1.000
Education in 1990s (0/1)	1,007	0.098	0.298	0.000	0.000	0.000
Education in 2000s (0/1)	1,007	0.015	0.121	0.000	0.000	0.000

Table A2. Summary statistics of firm, board, and CEO characteristics

This table reports summary statistics on firm financials, board structure, and CEO characters in the sample.

	Count	Mean	SD	p25	Median	p75
Panel A: Firm characteristics						
Firm size	3,828	8.999	1.436	7.997	8.931	9.971
ROA	3,828	0.052	0.085	0.020	0.057	0.097
Book-to-market ratio	3,828	0.399	0.355	0.176	0.316	0.527
Leverage	3,828	0.233	0.121	0.143	0.211	0.302
PPE	3,828	0.240	0.170	0.100	0.188	0.351
Tobin's q	3,828	2.254	1.486	1.310	1.777	2.615
Institutional ownership	3,828	0.786	0.192	0.716	0.829	0.913
Sales	3,828	17261.774	31997.712	2334.286	5763.512	15694.500
Panel B: Board characteristics						
Board size	3,828	10.294	2.025	9.000	10.000	12.000
Board independence	3,828	0.873	0.061	0.857	0.889	0.909
Board gender ratio	3,828	0.781	0.110	0.714	0.786	0.857
CEO is chair (0/1)	3,828	0.906	0.292	1.000	1.000	1.000
Panel C: CEO characteristics						
Male CEO (0/1)	3,828	0.939	0.239	1.000	1.000	1.000
CEO age	3,828	57.359	6.263	54.000	58.000	61.000

B Variable Definitions

Variable	Definition	Source
Scope 1 emissions	The amount of Scope 1 carbon emissions produced by a firm in a given year. Scope 1 emissions are emissions produced directly by facilities controlled by the firm.	Refinitv ESG
Scope 2 emissions	The amount of Scope 2 carbon emissions of a firm in a given year. Scope 2 emissions are indirect emissions related to energy consumption of the firm, such as electricity and heat.	Refinitv ESG
Scope 3 emissions	The amount of Scope 3 carbon emissions related to a firm in a given year. Scope 3 emissions are emissions caused by the operation of the firm but produced by other entities.	Refinitv ESG
Scope 1 carbon intensity	Scope 1 carbon emissions produced by a firm in a given year, measured in tonnes, divided by the firm's revenue of the year, measured by million dollars.	Refinitiv ESG & CCM
Scope 2 carbon intensity	Scope 2 carbon emissions produced by a firm in a given year, measured in tonnes, divided by the firm's revenue of the year, measured by million dollars.	Refinitiv ESG & CCM
Scope 3 carbon intensity	Scope 3 carbon emissions produced by a firm in a given year, measured in tonnes, divided by the firm's revenue of the year, measured by million dollars.	Refinitiv ESG & CCM
Extreme weather experience (0/1)	Indicator variable that equals 1 if the CEO experienced climate-related extreme weather events that caused economic damage during impressionable years. Climate-related extreme weather events include heat, wildfires, droughts, hurricanes, coastal events, and flooding.	SHELDUS
Extreme weather experience (mil$)	The amount of economic damage caused by the climate-related extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions.	SHELDUS
Warming extreme weather experience (0/1)	Indicator variable that equals 1 if the CEO experienced climate-related warming extreme weather events that caused economic damage during impressionable years. Climate-related warming extreme weather events include heat, wildfires, and droughts.	SHELDUS
Warming extreme weather experience (mil$)	The amount of economic damage caused by the climate-related warming extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions.	SHELDUS

Non-warming extreme weather experience (0/1)	Indicator variable that equals 1 if the CEO experienced climate-related non-warming extreme weather events that caused economic damage during impressionable years. Climate-related warming extreme weather events include hurricanes, coastal events, and flooding.	SHELDUS
Non-warming extreme weather experience (mil$)	The amount of economic damage caused by the climate-related non-warming extreme weather events the CEO experienced during impressionable years, measured in 2019 dollars in millions.	SHELDUS
Winter extreme weather experience (0/1)	Indicator variable that equals 1 if the CEO experienced severe winter weather events that caused economic damage during impressionable years.	SHELDUS
Non-warming extreme weather experience (mil$)	The amount of economic damage caused by the severe winter weather the CEO experienced during impressionable years, measured in 2019 dollars in millions.	SHELDUS
Early life log economic damage of extreme weather	The logarithm of 1 plus the economic damage caused by the climate-related extreme weather events CEOs experienced between ages 5 to 15 in their birth counties, measured in 2019 dollars in millions, and using hand-collected data on CEO birth place.	SHELDUS
Recent log economic damage of extreme weather	The one-year lagged logarithm of 1 plus the economic damage caused by the climate-related extreme weather events that occurred in the firm headquarters county, measured in 2019 dollars.	SHELDUE
Frequency of climate change words	The sum of frequencies for "climate change" and "global warming" among all English books published in a given year.	Google Ngram
Early life log economic damage of extreme weather	The logarithm of 1 plus the economic damage caused by the climate-related extreme weather events CEOs experienced between ages 5 to 15 in their birth counties, measured in 2019 dollars in millions, and using hand-collected data on CEO birth place.	SHELDUS
Recent log economic damage of extreme weather	The one-year lagged logarithm of 1 plus the economic damage caused by the climate-related extreme weather events that occurred in the firm headquarters county, measured in 2019 dollars.	SHELDUE
Report environmental expenses (0/1)	Indicator variable that equals 1 if the firm reports its environmental expenditures or if the firm reports that it makes proactive environmental investments.	Refinitiv ESG
Make environmental investments (0/1)	Indicator variable that equals 1 if the firm reports on making proactive environmental investments or expenditures.	Refinitiv ESG
Restoration initiatives (0/1)	Indicator variable that equals 1 if the firm reports or provides information on company-generated initiatives to restore the environment.	Refinitiv ESG