参赛队员姓名：王可盈

中学：上海光华学院剑桥国际中心

学校地址：上海市浦东新区川周公路 2788 号

省份：上海市

国家：中国

指导教师姓名：林嵘

指导教师单位：上海光华学院剑桥国际中心

论文题目：Climate Change and Inconsistency in ESG

Climate Change and Inconsistency in ESG

Abstract: Despite evidence that ESG participation boosts financial performance, conflicting stakeholder interests that prevent full corporate engagement in ESG activities. We aim to better explain this paradox by examining the differing impacts of exogenous climate change shocks on ESG dimensions and financial performance. Our findings reveal that water scarcity generally improves overall ESG scores, particularly by boosting environmental and governance performance, while negatively affecting social performance. Conversely, high temperature shocks show mixed effects, sometimes enhancing and other times diminishing various ESG components, underscoring the complexity of corporate responses to climate stress. We identify two mechanisms behind these inconsistencies: limited resources compel firms to prioritize certain ESG aspects, leading to trade-offs; heightened risk perceptions encourage firms to adopt precautionary financial measures, which may constrain ESG investments.

Keywords: ESG paradox; Corporate performance; High temperature; Water scarcity; Stakeholder conflicts

1 Introduction

In recent decades, corporate engagement in Environmental, Social, and Governance (ESG) initiatives, also known as Corporate Social Responsibility (CSR) activities, has shifted from a peripheral concern to a core component of business strategy (Khan et al., 2016; Porter & Kramer, 2011). Existing literature strongly indicates that corporate participation in ESG/CSR not only fulfills societal expectations but also improves corporate financial performance (CFP) (Eccles et al., 2014; Friede et al., 2015). A comprehensive meta-analysis by Friede et al. (2015) reinforces this point, showing that around 90 percent of studies find a non-negative relationship between ESG activities and financial performance, with a significant majority of these studies, encompassing over 2,000 empirical papers, reporting positive outcomes.

Despite this robust evidence supporting the financial benefits of ESG engagement, a paradox persists: many firms do not fully integrate ESG into their core strategies or engage meaningfully in these activities (Amel-Zadeh & Serafeim, 2018; Eccles & Klimenko, 2019). Data from 2007 to 2022 shows that while the number of independent ESG/Social Responsibility reports issued by A-share listed companies in China has generally increased, the proportion remains relatively low, hovering between 20% and 25% (IIGF, 2023). This observation raises a critical question: if ESG practices are indeed associated with improved financial performance, why do numerous firms remain reluctant to adopt them comprehensively? This apparent disconnect, often referred to as the "ESG paradox," forms the crux of this research (Grewatsch & Kleindienst, 2017). The aim of this study is to investigate whether conflicts exist among various stakeholders and how these conflicts manifest. This is accomplished by transforming the conflicts among different stakeholders into inconsistency among the elements of ESG and financial performance. The study holds significant policy implications, as the existence of such conflicts could influence the extent and effectiveness of corporate ESG engagement.

Identifying an exogenous shock that impacts corporate ESG engagement while resulting in both gains and losses for different stakeholders is a challenge. To tackle this, we use a stylized fact that climate change acts as an exogenous shock to economic activity, providing a quasi-experimental framework (Hsiang, 2016; Carleton and Hsiang, 2016). This approach allows us to estimate the varied effects on stakeholders and gain a deeper understanding of the challenges in aligning their interests with corporate ESG strategies. Our study aims to analyses how companies can better manage stakeholder conflicts and integrate ESG considerations into their strategic goals.

In this paper, we use a unique dataset that combines detailed ESG ratings from the HuaZheng system with high-resolution climate data from TerraClimate, focusing on A-share listed companies in China from 2009 to 2023. By aligning firms' geographic coordinates with gridded climate data, we accurately measure climate shocks, such as high temperature and water scarcity events. These shocks are identified using standardized anomalies, showing deviations from long-term regional averages. Our empirical approach applies a two-way fixed effect model, along with industry and provincial fixed effects, to estimate the impact of climate variability on ESG performance and financial outcomes. This method allows us to understand how climate change affects ESG factors and financial results, shedding light on how companies manage stakeholder conflicts and resource constraints under environmental stress.

Our baseline analysis demonstrates that climate shocks, particularly high temperature and water scarcity, significantly affect various dimensions of ESG performance. Using a robust fixed effect model, our findings show that water scarcity generally enhances overall ESG scores, with positive effects observed in environmental and governance aspects but a negative impact on social scores. High temperature shocks produce inconsistent effects across ESG components, underscoring the complexity of balancing different ESG priorities. Further analysis indicates that these climate shocks also have direct financial implications: high temperature shocks are linked to small but significant increases in financial metrics like ROA, ROE, and ROIC, whereas water scarcity has a negative effect on profitability measures, including ROE and ROS. To ensure the robustness of these findings, we employed alternative ESG indicators and adjusted the measurement of climate shocks. These robustness checks confirm the stability of our results, demonstrating that climate shocks consistently influence corporate ESG and financial performance, regardless of the data source or shock measurement method used.

We identify two main mechanisms that explain the inconsistencies between ESG performance and financial outcomes under climate shocks. First, when faced with limited resources, companies are often forced to make strategic trade-offs to deal with environmental stress. This can lead them to prioritize certain ESG areas or financial stability over others. For instance, during periods of water scarcity, a firm might focus on improving its environmental and governance scores while neglecting social initiatives. Second, increased risk awareness due to climate variability drives companies to adopt cautious financial strategies, like boosting cash reserves and fine-tuning inventory management. Although these measures help manage risk, they can also limit resources available for ESG initiatives. This creates a paradox where actions aimed at protecting financial health may unintentionally undermine broader sustainability goals.

Our analysis contributes to existing literature in three major aspects. Firstly, we reveal the conflicting relationships within ESG components. While ESG is often treated as a unified "umbrella term" (Edmans, 2023; Li et al., 2024; Liang et al., 2024), this can obscure the conflicting interests among stakeholders. Existing literature has recognized that what benefits shareholders may not necessarily benefit employees or the local community, who might prioritize sustainability or equity over short-term profits (Hart & Zingales, 2017; Matten & Moon, 2020). However, these studies often limit their analysis to conflicts within a single dimension, lacking a comprehensive examination of the complex trade-offs between the various components of ESG and financial performance. Our study is closest to Nie et al. (2023), which uses an Environmental Inspection Campaign as a quasi-natural experiment. However, such campaigns often suffer from significant self-selection bias.

In contrast, our study leverages the spatial and temporal variations in the gradually shifting local climate, providing a more robust and exogenous source of variation. Furthermore, we extend Nie et al.'s three-dimensional framework by examining the inconsistencies among environmental (E), social (S), governance (G) factors, and CFP. This more detailed approach sheds light on the complex conflicts of interest among stakeholders. Our study challenges the idea that higher ESG scores automatically lead to benefits for all stakeholders. This nuanced perspective on the "ESG paradox" (Eccles et al., 2014) adds to the ongoing discussion about how firms can better balance these competing demands (Flammer, 2015).

Secondly, this study adds to the growing literature on the effects of climate change on corporate performance, focusing specifically on the nuanced impacts on ESG factors and financial outcomes. Previous research has shown that climate risks, such as extreme weather events, can disrupt corporate operations by reducing productivity, hindering business continuity, and lowering profitability (Zhang et al., 2018; Chen and Yang, 2019; Addoum et al., 2020). Climate change also influences corporate ESG practices by shaping environmental strategies, social responsibilities, and governance structures. While earlier studies have examined the aggregate effect of climate risks on overall

ESG performance (Li et al., 2024; Liang et al., 2024), few have explored how individual ESG components are differently impacted.

Our study contributes to this discussion by identifying two main mechanisms climate risks can lead to inconsistencies between ESG and financial performance. First, firms often face resource limitations when dealing with climate change, which forces them to make strategic choices. This can result in prioritizing environmental initiatives at the expense of social or governance efforts, leading to conflicting outcomes within different ESG areas. Second, heightened risk awareness due to climate change can alter corporate behavior. Companies may adopt financial strategies like increasing cash reserves or adjusting inventory turnover to guard against potential shocks, which can unintentionally clash with their ESG commitments. By exploring these mechanisms, our study provides a more detailed understanding of how climate risks shape corporate strategies, going beyond general ESG metrics to explore the underlying factors that cause discrepancies between ESG objectives and financial performance.

Thirdly, our findings shed light on how different climate risks, especially temperature and water supply, affect firm performance in varying ways. While previous research has broadly documented the impacts of these climate factors on corporate outcomes, few studies have delved into how firms respond differently to specific climate risks (Liu et al., 2024; Almaghrabi, 2023; Huang et al., 2023). For example, rising temperatures can disrupt operations and supply chains, particularly in coastal areas, leading to lower financial returns (Liu et al., 2024). Likewise, changes in water supply can significantly reduce productivity in industries that rely on stable water resources, like agriculture and manufacturing, resulting in higher operational costs (Huang et al., 2023).

Our study fills this gap by examining how firm performance varies with exposure to temperature changes versus fluctuations in water supply. We find that companies adopt different adaptive behaviors and resilience strategies depending on the type of climate risk they face. This provides a more nuanced understanding of how specific climate variables interact with corporate performance, adding depth to the existing literature.

The remainder of the paper is organized as follows. Section 2 reviews relevant literature and conceptual framework. Section 3 discusses data and measurement methods. Section 4 outlines the empirical strategy. Section 5 presents the effects of climate change on ESG inconsistencies. Section 6 explores mechanisms behind these effects. Section 7 concludes.

2 Literature review and conceptual framework

2.1 Climate change and inconsistency in ESG

The impact of climate change on corporate Environmental, Social, and Governance (ESG) performance has received growing attention, especially regarding the varied effects on different ESG dimensions. Environmental factors, such as high temperatures and water scarcity, significantly influence corporate environmental initiatives. Companies facing these conditions are more likely to invest in environmental management practices, such as reducing greenhouse gas emissions, improving energy efficiency, and optimizing water use, to mitigate their environmental footprint (Linnenluecke & Griffiths, 2010).

However, the social dimension of ESG often responds differently to climate pressures. While firms may prioritize environmental investments, social initiatives like employee welfare, community engagement, and social donations may receive less focus when resources are limited (Flammer, 2015). This trade-off occurs because environmental initiatives can directly address climate risks and generate cost savings, whereas the benefits of social initiatives are less immediate (Bansal et al., 2015). Such prioritization can lead to inconsistencies in a company's overall ESG performance.

Governance practices are also affected by climate change, though the impact is more complex. Effective governance can enhance risk management and support stronger ESG performance (Eccles et al., 2014). However, governance structures may also prioritize immediate financial performance and shareholder returns during climate stress, potentially sidelining long-term sustainability goals (Grewatsch & Kleindienst, 2017). This variability in governance responses can contribute to inconsistent ESG outcomes.

Financial performance, closely linked to ESG strategies, also varies under climate pressures. Climate-induced resource constraints can differently affect profitability, depending on a firm's adaptive capacity and strategic priorities (Porter & Kramer, 2006). Firms investing heavily in adaptive measures may face short-term profitability reductions due to increased costs (Orlitzky et al., 2003). In contrast, companies successfully integrating climate resilience into their operations may see enhanced long-term financial performance through reduced vulnerability and improved efficiency (Clark et al., 2015).

