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Extreme Weather Impacts on Stock Price Crash Risk: Evidence from China

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Abstract

Extreme weather events have increasingly imposed significant shocks on corporate operations and the financial system's stability. This study examines the impact of extreme weather on the stock price crash risk and its underlying mechanisms using a sample of A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2010 to 2023. The results demonstrate that extreme weather significantly increases the stock price crash risk for listed companies. After addressing endogeneity issues and conducting a series of rigorous robustness tests, the core conclusions remain robust. Channel analyses reveal that extreme weather exacerbates stock price crash risk by deteriorating corporate fundamentals, reducing the quality of financial disclosures, and exacerbating information asymmetry. Heterogeneity analysis further indicates that the reinforcement effect is more pronounced among firms in the eastern region, firms with high-quality information disclosures, and non-state-owned enterprises. These findings contribute to the literature by identifying novel determinants of stock price crash risk and shedding light on the role of climate risk among investors.

Keywords

extreme climate, stock market crash risk, information asymmetry, information disclosure

1. Introduction

Against the backdrop of profound changes in the global climate governance system and the incorporation of “dual carbon” targets into national development strategies, climate change has evolved from a long-term environmental issue into an urgent factor affecting economic and social systems. The Sixth Assessment Report of the United Nations Intergovernmental Panel on Climate Change [1] clearly states that the frequency, intensity, and duration of extreme weather events have increased substantially worldwide, imposing systematic shocks on regional production networks and firm operations. Over the past four decades, European countries have suffered losses ranging from 450 billion to 520 billion euros; China has also been severely affected by climate-related disasters, with the 2008 nationwide cold snap, the 2020 heavy rainfall in the Yangtze and Huai River basins, and the 2021 “extreme rainstorm” in Henan causing direct economic losses of 151.7 billion, 132.2 billion, and 120.1 billion yuan, respectively. Such shocks not only cause direct damage to physical assets and supply chains but also transmit potential risks to financial markets through channels such as corporate financial stability, disclosure practices, and investor expectations.

Existing research on the risk of stock price crashes is primarily based on theories of information asymmetry and agency conflicts [2], which suggest that management engages in hoarding bad news. This is primarily manifested in opaque financial reporting [3] and poor quality of information disclosure [4]. These behaviors are regarded as key channels amplifying the stock price crash risks. Within this framework, extreme weather events may exacerbate this risk through two channels. The first is the physical risk channel that extreme weather events directly lead to corporate asset impairments [5], production disruptions, and cash flow volatility [6], thereby deteriorating corporate fundamentals and increasing operational uncertainty. The second is the transition risk and disclosure channel. Under increasingly stringent climate regulations, firms may face regulatory penalties and reputational damage due to inadequate environmental disclosures or "greenwashing," further triggering a crisis of market confidence [7]. Both channels may strengthen managers' incentives to conceal bad news, ultimately causing a stock price crash when negative information is released in a concentrated manner.

However, existing literature predominantly focuses on the impact of macro-level climate policies on corporate environmental investments or green innovation, finding that climate policy uncertainty crowds out both real-economy investments and green innovation investments [8] and significantly increases the volatility of the S&P Green Bond Index, the Global Clean Energy Index, and the Dow Jones Sustainability Index [9]. At the same time, environmental initiatives such as green product innovation and pollution control are often accompanied by severe information asymmetry and high uncertainty, which may have a significant negative impact on financial performance [10]. In addition, major adjustments in climate policy can also amplify the green credit bubble effect, significantly increasing banks' risk levels and exacerbating the climate transition risks they face [11]. Corporate uncertainty is the underlying mechanism driving stock price volatility [12]. The core logic lies in the fact that uncertainty affects future cash flow and capital cost assessments, thereby amplifying stock price volatility [3]. The uncertainties triggered by extreme weather do not operate in isolation. On the contrary, they are intertwined with uncertainty in the macroeconomic, financial, and energy policy domains and reinforce one another. This interaction creates a coupling effect that significantly increases stock market risk.