Overall, climate change does not affect all ESG and financial performance aspects in the same way. The impact depends on the specific climate risks each firm faces and how they respond strategically. This variability forces companies to balance their ESG commitments, often leading to uneven outcomes across ESG categories and financial performance (Bergman et al., 2019).

2.2 Climate change and limited resources

The differential impact of climate change on corporate ESG and financial performance can be explained through the lens of resource constraints and prioritization decisions. According to resource-based theory, firms operate with limited resources that must be allocated strategically to optimize their overall objectives (Barney, 1991; Peteraf, 1993). When faced with climate change shocks, companies must decide how to allocate these finite resources across various competing needs, such as environmental management, social contributions, and financial operations (Hart, 1995; Russo & Fouts, 1997). These allocation decisions are influenced by stakeholder pressures and perceived returns on investments in different areas (Porter & Kramer, 2011; Eccles et al., 2014).

For instance, a firm might choose to invest heavily in environmental initiatives to mitigate the impacts of high temperatures or water scarcity, which could limit the resources available for other critical areas like research and development or administrative functions. The opportunity cost of focusing on environmental performance may lead to underinvestment in other areas, potentially affecting social performance and financial outcomes differently (Hart & Dowell, 2011). This trade-off highlights that improvements in one dimension of ESG performance might come at the expense of another, demonstrating the complex balancing act companies face in response to climate change (King & Lenox, 2002; Orlitzky et al., 2003).

Furthermore, stakeholder theory suggests that firms' resource allocation decisions are often influenced by the diverse demands of different stakeholder groups (Donaldson & Preston, 1995; Freeman, 2010). Shareholders may prioritize financial returns, while regulators, customers, and the public might push for enhanced environmental performance. The need to balance these sometimes-conflicting demands can lead firms to prioritize certain aspects of ESG performance over others, depending on which stakeholder group wields more influence or poses greater risks (Mitchell et al., 1997; Agle et al., 1999). This prioritization can result in inconsistencies in how climate shocks impact various aspects of a firm's ESG performance and financial health, reflecting the strategic navigation of limited resources in response to external pressures (Delmas & Toffel, 2008; Eccles et al., 2012).

This theoretical perspective explains why firms might respond differently across ESG and financial dimensions when faced with climate change shocks, emphasizing the need to understand internal resource allocation and the impact of stakeholder pressures (Ioannou & Serafeim, 2012; Flammer, 2013).

2.3 Climate change and rising risk

The link between climate change and heightened risk perceptions among corporate managers is increasingly recognized as crucial in shaping strategic business decisions. As climate change intensifies the frequency and severity of extreme weather events, managers are prompted to reassess their risk management frameworks to ensure organizational resilience (Bansal et al., 2015; Flammer, 2021). This heightened risk perception often leads to precautionary behaviors, such as increasing cash reserves to mitigate potential financial disruptions from unforeseen climate shocks (Bates et al., 2009; Graham et al., 2015). Holding more cash provides firms with the liquidity needed to handle unexpected costs or operational interruptions, thereby maintaining financial stability in uncertain environmental conditions (Palazzo, 2012; Harford et al., 2008).

Besides holding more cash, companies may adjust their inventory management to mitigate climate-related risks. Firms facing high-temperature risks or water scarcity might increase inventory turnover rates, reducing the days goods remain in inventory and overall inventory levels. This approach minimizes capital tied up in stock, enhancing cash flow and providing flexibility to respond to sudden climate-related supply chain disruptions (Ellinger et al., 2011; Gaur, Fisher, & Raman, 2005). Optimizing inventory management ensures firms do not overcommit resources to stock that may not sell during climate-induced market disruptions (Sheffi, 2015; Sodhi, 2020).

These risk management strategies vary across different types of climate risks. High temperatures may drive firms to invest in cooling technologies or infrastructure, while water scarcity might lead to investments in water-efficient processes or alternative water sources (Linnenluecke & Griffiths, 2010; Zilberman et al., 2002). The specific climate threat informs the managerial response, underscoring the need for tailored strategies that address unique environmental challenges (Dess & Beard, 1984).

These findings reveal the complex relationships between climate change, risk perception, and corporate behavior. As managers become more aware of climate risks, they are likely to adjust their strategies to boost resilience, focusing on managing cash flow and improving inventory efficiency. Such adaptive measures show a proactive stance on risk management and illustrate the range of corporate responses to different climate challenges (Luo & Bhattacharya, 2009; Pinkse & Kolk, 2012). Understanding these patterns is crucial for crafting corporate policies that address the changing landscape of climate risk.

2.4 Conceptual framework

In summary, this chapter examined how climate change can cause inconsistencies in ESG performance by analyzing the effects of high temperatures and water scarcity on different ESG aspects and financial outcomes. The analysis identified two main mechanisms: limited resources restrict firms from evenly distributing investments across ESG and financial areas, while increased risk perceptions lead to changes in corporate strategies, affecting cash management and inventory turnover. These findings form the basis of our theoretical framework, shown in the conceptual diagram (Figure 1), which outlines the relationships between climate change, resource allocation, risk perception, and ESG performance.

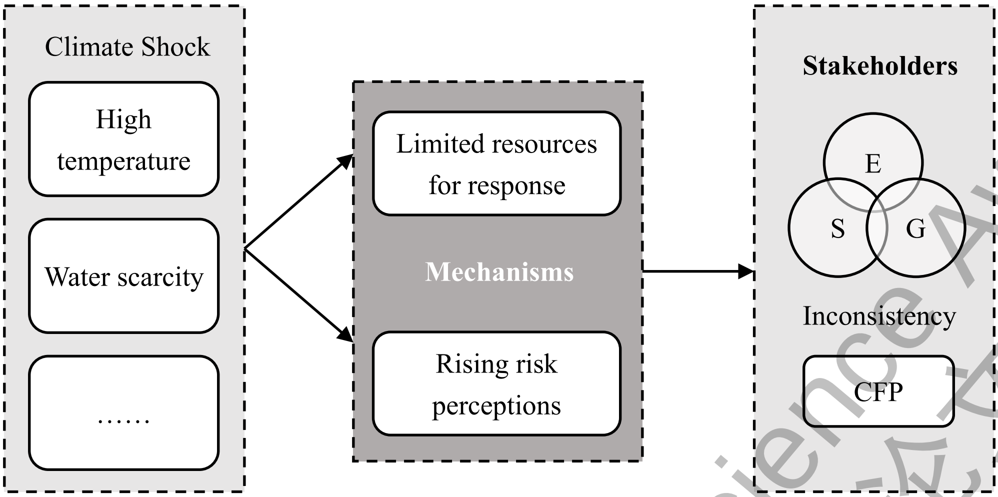

Figure 1. Conceptual framework

3 Data

3.1 Data and sample

Chinese listed companies provide an ideal sample for studying the ESG paradox because, as a developing country, China faces unique challenges balancing rapid economic growth with sustainability, and its listed companies currently have a low rate of ESG disclosure amidst increasing regulatory and societal pressures.

Based on the A-share listed companies from the Shanghai and Shenzhen stock exchanges in China, this study uses data from the China Stock Market and Accounting Research Database (CSMAR) and Wind Database. Since ESG data has been recorded starting from 2009, the research period selected for this study spans from 2009 to 2023. To avoid the influence of outlier samples, the raw data has been processed as follows, drawing on methods from existing research (Fang et al., 2023): (1) Due to the unique nature of the financial industry's asset-liability structure and regulatory policies, we excluded data from the financial industry; (2) We removed companies with statuses such as "ST", "*ST", "suspended listing", "terminated listing", and "delisting consolidation period"; (3) We excluded samples with significant missing values in key variables; (4) We also excluded samples that clearly did not comply with accounting standards. Our final sample comprises of 5,144 unique companies and 44,218 company-year observations from 2009 to 2023.

High temperatures and water scarcity significantly impact business operations by affecting employee productivity, increasing energy consumption, disrupting supply chain stability, and reducing raw material availability, leading to higher operational costs and production disruptions (Burke, Hsiang, & Miguel, 2015; Dell, Jones, & Olken, 2018). These two indicators are crucial for understanding the economic impacts of climate change because they exemplify how environmental shifts can disrupt business activities and necessitate adaptive strategies (Deschênes & Greenstone, 2007). By focusing on temperature and water scarcity, this study aims to illustrate the economic burdens imposed by climate shocks and emphasize the need for robust corporate adaptation measures (Kolstad & Moore, 2020; Carleton & Hsiang, 2016).

Previous studies have primarily used rainfall as an indicator of water variability (Fisher et al., 2012). However, in this study, we focus on the water runoff which is a more complete measure of water variability. In hydrology, runoff is defined as the flow of water on the surface and/or underground that occurs after rainfall, snowmelt, or irrigation. This includes water that is not absorbed by the soil and ultimately flows into rivers, lakes, reservoirs, or oceans (Abatzoglou et al., 2018). These elements make runoff a better indicator of the actual water variability in a region than precipitation alone, offering a more direct measure of the volume of fresh water reaching farmlands and water bodies. Unlike precipitation, which is only one part of the water cycle, runoff directly relates to crucial economic activities such as crop irrigation, hydropower generation, and drinking water supply. Therefore, water management policies are increasingly focusing on the effective management and allocation of runoff rather than just precipitation (Shen et al., 2008). This makes runoff data not only more actionable but also more pertinent for policy decisions.

Water runoff and temperature data come from the Monthly Climate and Climatic Water Balance for Global Terrestrial Surfaces (TerraClimate). The TerraClimate dataset is well-known for its high-resolution, monthly climate and hydrology data, making it a popular choice for a wide range of environmental and agricultural research (Abatzoglou et al., 2018). Runoff and temperature data is accessible at the level of individual month-gridcells, which are 1/24° in size.

To link the gridded climate data with micro-level data from publicly listed companies, we obtained the geographic coordinates (latitude and longitude) of all company office locations in our sample. We then matched these coordinates with the gridded data using a point extraction method. This standard approach, widely used in the literature (e.g., Addoum et al., 2020; Pankratz et al., 2023), allows us to align grid-cell-level climate data with specific geographic points, ensuring that our analysis accurately captures regional variations in climate conditions.

3.2 Measuring ESG and CFP performance

The primary dependent variables in this study are sourced from the HuaZheng ESG rating. The HuaZheng ESG rating aims to evaluate a company's performance in three areas: Environmental (E), Social (S), and Governance (G). It includes an overall score and three sub-scores, with each score having a maximum of 100 points. This data is built on publicly disclosed data from listed companies, periodic reports, temporary announcements, corporate social responsibility, and sustainability reports. It also utilizes data from government and regulatory websites, as well as news media. The system is based on international mainstream ESG evaluation frameworks and has been adjusted to reflect the characteristics of the Chinese market. Its high update frequency (quarterly updates), extensive coverage (including all A-share listed companies), and high data availability are the reasons why it is widely used in academic literature (Deng et al., 2023). In the robustness tests, we also use ESG data from HeXun and Bloomberg to measure alternative approaches to ESG.

While we have already obtained the Environmental, Social, and Governance sub-scores, we further select specific sub-indicators within each category to validate our conclusions. This approach not only provides a more detailed explanation of why each score varies but also enhances the robustness of our analysis. For the Environmental dimension, we selected indicators such as Chemical Oxygen Demand (COD) emissions, Ammonia Nitrogen (NH) emissions, Sulfur Dioxide (SO_2) emissions, and Nitric Oxide

(NO) emissions, reflecting the company's impact on air and water quality. In the Social dimension, we include metrics such as Income per Employee (IncomePerEmp), Cash Effective Tax Rate (CashTaxRate), and whether the company conducts layoffs (ConductLayoff), which reflect employee welfare and corporate financial practices. For the Governance dimension, we examine the proportion of female managers (FemaleMgr), shareholder meeting attendance rate (Attend), shareholder equity over total assets (SE), the proportion of independent directors (IndepDir), and the CEO-to-employee pay ratio (CEOPay). These indicators help us assess the company's leadership diversity, shareholder involvement, financial structure, and pay equity.

We have also selected Return on Assets (ROA), Return on Equity (ROE), Return on Invested Capital (ROIC), and Return on Sales (ROS) as key financial performance indicators because they provide a comprehensive view of a firm's financial efficiency and profitability. ROA, which is net profit over total assets, indicates how effectively a company uses its assets to generate profit. ROE, calculated as net profit over shareholders' equity, shows the return generated on shareholders' investments, highlighting the efficiency of using equity capital. ROIC, defined as net profit over total capital invested, measures profitability relative to all invested capital, revealing how well a company utilizes its overall capital to generate earnings. Lastly, ROS, calculated as net profit over total sales (revenue), illustrates the efficiency of a company's operations by showing what percentage of revenue turns into profit, reflecting cost management and pricing strategies. Together, these indicators provide a solid basis for evaluating a company's financial health and operational performance.[①]

3.3 Measuring climatic shock

We use temporal and spatial variations in temperature and water availability shocks to address the challenge of identifying exogenous shocks that impact corporate ESG engagement and lead to stakeholder gains and losses. Due to varying climatic conditions, temperature and water availability differ significantly across regions, making it essential to define these factors based on typical regional levels. For instance,

① Detailed definitions of all variables used in this paper can be found in Table A.1.

temperatures of 40°C might be unusual and alarming in northeastern China but common in the northwest. High temperatures may be typical in summer yet abnormal in spring. Similarly, several consecutive months of zero runoff may signal severe water scarcity in southern China, but could be normal in the northwest. Therefore, assessing temperature extremes and water scarcity must consider typical local temperature and water availability levels, as well as the specific months involved. Both variables are crucial for understanding regional climatic impacts and their implications for local ecosystems and economic activities.

To address the requirement for precise identification based on location and month, we calculate standardized anomalies for temperature and runoff using TerraClimate data. These anomalies represent deviations from long-term monthly normals, allowing for comparisons across locations and months, and are expressed in standard deviations (Marbler, 2024). Standardized temperature anomalies ($TA_{i,t,j}$) and water runoff anomalies ($RA_{i,t,j}$) for each geographical coordinate i, year t, and month j are calculated by dividing the difference between the observed temperature or runoff in year t month j ($T_{i,t,j}$ for temperature, $R_{i,t,j}$ for runoff), and the past 10-year moving average for the same month ($\widetilde{T_{i,t,j}}$ for temperature, $\widetilde{R_{i,t,j}}$ for runoff) by the past 10-year standard deviation for the month ($\sigma_p(T_{i,t,j})$ for temperature, $\sigma_p(R_{i,t,j})$ for runoff).

$$\begin{cases} TA_{i,t,j} = \dfrac{T_{i,t,j} - \widetilde{T_{i,t,j}}}{\sigma(T_{i,t,j})}, \text{ for } j = 1,2,\dots,12; i = 1,2,\dots,N \\ RA_{i,t,j} = \dfrac{R_{i,t,j} - \widetilde{R_{i,t,j}}}{\sigma(R_{i,t,j})}, \text{ for } j = 1,2,\dots,12; i = 1,2,\dots,N \end{cases} \quad (1)$$

Monthly temperature anomalies (TAs) and runoff anomalies (RAs) display the departure of a coordinate's temperature and runoff from their long-term averages during the preceding 10 years, measured in standard deviations for the corresponding month. For temperature anomalies, negative values represent cooler-than-average conditions, while positive values indicate warmer-than-average conditions. Similarly, for runoff anomalies, negative values signify arid conditions (water shortage exposure), whereas positive values indicate abundant conditions (water surplus exposure). For example, a TA of 2 for coordinate i in year t, month j suggests that temperatures were two standard deviations above the typical monthly average, while an RA of -2 indicates a level of dryness two standard deviations below the typical runoff average.

We define a month as experiencing a positive temperature or runoff shock if the standardized anomaly in that month is above 1.036, which corresponds to the 85th percentile of the long-term distribution for that specific month. Conversely, a month is considered to have a negative temperature or runoff shock if the standardized anomaly is below -1.036, reflecting the 15th percentile of the long-term distribution. We then count the number of months in a year that meet these criteria and add up the same number of positive (and negative) shocks. Thus, the values of the core independent variables TempPosNum, TempNegNum, WaterPosNum, WaterNegNum are determined by the following equation:

$$\begin{cases} TempPosNum_{i,t} = \sum_{j=1}^{12} I\left(TA_{i,t,j} > 1.036\right) \\ TempNegNum_{i,t} = \sum_{j=1}^{12} I\left(TA_{i,t,j} < -1.036\right) \end{cases} \tag{2}$$

$$\begin{cases} WaterPosNum_{i,t} = \sum_{j=1}^{12} I\left(RA_{i,t,j} > 1.036\right) \\ WaterNegNum_{i,t} = \sum_{j=1}^{12} I\left(RA_{i,t,j} < -1.036\right) \end{cases} \tag{3}$$

where I is an indicator function that equals 1 if the condition inside the parentheses is true and 0 otherwise. These calculations allow us to quantify the frequency of extreme temperature and runoff conditions based on their standardized deviations from the mean.

3.4 Summary statistics

Table 1 presents descriptive statistics for the primary variables used in this study, categorized into three panels: ESG scores, corporate financial performance, and climate shocks.

Firstly, Panel A of Table 1 reports statistics for various ESG-related scores. The total ESG score exhibits an average value of 73.142, with a standard deviation of 4.839, suggesting a moderate variation across companies. [2] The environmental score, representing firms' environmental performance, has a mean of 60.746 and a higher standard deviation of 7.087, indicating greater variability in corporate environmental practices. Meanwhile, the social and governance scores display mean values of 74.423 and 79.225, respectively. The standard deviations of 8.854 for the social score and 6.564 for the governance score highlight the differences in how companies approach social responsibility and governance structures.

Secondly, Panel B provides an overview of corporate financial performance indicators, including Return on Assets (ROA), Return on Equity (ROE), Return on Capital Invested (ROCI), and Return on Sales (ROS). [3] The mean ROA is calculated at 0.040, with a standard deviation of 0.069, indicating relatively low but varied returns on assets across firms. The ROE shows a mean of 0.061 and a higher standard deviation of 0.144, reflecting substantial variability in profitability relative to shareholders' equity. ROCI and ROS have mean values of 0.049 and 0.068, respectively, suggesting moderate levels of financial performance. Notably, ROS has the highest variability among these measures, as evidenced by a standard deviation of 0.228.

Thirdly, Panel C focuses on climate shocks, specifically the frequency of positive and negative temperature and runoff shocks. The data reveal that the average number of positive temperature shocks is 2.566, with a standard deviation of 1.644, implying that such events are relatively frequent. In comparison, the mean number of negative temperature shocks is lower at 1.392, although they remain significant, as indicated by a standard deviation of 1.363. Similarly, positive runoff shocks occur more often than negative ones, with average occurrences of 1.867 and 1.037, respectively, underscoring the presence of both types of events.

Finally, we provide a visual representation of the annual distribution of temperature and runoff shocks throughout the study period in Figure 1. In Figure 2(A), the average number of positive and negative temperature shocks is depicted, revealing

[2] The data distribution pattern can be seen in Panel (A) of Figure A.1.
[3] The data distribution pattern can be seen in Panel (B) of Figure A.1.

fluctuations over the years. Similarly, Figure 2(B) demonstrates the annual variations in runoff shocks, with the presence of both positive and negative impacts. Notably, both panels of Figure 2 indicate a rising trend in the frequency and proportion of high temperature and water shortage shocks in recent years, reflecting broader patterns of global climate change. These trends emphasize the increasing relevance of climate-related risks to firms, aligning with the global shift towards greater environmental awareness and resilience.

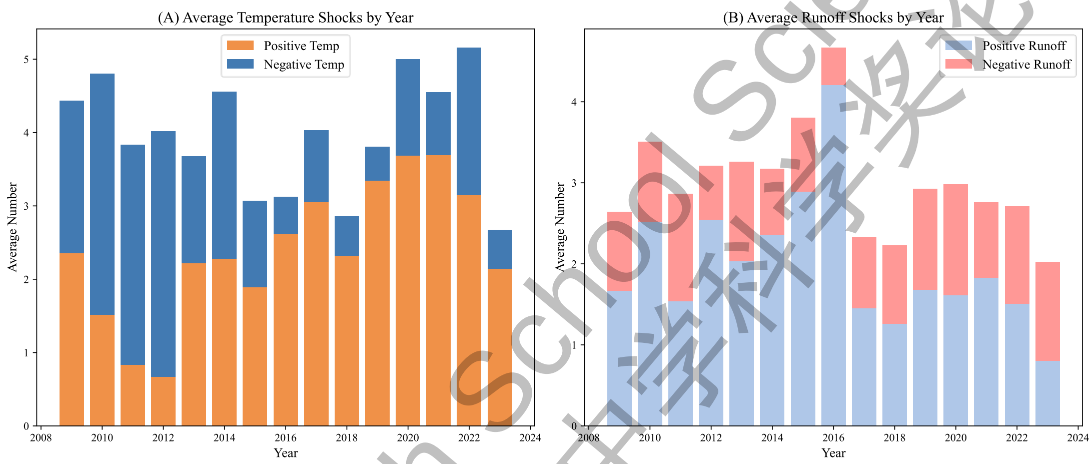

Figure 2. Annual distribution of temperature and runoff impact

Notes: Panel (A) displays the average number of positive (in blue) and negative (in orange) temperature shocks per year. Panel (B) shows the average number of positive (in blue) and negative (in red) runoff shocks per year.

Table 1. Summary statistics

Variables	# of Obs.	Mean	Median	S.D.	Min	Max
Panel A: ESG score						
TotalScore	44218	73.142	73.36	4.839	57.51	83.84
EnviroScore	44218	60.746	60.56	7.087	45.72	80.42
SocialScore	44218	74.423	75.21	8.854	47.09	100
GovScore	44218	79.225	80.56	6.564	53.94	91.07
Panel B: Corporate financial performance						
ROA	44214	0.040	0.039	0.069	-0.287	0.233

ROE	43919	0.061	0.073	0.144	-0.834	0.391
ROIC	44117	0.049	0.054	0.087	-0.456	0.263
ROS	44191	0.068	0.077	0.228	-1.549	0.595
Panel C: Climate shock						
TempPosNum	44218	2.566	2	1.644	0	10
TempNegNum	44218	1.392	1	1.363	0	7
WaterPosNum	44218	1.867	2	1.489	0	8
WaterNegNum	44218	1.037	1	1.039	0	7

Notes: Table 1 presents the summary statistics of the main variables used in the study. Panel A reports statistics for ESG-related scores, Panel B summarizes key corporate financial performance metrics, and Panel C provides information on climate shocks. The detailed definitions of the variables involved are shown in Table A.1, and the summary statistics of more channel variables are shown in Table A.2.