Against this backdrop, investigating the impact of extreme weather on the risk of stock price crashes is particularly significant. Extreme weather events signify not only a direct exogenous shock but also represent a highly complex climate risk exposure at the corporate level. This directly influences investors' assessments of a company's asset value, supply chain stability, and long-term sustainable operational capacity [5], thereby disrupting the underlying assumptions of cash flow estimates [6]. More importantly, extreme climate risks are deeply embedded within a broad network of exogenous uncertainties, particularly those arising from global climate policy trajectories, the evolution of regulatory frameworks, and the restructuring of technological pathways [8, 9]. Such exogenous uncertainties will trigger a fundamental restructuring of economic rules, exerting profound and destabilizing effects on corporate fundamentals through channels such as direct asset impairments, disruptions to production operations, shifts in industry competitive landscapes, and carbon trading costs. In this process, management's incentive to conceal adverse news is significantly strengthened in order to mask the deterioration in fundamentals caused by climate shocks. Once this accumulated concealed bad news is eventually disclosed, the market may experience a sudden sell-off, thereby triggering the risk of a stock market crash.

Hence, using data of A-share firms listed on the Shanghai and Shenzhen stock exchanges from 2010 to 2023, this study systematically investigates the impact of extreme weather on stock price crash risk, its transmission mechanisms, and its heterogeneity. The findings reveal that extreme weather significantly increases the stock price crash risk. The conclusion that remains robust after a series of robustness tests, including replacing the dependent variable, adding control variables, and excluding 2020 data. Heterogeneity analyses show that the effect is more pronounced among firms in the eastern region, firms with high disclosure levels, and non-state-owned enterprises. Mechanism tests indicate that extreme temperatures exacerbate stock price crash risk mainly by intensifying information asymmetry and deteriorating corporate fundamentals. This study not only extends the theoretical boundaries of climate finance in emerging markets but also provides empirical evidence to assist regulators in refining climate disclosure frameworks and to help investors identify and manage climate-related risks.

The marginal contributions of this paper are primarily reflected in the following three aspects. First, we contribute to the emerging literature on the determinants of stock price crash risk. Existing literature has identified factors influencing stock price crash risk from various perspectives, such as information disclosure [13], managerial characteristics [14], corporate policies and internal governance [15], and culture [16], but none have considered the impact of climate factors. This study finds that extreme weather also increases the risk of stock price crashes, expanding our understanding of the specific determinants of this risk.

Second, most existing studies have merely established a macro-level correlation between extreme weather and market volatility, while remaining notably deficient in empirically examining the micro-level transmission mechanisms. This study is the first to empirically separate and validate two parallel and complementary mediating channels, information asymmetry and corporate fundamentals, within a unified framework. By tracing the complete causal chain through which macro-level climate shocks influence micro-level firm behavior and ultimately shape financial market outcomes, this study provides crucial micro-level evidence from China regarding the financial transmission of climate risks, thereby deepening the understanding in this field.

2. Literature Review

2.1 Stock Price Crash Risks and Their Determinants

Stock price crash risk refers to the probability that a specific stock's intrinsic value will plummet to an extremely negative level, typically due to unexpected events, the release of negative internal corporate news, or a sudden shift in investor sentiment. Regarding the origins of stock price crash risk, research suggests that information asymmetry between companies and investors, coupled with management's deliberate concealment of negative news, is the primary cause [17]. This theory stems from the widespread principal-agent problem within firms, positing that corporate management will protect its own interests by concealing negative information about the company. Behind this behavior, the company is likely facing deteriorating fundamentals such as insufficient innovation, a lack of market competitiveness in its products or services, profit pressures, and tight cash flow [18]. To prevent this negative information from reaching the capital markets, which could trigger declining investor expectations and other contagion effects, management is forced to conceal the bad news. However, a company cannot hide this negative information indefinitely; when the accumulated negative information reaches a level that the company cannot bear, it will gradually be exposed, shocking the market, increasing stock price volatility, and ultimately leading to a stock price crash [19]. Therefore, a stock price crash is not only a direct consequence of information asymmetry and management's concealment of adverse news, but also a retrospective punishment by the market for the deterioration of a company's fundamentals and the behavior of "poor-quality companies".

From the perspective of internal factors, the relevant literature primarily examines corporate governance, information disclosure, and management characteristics. Yuan and Shao [20] found that corporate governance structure and the level of financial information disclosure have a significant impact on the probability of a stock price crash; the less adequate the information disclosure, the higher the probability of a stock price crash. Liu and Li [21], using data from A-share listed companies in 2011, found that firms can reduce the likelihood of a stock price crash by increasing the disclosure of internal control information, and this effect is more pronounced in firms with higher levels of information asymmetry and weaker profitability. An empirical study by Zhang X et al. [22], utilizing a large language model, indicates that the degree of readability is strongly negatively linked to firm stock price crash risk. From the perspective of managerial behavior, Fu F et al. [23] found that long-term investments by institutions significantly mitigate risk by curbing managerial myopia, enhancing transparency, and improving accountability, thus deterring self-serving behavior. Pu et al. [24] found that board faultlines influence corporate risk-taking by disrupting internal board order, lowering its monitoring willingness and ability, and reducing investment efficiency. In summary, regardless of the specific factors involved, enhancing corporate transparency and reducing management's concealment of information are key to mitigating the risk of stock price crashes.

In addition, macroeconomic policies and the broader environment can influence corporate behavior and, consequently, the risk of stock price crashes. Dai Bingbin et al. [25] found in their study of monetary policy that tight monetary policy is positively correlated with the risk of stock price crashes, and that insufficient liquidity in funds and individual stocks significantly amplifies this effect. Green credit policies increase the risk of stock price crashes for heavily polluting firms by imposing financial constraints and reducing the quality of information disclosure [26]. Tax authority monitoring improves information disclosure quality through tax compliance channels, and the effect is more significant in firms with weak external supervision, weak internal governance, and firms located in non-Eastern areas and areas with lower fiscal pressure [27].

2.2 Economic Consequences of Extreme Climate Change

As a key component of climate risk, physical climate risks have received significant attention in recent years. According to the literature in this field, climate risks can be categorized into "physical risks" and "transition risks" [28]. "Physical risks" refer to direct economic and financial losses caused by climate risks. Extreme weather events, such as storms, floods, and heatwaves, significantly reduce corporate productivity, alter corporate financing structures, and have direct negative impacts on the macro economy, leading to disruptions in economic activity and a decline in the value of corporate assets. Consequently, the returns on their financial assets also drop sharply [29], thereby reducing corporate profitability [30].

At the same time, such risks can exacerbate volatility in financial markets, further triggering financial risks. This is because, when investors are paying close attention to climate change, the accumulation of physical risks can easily trigger panic among investors, which then spreads to financial markets such as the stock market [31]. When risk events such as abnormal heat waves and extreme droughts impact businesses and markets, investors tend to exhibit pronounced overreactions, thereby significantly depressing bond and stock prices [32]. Physical risks arising from extreme weather are also linked to insurance mechanisms for climate disasters. The occurrence of extreme weather may lead to impairment of fixed assets, substantially increase insurance claims, exacerbate volatility in the insurance sector, and further transmit these effects to other financial institutions, such as real estate firms [33]. Addoum [34] found that extreme temperatures affect the profitability of over 40% of industries, with temperature-sensitive sectors being particularly vulnerable. Consequently, central banks worldwide have issued warnings regarding the potential impact of climate risks on financial stability. Policymakers have also emphasized that assessing climate change as a potential source of systemic risk is crucial for ensuring the stability of the financial system [35].