4 Empirical Strategy

My empirical strategy involves using the cumulative random natural variations in monthly temperature and runoff as sources of exogenous climate shocks during the operating year to explain the year-to-year changes in corporate-level economic activity. To measure the effect of climate shocks on ESG and financial performance, we use an OLS regression to estimate the following equation:

$$Y_{i,t} = \beta_0 + \beta_1 TPN_{i,t} + \beta_2 TNN_{i,t} + \beta_3 WPN_{i,t} + \beta_4 WNN_{i,t} + \eta X_{i,t} + \lambda_i + f_r(t) + \varepsilon_{i,t} \quad (4)$$

where $Y_{i,t}$ denotes the ESG and financial performance variables for firm i in year t. This is the dependent variable we aim to explain through the various factors included in the model. $TPN_{i,t}$ and $TNN_{i,t}$ represent the positive and negative temperature shock numbers (TempPosNum, TempNegNum), respectively, for firm i in year t. $WPos_{i,t}$ and $WNeg_{i,t}$ denote the positive and negative runoff shock numbers (WaterPosNum, WaterNegNum), respectively, for firm i in year t.

$X_{i,t}$ represents a vector of control variables that account for other factors influencing corporate performance. These controls help isolate the effect of climate shocks from other potential influences. λ_i captures firm fixed effects, which control for unobserved, time-invariant characteristics of each firm. This ensures that the analysis accounts for unique attributes of each firm that do not change over time. $f_r(t)$ denotes a flexible specification of regional time effects, incorporated to control for temporal shocks at the regional level. In the preferred specification of our model, we include province-by-year fixed effects to ensure that any provincial shocks do not bias the results, thus providing a more accurate identification of the effects of climate shocks. $\varepsilon_{i,t}$ is the error term, capturing unobserved factors that may affect the dependent variable.

This model enables us to evaluate the differential impact of climate shocks—both positive and negative, temperature-related and runoff-related—on corporate performance. By incorporating firm fixed effects and province-by-year fixed effects, the model rigorously controls for both firm-specific characteristics and regional temporal trends, ensuring robust identification of the causal impact of climate events.

To ensure the robustness of our findings, we have tested an alternative model specification:

$$Y_{i,t} = \beta_0 + \beta_1 TPA_{i,t} + \beta_2 TNA_{i,t} + \beta_3 WPA_{i,t} + \beta_4 WNA_{i,t} + \eta X_{i,t} + \lambda_i + f_r(t) + \varepsilon_{i,t} \quad (5)$$

In this alternative model, $TPA_{i,t}$ represents positive deviations from the annual average temperature, replacing the earlier metric that focused solely on temperature extremes. Similarly, $TNA_{i,t}$, $WPA_{i,t}$, and $WNA_{i,t}$ capture negative temperature anomalies, positive runoff deviations, and negative runoff deviations from the annual averages, respectively. The rest of the model specifications remain consistent with our baseline regression, including control variables, firm fixed effects, and regional time effects. This adjustment allows us to examine the impact of sustained climate anomalies on corporate performance, providing further robustness to our analysis.

In addition, we implemented a third alternative model to further validate our findings:

$$Y_{i,t} = \beta_0 + \beta_1 TemNormal_{i,t} + \beta_2 WaterNormal_{i,t} + \eta X_{i,t} + \lambda_i + f_r(t) + \varepsilon_{i,t} \quad (6)$$

This specification introduces $TemNormal_{i,t}$ representing the normal temperature value for firm i in year t, calculated as the 10-year moving average of temperature at that location. Similarly, $WaterNormal_{i,t}$ is used to represent the normal runoff value based on the same methodology. These variables are included to capture the typical climatic conditions, allowing us to differentiate the impact of deviations from normality on corporate ESG and financial performance, thereby adding another layer of robustness to our analysis.

5 The effect of climate change on ESG inconsistencies

5.1 Benchmark results

We begin our analysis by examining the impact of climate shocks on ESG performance, as detailed in Table 2, using a standard two-way fixed effect model that includes firm fixed effects and year fixed effects to control for unobserved heterogeneity across firms and time. This approach allows us to isolate the effect of climate variability on ESG dimensions. The results presented in Column (1) reveal that both positive and negative temperature anomalies and water variability significantly affect various aspects of ESG performance. To capture the any unobserved industry differences that might influence these relationships, we enhance our model in Column (2) by introducing industry fixed effects, providing a more granular control over industry-specific fluctuations. However, to comprehensively address the potential limitations of these fixed effects models in capturing intricate regional and temporal patterns, we introduce a full set of provincial fixed effects in Column (3). This preferred specification not only incorporates firm and year fixed effects but also integrates regional time fluctuations, which helps in identifying the impacts of climate shocks more accurately by removing any noise due to province-level variations.

The results show that water and temperature anomalies have varying impacts on different components of ESG performance. For instance, water scarcity shocks significantly increase the overall ESG score, with similar positive effects observed for the environmental score and Governance score. However, these shocks negatively influence the social score, indicating that while environmental management might improve under scarcity conditions, social aspects such as employee welfare or community relations may suffer. In terms of economic significance from the regression results, a one standard deviation increase in water scarcity shocks will lead to an increase of 0.019 (0.055×1.644/4.839), 0.013 (0.0558×1.644/7.087), and 0.16 (0.0626 ×1.644/6.564) standard deviations in the company's total ESG score, environmental score, and governance score, respectively, while the social score will decrease by 0.298 (0.0688×1.644/8.854) standard deviations.[4] [5] High-temperature shocks also show inconsistent and significant effects across various dimensions of ESG. This finding underscores the challenge of balancing different ESG priorities when firms are subjected to environmental stress.

As shown in Table 3, the focus shifts to the direct financial implications of these climate shocks. High temperature shocks show a small yet statistically significant positive effect on financial metrics, such as ROA (0.0006, $p < 0.05$), ROE (0.0016, $p < 0.01$), and ROIC (0.0010, $p < 0.01$). These results suggest that warmer conditions might benefit certain sectors, possibly by extending growing seasons or reducing heating costs. In contrast, water scarcity shocks exert a negative impact on financial performance, particularly evident in ROE and ROS, which decrease by 0.0021 ($p < 0.05$) and 0.0027 ($p < 0.05$) respectively. These outcomes align with the idea that water scarcity imposes operational constraints that can diminish profitability.

Comparing the results from both tables provides a more detailed view. While certain climate shocks can improve specific ESG components, they may at the same time negatively impact financial performance or other aspects of ESG. For instance, the increase in ESG scores due to better environmental management in response to water scarcity does not necessarily lead to improved financial performance. Instead, it often

[4] Here, we standardized the regression coefficients. The advantage of standardization is that it removes the units from both independent and dependent variables (making their mean 0 and standard deviation 1), allowing the regression coefficients to be compared across variables with different scales.

[5] The standardized regression coefficient β^* equals the ordinary regression coefficient β multiplied by the ratio of the standard deviation of the independent variable X to the standard deviation of the dependent variable Y.

coincides with declines in profitability metrics like ROE and ROS. This contrast highlights the trade-offs companies face when balancing stakeholder expectations with financial outcomes under environmental stress.

These findings align with the broader concept of the "ESG paradox," where firms striving to improve their ESG performance due to climate pressures may still struggle to achieve corresponding financial gains. The results indicate that while ESG initiatives might help mitigate environmental risks and build resilience, they do not always align with immediate financial interests, especially in the face of resource shortages.

Table 2. Climate shock impacts on ESG performance

	(1)	(2)	(3)	(4)	(5)	(6)
		TotalScore		EnviroScore	SocialScore	GovScore
TempPosNum	-0.0248*	-0.0238*	-0.0238*	-0.0443**	0.0403*	-0.0466**
	(0.0144)	(0.0144)	(0.0144)	(0.0205)	(0.0239)	(0.0208)
TempNegNum	0.0361*	0.0386**	0.0386**	0.0348	-0.0052	0.0148
	(0.0194)	(0.0193)	(0.0193)	(0.0277)	(0.0348)	(0.0268)
WaterPosNum	-0.0110	-0.0103	-0.0103	-0.0507**	-0.0237	0.0043
	(0.0162)	(0.0161)	(0.0161)	(0.0219)	(0.0282)	(0.0231)
WaterNegNum	0.0566**	0.0550**	0.0550**	0.0558*	-0.0688*	0.0626*
	(0.0229)	(0.0227)	(0.0227)	(0.0312)	(0.0402)	(0.0330)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	Yes	Yes	Yes	Yes	Yes
Provincial FE	No	No	Yes	Yes	Yes	Yes
Obs	44218	44218	44218	44218	44218	44218

Notes: All regressions control for firm FE and year FE. Column (2) additionally controls for industry FE, and columns (3)-(6) additionally control for provincial FE. Standard errors (in brackets) are clustered at the firm level. The significance levels are *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.

Table 3. Climate shock impacts on corporate financial performance

	(1)	(2)	(3)	(4)
	ROA	ROE	ROIC	ROS
TempPosNum	0.0006**	0.0016***	0.0010***	0.0028***
	(0.0002)	(0.0005)	(0.0003)	(0.0008)
TempNegNum	0.0001	-0.0006	-0.0002	-0.0005
	(0.0003)	(0.0007)	(0.0004)	(0.0010)
WaterPosNum	0.0000	-0.0000	-0.0001	-0.0002
	(0.0003)	(0.0006)	(0.0003)	(0.0008)
WaterNegNum	-0.0006	-0.0021**	-0.0009*	-0.0027**
	(0.0004)	(0.0008)	(0.0005)	(0.0013)
Obs	44214	43919	44117	44191

Notes: All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The significance levels are *** p<0.01, ** p<0.05, and * p<0.1.

5.2 Alternative ESG indicators

Since the baseline regression results show that only high temperature and water scarcity shocks significantly affect corporate ESG and financial performance, we will focus exclusively on these two types of shocks in our subsequent regression analyses. Figure 3 illustrates the impact of high temperature and water scarcity shocks on various alternative ESG indicators, aiming to test the robustness of our results and identify how these environmental factors influence corporate behavior. The figure demonstrates that the effects of climate shocks differ notably across various environmental, social, and governance indicators, highlighting the need to understand these impacts in greater detail.

Environmental indicators reveal a mixed response to high temperature and water scarcity shocks, reflecting both the direct and indirect pathways through which these shocks influence corporate environmental performance. High temperature shocks tend to increase emissions of pollutants such as sulfur dioxide (SO_2) and chemical oxygen demand (COD), suggesting a deterioration in environmental management under temperature stress. This could be due to increased energy use or operational adjustments that prioritize immediate production over environmental controls. On the contrary, water scarcity shocks are associated with reduced emissions of nitric oxide (NO), indicating that firms may tighten their environmental practices to conserve water, potentially implementing more efficient processes. While some environmental metrics like these show significant responses, others, such as ammonia nitrogen (NH) emissions and certain other pollutants, remain unaffected, highlighting that the sensitivity to climate variability can vary among different environmental factors.

In examining the social indicators, the results suggest that high temperature shocks can lead to positive outcomes such as higher social scores and increased income per employee, perhaps reflecting a strategic emphasis on maintaining good employee relations and community support in the face of climate stress. This might be part of broader corporate strategies to mitigate the adverse impacts of high temperatures on employee productivity and morale. However, water scarcity shocks have a more detrimental effect on social indicators, including reductions in social scores and social donations, and a higher likelihood of layoffs. These negative impacts could result from firms reallocating resources to essential operational needs, thereby deprioritizing social initiatives during periods of water scarcity. Notably, some social indicators, such as the cash tax rate, show no significant response, indicating that not all social aspects are equally impacted by these shocks.