3. Theoretical Mechanisms and Research Hypotheses

3.1 Theoretical Framework of How Extreme Climate Shocks Affect Stock Price Crash Risk

The transmission of extreme climate events to the risk of corporate stock price crashes is essentially a process of transforming physical risks into financial risks. At its core lies how climate shocks disrupt the stability of corporate operations and ultimately trigger nonlinear crash effects in capital markets. Extreme climate events can directly damage a company's tangible assets, such as factories and equipment, disrupt production processes, and lead to reduced production capacity and revenue [34]. For example, floods may submerge manufacturing production lines, extreme heat may reduce agricultural output, and hurricanes may destroy energy companies' infrastructure. The destruction of physical assets caused by disasters such as hurricanes and floods forces firms to bear high restoration costs; such expenditures are often urgent and cannot be deferred, significantly depleting firms' cash reserves [36]. Furthermore, the decline in the collateral value of damaged assets triggers risk reassessments by financial institutions, leaving firms facing difficulties in extending debt maturities and a sharp rise in financing costs [37]. When these dual financial pressures reach a critical point, a firm's debt-repayment capacity will deteriorate substantially; at this stage, any signal of debt default could serve as the trigger for a precipitous plunge in stock prices.

The strong visual impact of extreme weather events and their widespread media coverage significantly alter collective perceptions in capital markets. Environmental anxiety triggered by disaster footage can easily lead to irrational panic, causing investors to indiscriminately sell off shares of climate-vulnerable companies and even entire industry sectors [32]. Behavioral resonance among institutional investors further amplifies this effect: ESG funds, driven by compliance requirements, passively reduce their holdings of impacted companies' stocks, potentially triggering a liquidity spiral; meanwhile, short sellers seize the opportunity to concentrate their positions on firms exposed to climate risks, accelerating the divergence of prices from fundamentals. This attention-driven trading behavior essentially amplifies the tail-risk attributes of climate shocks, causing the distribution of stock returns to exhibit significant negative skewness. This mechanism demonstrates that climate disasters not only affect the intrinsic value of firms but also create self-fulfilling conditions for stock price crashes by reshaping market expectations. Based on the above analysis, this paper proposes the following research hypothesis:

H1: Extreme temperatures exacerbate the risk of stock price crashes.

3.2 The Mechanism Through Which Extreme Climate Shocks Influence the Risk of Stock Price Collapse

The distinctiveness of climate risk lies in its difficult-to-quantify uncertainty; this ambiguity exacerbates information asymmetry. Based on agency theory, management may deliberately conceal negative information resulting from extreme climate events to protect their reputation, compensation, or job security [4]. Companies in high-carbon-emission industries may engage in “green washing” to embellish their climate response measures, deliberately concealing their environmental risk exposures [38]. Faced with long-term climate threats, corporate management’s decision-making may fall into the trap of “defensive myopia.” To maintain short-term performance, executives often cut investments in disaster-prevention infrastructure or accelerate the exercise and sale of stock options to lock in personal gains. At the board level, a lack of climate expertise often leads to an underestimation of the severity of physical risk exposure, resulting in the absence of climate audit mechanisms. This governance failure causes companies to gradually lose their ability to adapt to risks, meaning even minor climate shocks can result in disproportionate losses. However, concealment leads to the continuous accumulation of negative information. When the costs of concealment exceed the benefits, a flood of negative information can suddenly hit the market, triggering a stock price crash [39].

Given the sudden nature and uncertainty regarding the severity of extreme weather events, market reactions suggest that a deterioration in corporate fundamentals lowers investors’ expectations of a company’s future value. However, if negative information is not disclosed in a timely and adequate manner, investors may maintain an erroneous valuation of the company due to information lag. For example, asset impairment losses caused by extreme weather may be recognized late, or the impact of supply chain disruptions may be underestimated, providing management with an excuse to withhold information. They may attribute declining performance to “force majeure” rather than their own inadequate risk management, thereby reducing market accountability. Based on the above analysis, this paper proposes the following research hypothesis:

H2: Extreme temperatures exacerbate the risk of stock price crashes by deteriorating corporate fundamentals and increasing the degree of information asymmetry.

4. Data and Methods

4.1 Data Sources and Processing

We selected Chinese A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2010 to 2023 as the study sample and performed the following screening and processing: (1) Excluded companies in the financial sector; (2) Excluded companies listed for less than one year, those that had been delisted, or those with suspended listings; (3)Removed missing values;(4)To eliminate the influence of outliers, the values of continuous variables at the 1st and 99th percentiles were truncated. After the above data screening and processing, a total of 24,148 sample data points were obtained. The listed company data used in this study were sourced from the CSMAR database.

4.2 Variable Definitions and Measurement

4.2.1 Dependent Variables

Following the relevant research by Wang et al. [40], this study selects the negative return skewness coefficient (NCSKEW) and the down-up volatility ratio (DUVOL) as metrics for stock price crash risk. A higher value of NCSKEW indicates a greater degree of negative weekly stock returns for the company and a higher risk of stock price collapse; a higher value of DUVOL indicates a greater amplitude of stock price fluctuations around the mean, implying a higher risk of stock price collapse. The specific calculation formulas are as follows:

$$NCSKEW_{i,t} = -\frac{n(n-1)^{3/2}\sum w_{i,t}^3}{(n-1)(n-2)\left(\sum w_{i,t}^2\right)^{3/2}} \tag{1}$$

$$DUVOL_{i,t} = \log\left\{\left[\frac{(n_u-1)\sum_{Down} w_{i,t}^2}{(n_d-1)\sum_{up} w_{i,t}^2}\right]\right\} \tag{2}$$

Since the relevant literature has already provided a detailed introduction to the calculation methods and procedures for the above two variables, this paper will not elaborate further.

4.2.2 Core Explanatory Variables

This paper uses extreme high temperatures (HTD) and extreme low temperatures (LTD) as representatives of extreme climate for empirical analysis. These two types of extreme climate events often lead to common meteorological disasters. Extreme heat can trigger heatwaves, causing shortages in water and electricity supply and reducing labor productivity; extreme cold causes frost and cold damage, resulting in severe losses to agricultural production, transportation, and communications.

The data is sourced from the Global Climate Risk Integration Database (GCRID). The period from 1973 to 1992 was selected as the climate baseline. Using daily observational data from meteorological stations during the baseline period and the percentile relative threshold method, extreme thresholds for the city's meteorological indicators were defined, and the number of days with extreme temperature events was calculated for each year in the sample period from 1993 to 2023. Specifically, the daily maximum and minimum temperature records for the same date in each year of the climate reference period (e.g., January 1 of each year), sorted in ascending order, and the 90th percentile and 10th percentile values as the extreme high-temperature threshold and extreme low-temperature threshold, respectively. When the maximum temperature in a city on a given day exceeds the extreme high-temperature threshold for that day, it is considered that an extreme high-temperature event occurred in that city on that day. Finally, the daily-level data are aggregated to obtain the number of days with extreme climate events at the annual level. The number of days with extreme low-temperature events is extracted using the same method.

4.2.3 Control Variables

To enhance the reliability of the research findings, this study controls for relevant factors that may influence the risk of stock price crashes in listed companies. Drawing on the research by Kim [41] and Chang [42], we use firm-level variables such as firm size (SIZE), return on assets (ROA), leverage ratio (LEV), monthly excess turnover (Dturn), property, plant, and equipment (PPE), and Tobin's Q to control for the impact of fundamental firm characteristics on the risk of stock price crashes; we select macroeconomic variables (GDP) to control for the impact of macroeconomic characteristics on stock price crashes. See Table 1 for specific variable definitions.

Table 1: Definitions and Descriptions of Main Variables

Variable Type	Variable Name	Variable Symbol	Variable Definition
Dependent Variable	Negative Return Skewness	NCSKEW	See formula (1)
	Stock Price Volatility	DUVOL	See formula (2)
Independent Variable	Extreme High Temperature	HTD	Number of days exceeding the extreme high temperature threshold
	Extreme Low Temperature	LTD	Number of days exceeding the extreme low temperature threshold
Control Variable	Firm Size	Size	Logarithm of total assets
	Leverage	Lev	Ratio of total liabilities to total assets
	Return on Assets	ROA	Ratio of after-tax net profit to total assets
	Fixed Assets	PPE	Ratio of fixed assets to total assets
	Excess Turnover Rate	Dturn	Average daily turnover rate within the year
	Tobin's Q	Tobinq	Ratio of market value to total assets
	Regional Economic Development	GDP	Natural logarithm of GDP in the firm's region