The impact on governance indicators further highlights the differential effects of climate shocks on corporate behavior. High temperature shocks negatively affect governance metrics, such as the proportion of female managers and shareholder meeting attendance rates, which may suggest that governance practices become less rigorous or are neglected under temperature stress. This could be due to a shift in focus towards managing immediate operational challenges rather than maintaining robust governance practices. In contrast, water scarcity shocks tend to have a positive effect on governance scores and other governance-related measures, such as the proportion of independent directors and CEO pay ratios. These findings suggest that firms may reinforce their governance structures to better manage risks and ensure strategic decision-making in the face of limited water resources. However, not all governance metrics are impacted; some, like CEO-to-employee pay ratios, show no significant changes, demonstrating that the influence of climate shocks on governance can also vary.

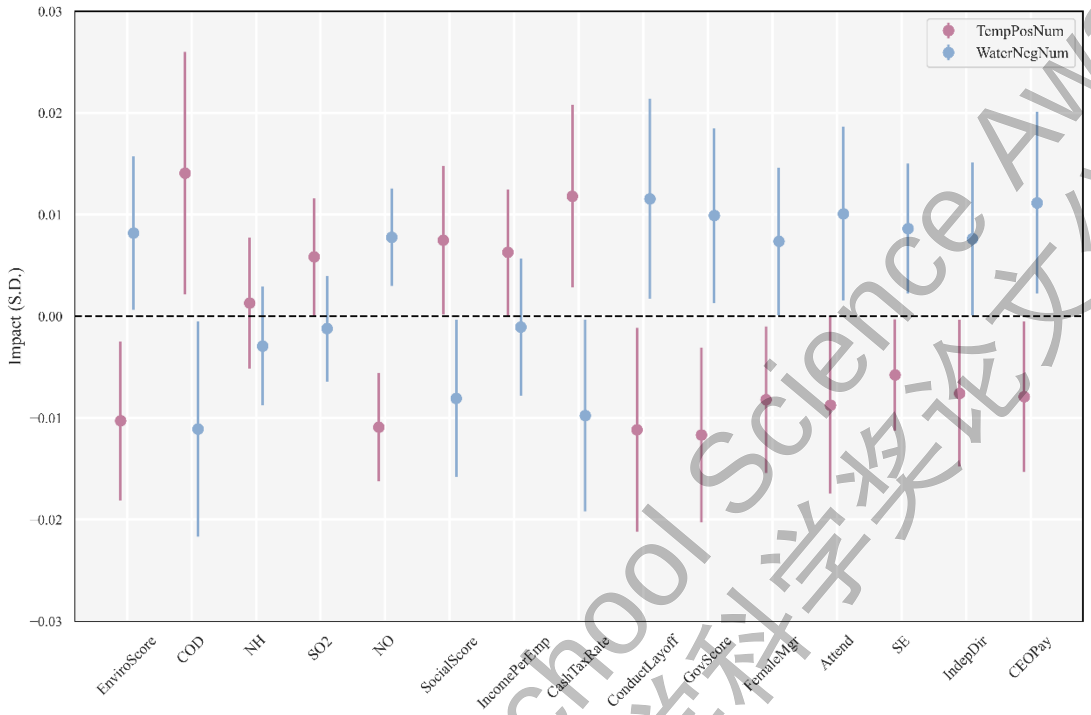

Figure 3. The impact of climate shocks

Notes: The figure illustrates the impact of high temperature and water scarcity shocks on alternative ESG indicators. Dots represent point estimates, with lines indicating 90% confidence intervals. All impact coefficients are normalized. The full results are reported in Table A.3-A.5.

5.3 Robustness test

Our baseline regression results are grounded in the HuaZheng ESG data. To test the robustness of these results, we sought alternative ESG data sources and employed data from the Listed Companies ESG Rating Database (ESGR) provided by the China Research Data Services Platform (CNRDS). The robustness check results, presented in Table 4, align closely with our baseline findings, affirming the stability of our conclusions. High temperature shocks continue to exhibit a negative impact on alternative total ESG scores and governance scores, consistent with the baseline results. Water scarcity shocks, on the other hand, show a positive effect on alternative environmental scores and governance scores, mirroring the patterns observed in the primary dataset. The alignment of these results with our baseline findings underscores the robustness of our analysis, confirming that the observed relationships between climate shocks and ESG performance are not dependent on the specific data source used but reflect broader and more generalizable trends.

Table 4. Robustness checks on alternative ESG scores

	(1) Alt.TotalScore	(2) Alt.EnviroScore	(3) Alt.SocialScore	(4) Alt.GovScore
TempPosNum	-0.0534*	-0.0205	0.0729*	-0.0572*
	(0.0312)	(0.0508)	(0.0433)	(0.0321)
WaterNegNum	0.0927**	0.1431*	-0.1507**	0.1639***
	(0.0469)	(0.0761)	(0.0624)	(0.0497)
Various FE	Yes	Yes	Yes	Yes
Obs	38833	38833	38833	38833

Notes: Compared with Equation (4), the dependent variable is replaced by the ESG score from CNRDS. All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The significance levels are *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.

The second robustness check involves altering the measurement of the key independent variable, climate shocks, to evaluate whether our findings remain consistent under different specifications. Instead of using the cumulative monthly climate shocks throughout the year as in the baseline regression, we substitute this measure with the annual average values of climate shocks. This adjustment allows us to test whether the impact of climate variability on ESG performance is sensitive to the temporal aggregation method used. The results of this robustness check are presented in Table 5.

As shown in Table 5, the alternative specification using annual average climate shocks yields results that are largely consistent with our baseline findings, further supporting the robustness of our conclusions. High temperature shocks continue to have a negative but not statistically significant impact on the overall ESG score and governance score, while positively affecting social scores. This suggests that even when climate shocks are measured on an annual basis, firms may prioritize social and community engagement in response to temperature increases, possibly as a strategy to mitigate the broader adverse impacts of heat stress.

Similarly, water scarcity shocks have a positive and significant impact on environmental and governance scores, suggesting that firms strengthen their environmental and governance practices in response to water shortages. However, water scarcity is negatively associated with social scores, indicating that companies may shift resources away from social initiatives to prioritize environmental compliance and governance improvements when water is scarce. These findings suggest that the main conclusions of our analysis—the varying impacts of climate shocks on different ESG dimensions—remain consistent, whether using monthly or annual climate shock measures, demonstrating the robustness and reliability of our results.

Table 5. Robustness checks on climate annual shocks

	(1)	(2)	(3)	(4)
	TotalScore	EnviroScore	SocialScore	GovScore
TempPosAnns	-0.0739	-0.1246*	0.1742*	-0.1261*
	(0.0518)	(0.0750)	(0.0904)	(0.0731)
WaterNegAnns	0.1053**	0.1434*	-0.1787*	0.1235*
	(0.0536)	(0.0782)	(0.0923)	(0.0724)
Various FE	Yes	Yes	Yes	Yes
Obs	44218	44218	44218	44218

Notes: Compared with Equation (4), the independent variable is replaced by the annual climate shock in Equation (5). All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The significance levels are *** p<0.01, ** p<0.05, and * p<0.1.

The third robustness check further validates our findings by replacing the cumulative monthly climate shocks used in the baseline regression with climate normals, defined as the 10-year moving average values for temperature and runoff, as specified in Equation (6). This approach captures typical climatic conditions, allowing us to assess the impact of deviations from these norms on corporate ESG performance. The results of this robustness check are presented in Table 6.

The results shown in Table 6 are largely consistent with those of the baseline regressions, affirming the robustness of our findings. For instance, high temperature normal values have a negative impact on the total ESG score and governance score, which is consistent with the baseline results. Similarly, water normal values show a positive and significant effect on the environmental score, reinforcing the notion that companies improve their environmental practices in response to deviations from normal water conditions.

However, there are some differences when compared to the baseline results. The TemNormal variable shows a positive effect on the social score, which is not observed in the baseline regression. This discrepancy may be attributed to the different ways temperature extremes and norms impact social initiatives. While temperature extremes might necessitate immediate social responses, such as employee welfare measures, consistent deviations from normal temperatures could lead to more sustained social engagement by firms over time. Additionally, the insignificant impact of WaterNormal on SocialScore and GovScore, unlike the more pronounced effects seen with monthly cumulative shocks, suggests that firms might respond more actively to immediate shocks than to long-term averages.

These differences are reasonable and do not weaken the strength of our conclusions. They show that while the specific measurement of climate variables may affect the estimated impact on some ESG components, the overall message remains consistent: climate variability, whether assessed through short-term shocks or long-term averages, has a significant impact on corporate ESG performance. The observed variations underline the need to consider both immediate and long-term climate conditions when analyzing corporate responses to environmental challenges, ensuring a thorough and nuanced understanding of ESG impacts.

Table 6. Robustness checks on climate normals

	(1)	(2)	(3)	(4)
	TotalScore	EnviroScore	SocialScore	GovScore
TemNormal	-0.0677*	-0.1249**	0.1065*	-0.0913*

	(0.0389)	(0.0518)	(0.0625)	(0.0551)
WaterNormal	0.0014*	0.0035***	-0.0009	0.0005
	(0.0008)	(0.0009)	(0.0012)	(0.0011)
Various FE	Yes	Yes	Yes	Yes
Obs	44218	44218	44218	44218

Notes: Compared with Equation (4), the independent variable is replaced by the climate normals in Equation (6). All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The significance levels are *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.

In the baseline regressions, we deliberately avoided including additional control variables to maintain the quasi-experimental nature of the setting, where weather variations are exogenous to firm operations (Hsiang, 2016; Carleton & Hsiang, 2016). Adding extra controls could lead to bad control issues (Cinelli et al., 2024), potentially obstructing the pathways through which climate shocks influence corporate operations. However, concerns may still arise regarding the potential confounding effects of firm-specific characteristics on the relationship between climate and ESG performance, particularly since larger firms are often perceived to perform better in ESG metrics. To address these concerns and provide additional support for our baseline estimates, we incorporate a set of additional control variables, including firm age and size. This helps to ensure that our findings are not driven by inherent firm characteristics that might skew the observed relationships.

Furthermore, while runoff is generally considered a superior indicator of water supply compared to precipitation (Russ, 2020), concerns remain about the possibility that the relationship between runoff and corporate ESG performance could be indirectly influenced by precipitation, given the close correlation between the two. To account for this, we also include precipitation data as a control variable to isolate the direct impact of runoff on ESG performance.

The results from adding these additional control variables are presented in Table 7. The inclusion of firm size (LnAssets) and sales (LnSales) as controls shows a positive and significant relationship with total ESG scores and governance scores, supporting the notion that larger firms tend to have better ESG performance. The robustness of our core findings is further confirmed, as high temperature shocks still exhibit a negative impact on total ESG scores and governance scores, while water scarcity shocks continue to show a positive effect on environmental and governance scores. The introduction of precipitation as a control variable yields significant positive coefficients, suggesting that even when accounting for precipitation, the direct impact of runoff on ESG indicators remains robust. However, it is worth noting the negative impact of water scarcity on social scores, indicating that firms might still prioritize environmental and governance adjustments over social initiatives under water-stressed conditions.