4.3 Empirical Model Design

We construct the following empirical model to estimate the impact of climate risk on stock price crash risk:

$$Crash_{i,t} = \alpha_0 + \alpha_1 temperature_{i,t} + \alpha_2 Controls_{i,t} + \mu_i + \gamma_i + \varepsilon_{i,t} \quad (3)$$

The dependent variable is firm-specific stock price crash risk (Crash), measured by the negative return skewness (NCSKEW) and the down-to-up volatility ratio (DUVOL), respectively. The independent variable is extreme temperature, measured by extreme high temperature (HTD) and extreme low temperature (LTD), respectively. Controls represent the corresponding control variables. μ_i and γ_i denote firm and time fixed effects, respectively, and $\varepsilon_{i,t}$ is the error term. If the research hypothesis holds, the estimated coefficient α_1 should be significantly positive.

5. Analysis of Empirical Results

5.1 Descriptive Statistics

Table 2 reports the main descriptive statistics. In the sample, the mean of the skewness coefficient for negative stock returns is -0.427, with a standard deviation of 0.717; the minimum and maximum values are -2.670 and 1.614, respectively; the mean of stock price volatility is -0.291, the standard deviation is 0.475, and the minimum and maximum values are -2.932 and 3.375, respectively. The above indicates significant differences in the risk of stock price crashes across companies, which is consistent with existing research. The mean for extreme low temperatures is 17.263, with a standard deviation of 8.047; the minimum and maximum values are 2.703 and 39.865, respectively. The mean for extreme high temperatures is 52.081, with a standard deviation of 14.2992; the minimum and maximum values are 0.000 and 111.712, respectively. This indicates that there are also significant differences among the various extreme climate indicators, which provides a research scope for the empirical analysis in this paper.

Table 2: Descriptive Statistics

Variable	Sample Size	Mean	Std	Min	Median	Max	Skewness	Kurtosis
NCSKEW	24148	-0.427	0.717	-2.670	-0.374	1.614	-0.364	3.956
DUVOL	24148	-0.291	0.475	-2.932	-0.288	3.375	0.081	3.814
LTD	24148	17.263	8.047	2.703	16.216	39.865	0.464	2.635
HTD	24148	52.081	14.292	0.000	51.351	111.712	0.062	3.838
Lev	24148	0.434	0.205	0.051	0.427	0.908	0.176	2.198
PPE	24148	20.117	16.021	0.148	16.456	69.621	1.034	3.611
ROA	24148	3.460	6.018	-26.214	3.510	18.720	-1.416	9.000
Size	24148	22.376	1.323	19.916	22.169	26.465	0.793	3.529
Dturn	24148	1.683	1.252	0.178	1.330	6.470	1.506	5.396
Tobinq	24148	1.985	1.223	0.833	1.606	8.632	2.592	11.697
GDP	24148	11.563	0.495	10.050	11.650	12.223	-0.906	3.294

5.2 Baseline Regression

Table 3 presents the baseline regression results evaluating the impact of extreme cold and extreme heat on the risk of stock price crashes. The results of the univariate regression in columns (1) and (5) indicate that, at the 1% significance level, the LTD coefficient is positive and statistically significant. Columns (2) and (6) report the results after controlling for covariates; the LTD coefficients are 0.0041 and 0.0024, respectively, both of which are significant at the 1% level. These empirical results strongly support Hypothesis 1, confirming a positive correlation between extremely low temperatures and the risk of stock price crashes; similarly, the regression results for extreme high temperatures in columns (2) and (7) indicate a positive correlation with the risk of stock price crashes at the 1% significance level, and the results remain significant after controlling for variables.

Meanwhile, the coefficient for firm size in Table 3 is significantly positive at the 1% level, indicating that larger firms face a higher risk of stock price crashes. One possible explanation is that larger firms have more complex business structures and broader market influence, making them more susceptible to various uncertainties [43].