Overall, these robustness checks underscore the reliability of our baseline findings. By accounting for additional firm characteristics and potential indirect effects of precipitation, we ensure that the observed relationships between climate shocks and ESG performance are not artifacts of omitted variable bias, but rather reflect genuine, underlying patterns.

Table 7. Robustness checks on additional control variables

	(1)	(2)	(3)	(4)
	TotalScore	EnviroScore	SocialScore	GovScore
TempPosNum	-0.0262*	-0.0455**	0.0349	-0.0491**
	(0.0144)	(0.0205)	(0.0238)	(0.0207)
WaterNegNum	0.0517**	0.0482	-0.0687*	0.0596*
	(0.0224)	(0.0311)	(0.0398)	(0.0328)
LnAssets	0.6577***	0.8988***	0.4581***	0.4731***
	(0.0922)	(0.1234)	(0.1622)	(0.1446)
LnSale	0.2557***	-0.0239	1.1263***	0.1385
	(0.0729)	(0.0984)	(0.1373)	(0.1195)
Precipitation	0.0007**	0.0011***	0.0008	0.0004
	(0.0003)	(0.0004)	(0.0005)	(0.0005)
Various FE	Yes	Yes	Yes	Yes
Obs	44187	44187	44187	44187

Notes: The regression equation follows equation (4), with the addition of control variables, including LnAssets, LnSales, and Precipitation. All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The significance levels are *** p<0.01, ** p<0.05, and * p<0.1.

The final robustness check applies winsorization to the ESG scores to minimize the influence of potential outliers. Although the baseline results did not implement winsorization to preserve the economic significance of some extreme values, this step was taken to ensure that our conclusions are not distorted by outliers. By capping the extreme values of ESG scores, we tested whether the relationships observed in the baseline regressions hold. As shown in Table 8, the winsorized results are consistent with the baseline findings, confirming the robustness of our conclusions. High temperature shocks and water scarcity shocks continue to significantly impact ESG scores in expected directions, indicating that our results are stable and not driven by extreme data points. This demonstrates that the core relationships between climate shocks and ESG performance remain valid even after controlling for outliers.

Table 8. Robustness checks on wincernized variables

	(1)	(2)	(3)	(4)
	Win.TotalScore	Win.EnviroScore	Win.SocialScore	Win.GovScore
TempPosNum	-0.0240*	-0.0443**	0.0389	-0.0464**
	(0.0144)	(0.0205)	(0.0237)	(0.0207)
WaterNegNum	0.0548**	0.0558*	-0.0656*	0.0626*
	(0.0226)	(0.0312)	(0.0398)	(0.0329)
Various FE	Yes	Yes	Yes	Yes
Obs	44218	44218	44218	44218

Notes: Compared with Equation (4), the independent variable is replaced by the wincernized variables (99%). All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The significance levels are *** p<0.01, ** p<0.05, and * p<0.1.

6 Further mechanisms: Limited resources and rising risks

6.1 Climate change and limited resources for response

The inconsistency between corporate ESG and financial performance due to climate change can be partly explained by the limited resources companies have to respond to environmental shocks. To examine this mechanism, we constructed specific variables representing firms' resource allocation strategies under climate stress, focusing on key areas such as environmental investment, R&D spending, social donations, and working capital management. These variables are designed to capture how companies balance their ESG commitments and financial priorities in response to high temperatures and water scarcity.

From a managerial perspective, corporate leaders must navigate conflicting stakeholder interests, balancing the immediate need for operational stability with longer-term ESG goals. Table 9 provides empirical evidence supporting this mechanism, showing how companies allocate resources when faced with high temperatures and water scarcity, which can lead to discrepancies between ESG dimensions and financial performance.

High temperature shocks, for instance, negatively impact environmental investments, as indicated by a significant reduction in environmental investment relative to total assets. This suggests that firms may deprioritize environmental spending to preserve resources for immediate operational needs, reflecting a conflict between environmental objectives and financial stability. Similarly, negative coefficients for R&D and administrative expenses indicate that companies might cut back on innovation and management spending to maintain cash flow or stabilize short-term financial performance, implying a preference for immediate financial stability over long-term initiatives.

Conversely, water scarcity shocks encourage firms to allocate more resources to environmental investments and R&D, as shown by positive and significant coefficients. This indicates a strategic focus on mitigating long-term risks associated with water scarcity, even if it means reallocating resources away from other areas such as social donations or immediate working capital needs. The observed increase in the working capital ratio highlights a cautious approach to liquidity management, demonstrating that firms may prioritize financial buffers over social or environmental commitments. This behavior points to a paradox where efforts to address water scarcity can enhance certain ESG aspects, like environmental sustainability and financial stability, while potentially neglecting social factors.

These findings underscore the inherent conflicts and trade-offs that firms face when responding to climate-related shocks with limited resources. Managers often prioritize financial stability and operational continuity, which can lead to decisions that contradict broader ESG goals, creating a paradox where enhancing certain ESG dimensions may compromise others. This complexity in corporate decision-making underscores the need for integrated strategies that align sustainability goals with financial imperatives. By recognizing the interdependencies between ESG components and financial performance, companies can develop approaches that ensure efforts to enhance ESG do not undermine financial health, and vice versa.

Table 9. Mechanism analysis: Limited resources

	(1) EnvInvest	(2) SocDonations	(3) WC_Ratio	(4) RnD_Expenses	(5) SalesExpenses	(6) AdminExpenses
TempPosNum	-0.0310**	-0.0003*	-0.1988*	-0.0200**	-0.0278**	-0.0321*
	(0.0147)	(0.0001)	(0.1145)	(0.0096)	(0.0141)	(0.0175)
WaterNegNum	0.0331*	0.0004*	0.3404*	0.0254*	0.0531**	0.0453*
	(0.0196)	(0.0002)	(0.2048)	(0.0143)	(0.0249)	(0.0271)
Various FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	36446	39107	43243	21880	43776	43256

Notes: The regression equation is consistent with equation (4). All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The significance levels are *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.

6.2 Climate change and rising risk perceptions

The impact of climate change on corporate behavior extends beyond immediate operational adjustments; it also significantly influences managerial risk perceptions. To validate this mechanism, we developed variables to capture how companies alter their risk management strategies in response to climate shocks, focusing on indicators such as cash holdings, inventory turnover, and inventory days. These variables reflect managerial responses to perceived risks, allowing us to analyze how heightened risk perceptions, triggered by climate shocks, affect corporate financial and ESG strategies.

Table 10 illustrates the empirical evidence supporting this mechanism, demonstrating how these heightened risk perceptions can lead to inconsistencies between ESG objectives and financial performance. The findings reveal that high temperature shocks lead to increased cash holdings, as indicated by the positive and significant coefficient. This suggests that firms anticipate disruptions from extreme temperatures and prefer higher liquidity as a safeguard against unforeseen financial strains. While holding more cash is prudent for risk management, it may divert resources away from ESG investments, potentially hindering improvements in ESG performance. This illustrates the paradox firms face: preparing for climate-induced financial instability can lead to underinvestment in long-term sustainability, conflicting with broader ESG goals.

Conversely, water scarcity shocks prompt different risk responses. Firms experiencing these shocks tend to reduce cash holdings and focus on optimizing inventory management, as reflected in lower inventory turnover. This suggests a strategy of maintaining a leaner operation to preserve cash flow amid water scarcity. However, the observed increase in inventory turnover days highlights a potential risk: while efficient inventory management supports resilience, it may reduce the firm's agility in responding to supply chain disruptions. These risk-driven adjustments can lead to inconsistencies, where efforts to stabilize operations and maintain financial health may impact other ESG dimensions, such as social commitments or environmental practices.

These findings underscore the complex nature of corporate responses to climate risks and the trade-offs involved. While strategies like increasing liquidity or optimizing inventory turnover are designed to ensure financial stability, they can inadvertently limit a firm's capacity to invest in ESG initiatives, leading to inconsistencies across different ESG dimensions. This inconsistency arises when firms prioritize short-term financial survival over long-term ESG commitments, creating a misalignment between sustainability goals and financial prudence.

Table 10. Mechanism analysis: Rising risks

	(1)	(1)	(2)	(3)
	CashHoldings	InvTurnover	InvTurnDays	NetInventory
TempPosNum	0.0014***	0.1616**	-1.1837**	-0.0018**
	(0.0004)	(0.0802)	(0.4893)	(0.0008)
WaterNegNum	-0.0015**	-0.2314**	1.6920*	0.0029*
	(0.0007)	(0.1122)	(0.8873)	(0.0016)
Various FE	Yes	Yes	Yes	Yes
Obs	44218	42847	42847	42901

Notes: The regression equation is consistent with equation (4). All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The significance levels are *** p<0.01, ** p<0.05, and * p<0.1.

7 Conclusion

The rise of ESG initiatives as key parts of corporate strategy has revealed a paradox: although there is substantial evidence linking ESG participation to better financial performance, many companies still do not engage in ESG activities. This study addresses this paradox by examining how conflicting stakeholder interests lead to discrepancies between ESG and financial performance, using climate change as an external shock to examine these relationships.

Our baseline regression results indicate that both high temperature and water scarcity shocks have significant yet varying impacts on ESG performance. Water scarcity shocks, for instance, are associated with increases in overall ESG scores, driven by improvements in environmental and governance aspects. However, these same shocks lead to a decline in social performance, highlighting a trade-off where resources are diverted to environmental management at the expense of social initiatives such as employee welfare and community relations. High temperature shocks also exhibit inconsistent effects across different ESG dimensions, reinforcing the challenge firms face in aligning their ESG priorities under environmental stress.

Further, the financial analysis shows that climate shocks have divergent impacts on corporate profitability. While high temperature shocks have a modest positive effect on financial metrics like ROA, ROE, and ROIC, suggesting potential benefits for certain sectors, water scarcity shocks negatively affect profitability measures, such as ROE and ROS. This dichotomy underscores the complexity of managing ESG and financial objectives simultaneously, as efforts to improve ESG performance under climate-induced pressures may not necessarily translate into immediate financial gains.

To ensure the robustness of these findings, we conducted several tests, including using alternative ESG data sources and adjusting the measurement of climatic shocks to annual averages and climate normals. These tests confirm that our results hold across different specifications, underscoring the reliability of our conclusions about the complex relationship between climate change and ESG performance.

The study identifies two key mechanisms driving the observed inconsistencies. First, the limited resources available to firms necessitate trade-offs in how these resources are allocated when responding to climate shocks. Firms may prioritize immediate operational needs and financial stability over ESG commitments, leading to divergent outcomes across different ESG dimensions. Second, heightened risk perceptions due to climate change lead firms to adopt precautionary measures, such as increasing cash holdings and optimizing inventory turnover. While these strategies are prudent for managing financial risks, they may constrain the firm's ability to invest in ESG initiatives, further contributing to the “ESG Paradox”.

Based on our findings, several policy recommendations can help firms balance ESG performance with financial stability amid climate change. Policymakers should create incentives, such as tax breaks or subsidies, to encourage firms to invest evenly across all ESG areas, preventing trade-offs that favor environmental or governance aspects over social commitments. Additionally, regulatory frameworks should support resilience against specific climate risks by promoting industry-specific guidelines and technologies. For instance, policies that encourage water-efficient practices would benefit sectors prone to water scarcity, while those facing high temperatures could be incentivized to adopt cooling technologies. By fostering balanced ESG engagement and equipping firms to handle various climate challenges, policymakers can help align sustainability goals with financial stability, ensuring long-term resilience.

In conclusion, our findings underscore the challenges companies face in balancing ESG performance with financial stability amid climate change. Recognizing the trade-offs and underlying factors behind these inconsistencies is essential for creating strategies that align corporate sustainability goals with financial needs. Future research should examine other climate risks and broader contexts to further understand how firms can manage the complexities of climate change while achieving consistent ESG and financial outcomes.

Appendix A

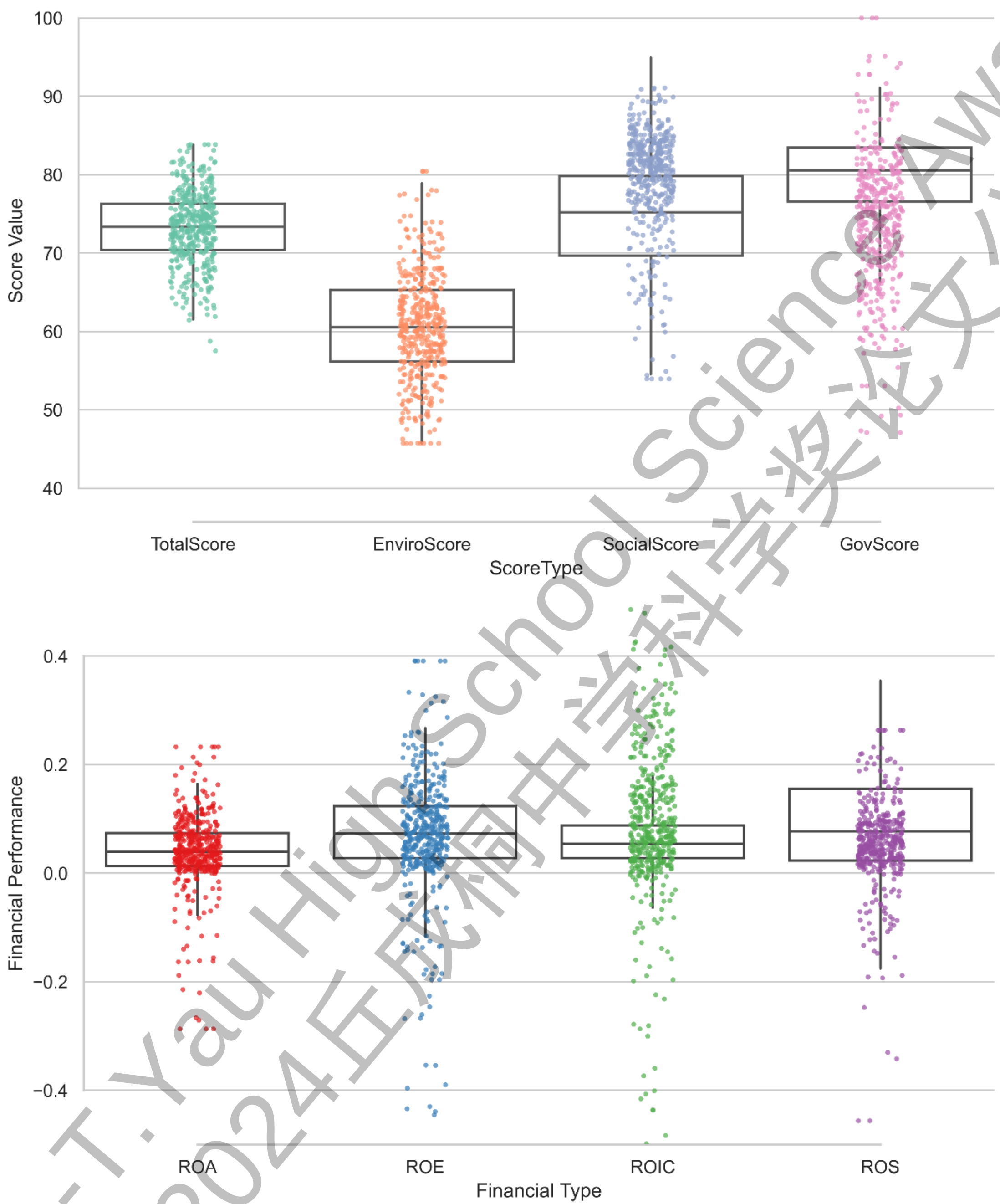

Figure A.1. Distribution of ESG scores and financial performance indicators

Appendix B

Table B.1. Detailed definitions of all variables

Variables	Definition

TotalScore	Total ESG score from HEXUN's CSR
EnviroScore	Environmental score from HEXUN's CSR
SocialScore	Social score from HEXUN's CSR
GovScore	Governance score from HEXUN's CSR
ROA	Net profit over total assets
ROE	Net profit over shareholders' equity
ROIC	Net profit over total invested capital
ROS	Net profit over total sales (revenue)
TempPosNum	Total months per year with positive temperature shocks
TempNegNum	Total months per year with negative temperature shocks
WaterPosNum	Total months per year with positive water supply impacts
WaterNegNum	Total months per year with negative water supply impacts
COD	Chemical oxygen demand emissions
NH	Ammonia nitrogen emissions
SO_2	Sulfur dioxide emissions
NO	Nitric oxide emissions
IncomePerEmp	Income per employee
CashTaxRate	Cash effective tax rates
ConductLayoff	Whether the company conducts layoffs
FemaleMgr	Proportion of female managers
Attend	Shareholder meeting attendance rate
SE	Shareholder equity over total assets
IndepDir	Proportion of independent directors
CEOPay	CEO-to-employee pay ratio
EnvInvest	Environmental investment over total assets
SocDonations	Social donations over total assets
WC_Ratio	Working capital ratio
RnD_Expenses	Research and development expenses ratio
SalesExpenses	Sales expenses ratio

AdminExpenses	Administrative expenses ratio
CashHoldings	The sum of cash and cash equivalents plus trading financial assets, divided by total assets.
InvTurnover	Inventory turnover ratio
InvTurnDays	Inventory turnover days
NetInventory	Net inventory over operating income

Table B.2. Supplementary descriptive statistics

Variables	# of Obs.	Mean	Median	S.D.	Min	Max
Panel A: EnviroScore indicators						
COD	35962	417.091	392.995	264.649	0.12	1100
NH	36075	1087.409	1089.8	294.096	450.09	1760
SO_2	36004	1251.929	1261.6	326.947	540.18	1980
NO	36075	1837.053	1862.01	471.507	810	2860
Panel B: SocialScore indicators						
IncomePerEmp	42976	22022.12	16445.68	19657.74	187.150	127538.6
CashTaxRate	44000	0.142	0.142	0.181	-0.711	0.818
ConductLayoff	44072	0.384	0	0.486	0	1
Panel C: GovScore indicators						
FemaleMgr	44179	17.142	14.286	17.169	0	100
Attend	29896	49.625	49.75	16.959	0.065	100
SE	44150	55.469	56.464	25.099	-756.634	551.735
IndepDir	44000	37.547	36.364	5.400	0	100
CEOPay	42734	91.759	50.379	144.785	4.813	1763.301
Panel D: Channel variables						
EnvInvest	34385	7.681	4.141	9.549	0	55.463
SocDonations	39107	0.018	0.003	0.038	0	0.245
WC_Ratio	43243	32.598	41.790	47.595	-246.678	94.448

RnD_Expenses	21880	5.131	3.936	4.979	0.022	33.391
SalesExpenses	43776	6.7632	3.9123	8.0858	0	48.6042
AdminExpenses	43256	8.489	6.889	6.273	0.808	47.002
CashHoldings	44218	0.2161	0.1709	0.1586	0	1
InvTurnover	42847	9.816	3.856	28.489	0.157	463.875
InvTurnDays	42847	166.946	95.032	258.317	0.775	2335.761
NetInventory	42901	0.303	0.187	0.434	0.000	4.009

Table B.3. Regression results of alternative environmental score indicators

	(1)	(2)	(3)	(4)	(5)
	EnviroScore	COD	NH	SO_2	NO
TempPosNum	-0.0443**	2.2669*	0.2343	1.1611*	-3.1293***
	(0.0205)	(1.1655)	(0.7005)	(0.6916)	(0.9276)
WaterNegNum	0.0558*	-2.8261*	-0.8284	-0.3792	3.5281***
	(0.0312)	(1.6404)	(1.0043)	(0.9956)	(1.3259)
Various FE	Yes	Yes	Yes	Yes	Yes
Obs	44218	35962	36075	36004	36075

Notes: All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The variables TempNegNum and WaterPosNum are omitted from the report. The significance levels are *** p<0.01, ** p<0.05, and * p<0.1.

Table B.4. Regression results of alternative social score indicators

	(1)	(2)	(3)	(4)
	SocialScore	IncomePerEmp	CashTaxRate	ConductLayoff
TempPosNum	0.0403*	75.3410*	0.0013**	-0.0033*
	(0.0239)	(44.9287)	(0.0006)	(0.0018)
WaterNegNum	-0.0688*	-20.1498	-0.0017*	0.0054*
	(0.0402)	(77.5344)	(0.0010)	(0.0028)
Various FE	Yes	Yes	Yes	Yes

Obs	44218	42976	44000	44072

Notes: All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The variables TempNegNum and WaterPosNum are omitted from the report. The significance levels are *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.

Table B.5. Regression results of alternative governance score indicators

	(1)	(2)	(3)	(4)	(5)	(6)
	GovScore	FemaleMgr	Attend	SE	IndepDir	CEOPay
TempPosNum	-0.0466^{**}	-0.0856^{*}	-0.0902^{*}	-0.0880^{*}	-0.0249^{*}	-0.6964^{*}
	(0.0208)	(0.0458)	(0.0547)	(0.0507)	(0.0144)	(0.3972)
WaterNegNum	0.0626^{*}	0.1218^{*}	0.1645^{*}	0.2084^{**}	0.0396^{*}	1.5538^{**}
	(0.0330)	(0.0729)	(0.0850)	(0.0935)	(0.0238)	(0.7577)
Various FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	44218	44179	29896	44150	44000	42734

Notes: All regressions control for firm FE, year FE, industry FE, provincial FE. Standard errors (in brackets) are clustered at the firm level. The variables TempNegNum and WaterPosNum are omitted from the report. The significance levels are *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.

References

Abatzoglou, J. T., Dobrowski, S. Z., Parks, S. A., & Hegewisch, K. C. (2018). TerraClimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958–2015. Scientific data, 5(1), 1-12.

Addoum, J. M., Ng, D. T., & Ortiz-Bobea, A. (2020). Temperature shocks and establishment sales. The Review of Financial Studies, 33(3), 1331-1366.

Almaghrabi, K. S. (2023). Climate Change Exposure and Firm Performance: Does Managerial Ability Matter? Sustainability, 15(17), 12878.

Amel-Zadeh, A., & Serafeim, G. (2018). Why and how investors use ESG information: Evidence from a global survey. Financial Analysts Journal, 74(3), 87-103.

Bansal, P., Jiang, G. F., & Jung, J. C. (2015). Managing responsibly in tough economic times: Strategic and tactical CSR during the 2008-2009 global recession. Long Range Planning, 48(2), 69-79.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99-120.

Bates, T. W., Kahle, K. M., & Stulz, R. M. (2009). Why do U.S. firms hold so much more cash than they used to? The Journal of Finance, 64(5), 1985-2021.

Burke, M., Hsiang, S. M., & Miguel, E. (2015). Global non-linear effect of temperature on economic production. Nature, 527(7577), 235-239. https://doi.org/10.1038/nature15725

Carleton, T. A., & Hsiang, S. M. (2016). Social and economic impacts of climate. Science, 353(6304), aad9837. https://doi.org/10.1126/science.aad9837

Chen, X., & Yang, L. (2019). Temperature and industrial output: Firm-level evidence from China. Journal of Environmental Economics and Management, 95, 257-274.

Cinelli, C., Forney, A., & Pearl, J. (2024). A crash course in good and bad controls. Sociological Methods & Research, 53(3), 1071-1104.

Dell, M., Jones, B. F., & Olken, B. A. (2018). Temperature and income: Reconciling new cross-sectional and panel estimates. American Economic Review, 108(10), 2910-2940. https://doi.org/10.1257/aer.20150295

Delmas, M. A., & Toffel, M. W. (2008). Organizational responses to environmental demands: Opening the black box. Strategic Management Journal, 29(10), 1027-1055.

Deng, X., Li, W., & Ren, X. (2023). More sustainable, more productive: Evidence from ESG ratings and total factor productivity among listed Chinese firms. Finance Research Letters, 51, 103439.

Deschênes, O., & Greenstone, M. (2007). The economic impacts of climate change: evidence from agricultural output and random fluctuations in weather. American economic review, 97(1), 354-385.

Dess, G. G., & Beard, D. W. (1984). Dimensions of organizational task environments. Administrative Science Quarterly, 29(1), 52-73.

Donaldson, T., & Preston, L. E. (1995). The stakeholder theory of the corporation: Concepts, evidence, and implications. Academy of Management Review, 20(1), 65-91.

Eccles, R. G., & Klimenko, S. (2019). The investor revolution. Harvard Business Review, 97(3), 106-116.

Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). The impact of corporate sustainability on organizational processes and performance. Management Science, 60(11), 2835-2857.

Edmans, A. (2023). Grow the pie: How great companies deliver both purpose and profit (2nd ed.). Cambridge University Press.

Ellinger, A. E., Natarajarathinam, M., Adams, F. G., Gray, J. B., Hofman, D., & O'Marah, K. (2011). Supply chain management competency and firm financial success. Journal of Business Logistics, 32(3), 214-226.

Fang, M., Nie, H., & Shen, X. (2023). Can enterprise digitization improve ESG performance?. Economic Modelling, 118, 106101.

Fisher, A. C., Hanemann, W. M., Roberts, M. J., & Schlenker, W. (2012). The economic impacts of climate change: evidence from agricultural output and random fluctuations in weather: comment. American Economic Review, 102(7), 3749-3760.

Flammer, C. (2015). Does corporate social responsibility lead to superior financial performance? A regression discontinuity approach. Management Science, 61(11), 2549-2568.

Flammer, C. (2021). Corporate green bonds. Journal of Financial Economics, 142(2), 499-516.

Freeman, R. E. (2010). Strategic management: A stakeholder approach. Cambridge university press.

Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: aggregated evidence from more than 2000 empirical studies. Journal of sustainable finance & investment, 5(4), 210-233.

Gaur, V., Fisher, M. L., & Raman, A. (2005). An econometric analysis of inventory turnover performance in retail services. Management Science, 51(2), 181-194.

Graham, J. R., Leary, M. T., & Roberts, M. R. (2015). A century of capital structure: The leveraging of corporate America. Journal of Financial Economics, 118(3), 658-683.

Grewatsch, S., & Kleindienst, I. (2017). When does it pay to be good? Moderators and mediators in the corporate sustainability – corporate financial performance relationship: A critical review. Journal of Business Ethics, 145(2), 383-416.

Harford, J., Mansi, S. A., & Maxwell, W. F. (2008). Corporate governance and firm cash holdings in the US. Journal of Financial Economics, 87(3), 535-555.

Hart, O., & Zingales, L. (2017). Companies should maximize shareholder welfare not market value. Journal of Law, Finance, and Accounting, 2(2), 247-274.

Hart, S. L. (1995). A natural-resource-based view of the firm. Academy of Management Review, 20(4), 986-1014.

Hsiang, S. (2016). Climate econometrics. Annual Review of Resource Economics, 8(1), 43-75.

Huang, H., Lin, S., & Li, J. (2023). The Impact of Climate Risk on Firm Performance: Evidence from Precipitation Changes. Journal of Cleaner Production, 312, 127634.

International Institute of Green Finance (IIGF). 2023. ESG Action Report of Chinese Listed Companies (2022-2023). Beijing: Central University of Finance and Economics. https://iigf.cufe.edu.cn/info/1014/7437.htm

Ioannou, I., & Serafeim, G. (2012). What drives corporate social performance? The role of nation-level institutions. Journal of International Business Studies, 43(9), 834-864.

Khan, M., Serafeim, G., & Yoon, A. (2016). Corporate sustainability: First evidence on materiality. The Accounting Review, 91(6), 1697-1724.

King, A. A., & Lenox, M. J. (2002). Exploring the locus of profitable pollution reduction. Management Science, 48(2), 289-299.

Kolstad, C., & Moore, F. (2020). Estimating the economic impacts of climate change using weather observations. Review of Environmental Economics and Policy, 14(1), 1-20. https://doi.org/10.1093/reep/rez017

Li, C., Tang, W., Liang, F., & Wang, Z. (2024). The impact of climate change on corporate ESG performance: The role of resource misallocation in enterprises. Journal of Cleaner Production, 445, 141263.

Liang, Y., Tan, Q., & Pang, J. (2024). Bless or curse, how does extreme temperature shape heavy pollution companies' ESG performance?-Evidence from China. Energy Economics, 131, 107378.

Linnenluecke, M. K., & Griffiths, A. (2010). Beyond adaptation: Resilience for business in light of climate change and weather extremes. Business & Society, 49(3), 477-511.

Liu, L., Beirne, J., Azhgaliyeva, D., & Rahut, D. (2024). Climate Change and Corporate Financial Performance. Journal of Risk and Financial Management, 17(7), 267.

Luo, X., & Bhattacharya, C. B. (2009). The debate over doing good: Corporate social performance, strategic marketing levers, and firm-idiosyncratic risk. Journal of

Marketing, 73(6), 198-213.

Marbler, A. (2024). Water scarcity and local economic activity: Spatial spillovers and the role of irrigation. Journal of Environmental Economics and Management, 124, 102931.

Matten, D., & Moon, J. (2020). Reflections on the 2018 Decade Award: The meaning and dynamics of corporate social responsibility. Academy of Management Review, 45(1), 7-28.

Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. Academy of Management Review, 22(4), 853-886.

Palazzo, B. (2012). Cash holdings and firm value. Journal of Financial Economics, 104(3), 573-592.

Pankratz, N., Bauer, R., & Derwall, J. (2023). Climate change, firm performance, and investor surprises. Management Science, 69(12), 7352-7398.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: A resource-based view. Strategic Management Journal, 14(3), 179-191.

Pinkse, J., & Kolk, A. (2012). Addressing the climate change — Sustainable development nexus: The role of multistakeholder partnerships. Business & Society, 51(1), 176-210.

Porter, M. E., & Kramer, M. R. (2011). Creating shared value: How to reinvent capitalism—and unleash a wave of innovation and growth. Harvard Business Review, 89(1/2), 62-77.

Russ, J. (2020). Water runoff and economic activity: The impact of water supply shocks on growth. Journal of Environmental Economics and Management, 101, 102322.

Russo, M. V., & Fouts, P. A. (1997). A resource-based perspective on corporate environmental performance and profitability. Academy of Management Journal, 40(3), 534-559.

Sheffi, Y. (2015). The Power of Resilience: How the Best Companies Manage the Unexpected. MIT Press.

Shen, Y., Oki, T., Utsumi, N., Kanae, S., & Hanasaki, N. (2008). Projection of future world water resources under SRES scenarios: water withdrawal/Projection des ressources en eau mondiales futures selon les scénarios du RSSE: prélèvement d'eau. Hydrological sciences journal, 53(1), 11-33.

Zhang, P., Deschenes, O., Meng, K., & Zhang, J. (2018). Temperature effects on productivity and factor reallocation: Evidence from a half million Chinese manufacturing plants. Journal of Environmental Economics and Management, 88, 1-17.

Zilberman, D., Dinar, A., MacDougall, N., Khanna, M., Brown, C., & Scardaci, S.

(2002). Individual and institutional responses to the drought: The case of California agriculture. Journal of Contemporary Water Research & Education, 121(1), 17-23.

Acknowledgement

I would like to express my deepest gratitude to my advisor, Mr. Lin, for his comprehensive guidance throughout the research process, offering invaluable advice and support from the initial topic selection to the final completion of the paper. His assistance, provided entirely free of charge, helped me overcome many challenges in data acquisition, analysis, and modeling, while his expertise and rigorous approach significantly improved my understanding of the subject matter. Without his careful mentorship, this paper could not have been successfully completed.

My interest in ESG issues originates from my passion for economics, which deepened through my participation in various economic competitions and writing contests. As I reviewed numerous company reports, I became intrigued by the relationship between corporate social responsibility (CSR) and financial performance, especially the ESG paradox. To explore this paradox, I decided to investigate the differential impacts of climate shocks on various ESG dimensions and corporate financial performance.

With Mr. Lin's guidance, I was able to solidify my research topic by using climate change as an exogenous shock to study its varying effects on ESG components and financial outcomes. After conducting an extensive literature review and observing real-world corporate behavior, I gradually developed the research framework that underpins this paper.

During my research, I gathered ESG ratings from the HuaZheng system and aligned them with high-resolution climate data from TerraClimate, focusing on A-share listed companies in China between 2009 and 2023. By matching the geographic coordinates of companies with gridded climate data, I accurately calculated climate shocks, such as high temperatures and water scarcity, and identified these events using standardized anomalies. I applied a two-way fixed effects model, incorporating industry and provincial fixed effects, to estimate the impact of climate variability on ESG performance and financial outcomes.

Throughout the research process, I faced several challenges, such as difficulties in matching datasets due to formatting discrepancies. Mr. Lin guided me through the necessary logical steps to resolve these issues, offering effective technical advice that enabled me to clean and analyze the data successfully. Moreover, while writing the paper, I struggled to bridge the gap between theoretical concepts and practical applications, particularly in interpreting the complex effects of various ESG dimensions. Mr. Lin provided valuable feedback, helping me navigate these theoretical challenges and ensure that my analysis was rigorous and comprehensive.

In this project, I was primarily responsible for conducting the literature review, developing the research framework, collecting and analyzing the data, building the research model, and interpreting the results, as well as writing and organizing the entire paper. Mr. Lin assisted with topic selection, shaping the research direction, offering technical support for data analysis, improving the model, reviewing the paper's structure, providing feedback on its argumentation and logic, and supplying relevant literature and resources for further research.

I would like to extend my heartfelt thanks to Mr. Lin for his selfless support. His guidance not only enhanced my academic skills but also profoundly influenced my personal growth and research attitude. I would also like to thank all my classmates and friends who provided advice and encouragement throughout this research, as your support gave me the confidence to complete this project. Lastly, I am deeply grateful to the S.-T. Yau High School Science Award committee for offering such a valuable platform, which allowed me to combine theory with practice and motivated me to pursue academic excellence further.