Table 3: Baseline regression results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	NCSKEW				DUVOL			
ltd	0.0050***	0.0041***			0.0031***	0.0024***		
	(7.5397)	(5.4301)			(7.0611)	(4.7924)		
htd			0.0027***	0.0021***			0.0021***	0.0014***
			(6.3568)	(4.7023)			(7.1284)	(4.7087)
lev		-0.0819		-0.0691		-0.0593		-0.0522
		(-1.5227)		(-1.2875)		(-1.6439)		(-1.4488)
ppe		-0.0014**		-0.0015**		-0.0012***		-0.0013***
		(-1.9788)		(-2.0070)		(-2.5767)		(-2.6036)
roa		-0.0020*		-0.0017		-0.0027***		-0.0025***
		(-1.7201)		(-1.4366)		(-3.5174)		(-3.2560)
size		0.0621***		0.0442***		0.0296***		0.0187**
		(5.0687)		(3.6680)		(3.5914)		(2.3091)
dturn		-0.0879***		-0.0902***		-0.0621***		-0.0633***
		(-17.3189)		(-17.9429)		(-18.3488)		(-18.8350)
tobinq		0.0237***		0.0187***		0.0052		0.0023
		(4.0580)		(3.2450)		(1.2704)		(0.5763)
gdp		-0.0207		-0.0644**		0.0202		-0.0071
		(-0.7709)		(-2.4087)		(1.1362)		(-0.4040)
_cons	-0.5136***	-1.4743***	-0.5687***	-0.6002**	-0.3449***	-1.0728***	-0.3979***	-0.5422***
	(-41.1097)	(-5.2465)	(-25.0758)	(-2.3561)	(-41.4502)	(-5.6774)	(-25.9786)	(-3.1846)
N	24148	24148	24148	24148	24148	24148	24148	24148
R^2	0.1662	0.1807	0.1656	0.1804	0.1599	0.1774	0.1601	0.1774
F	56.8467	51.3714	40.4089	50.0159	49.8590	58.8419	50.8134	58.5751

5.3 Robustness Tests

The baseline regression results indicate that extreme temperatures are associated with an increased risk of stock market crashes. Although control variables have been included, potential concerns regarding endogeneity and omissions bias may still undermine the validity of these findings. To address these concerns and enhance the robustness of the results, the following methods were employed to conduct robustness and endogeneity tests.

5.3.1 Excluding 2020

The COVID-19 pandemic triggered severe volatility in global stock markets, presenting financial markets with unprecedented challenges. During this period, an increase in insider trading exacerbated information asymmetry in the market, which in turn intensified irrational investor sentiment and ultimately led to sharp declines in stock prices [44]. To isolate the impact of specific events on the stock market, we conducted a robustness test by excluding the 2020 samples and re-estimating the baseline regression model. Table 4 presents the regression results. Compared to the baseline regression, the coefficient between extreme temperatures and the risk of stock price crashes has decreased, but the overall significance and robustness of the results remain unaffected.

5.3.2 Replacing the explanatory variable with CCPRI

We replace the explanatory variable “extreme temperatures” with the Climate Physical Risk Index (CCPRI) to examine its relationship with the risk of stock price crashes. The results in columns (5) and (6) of Table 4 show that the Climate Physical Risk Index has a significant positive correlation with the risk of stock price crashes at the 1% level, confirming the robustness of the baseline regression.

5.3.3 Including control variables

In addition to the explanatory variables in the baseline regression, several other factors may influence the risk of stock price crashes. Existing research indicates that analyst coverage [45] and financial constraints [46]play a key role in influencing the risk of stock price crashes, while stronger corporate governance measures significantly reduce a firm’s financial risk [47]. Therefore, we introduce additional control variables to address the potential impact of omitted variable bias. Specifically, the omitted variables include financial constraints (SA) and control variables related to internal and external corporate governance: board size (board) and the proportion of independent directors (Indep). Table 5 presents the impact of extreme weather on stock crash risk after incorporating these additional control variables into the baseline. Consistent with the findings in

Table 2, the coefficients for LTD and HTD remain positive and statistically significant, reaffirming the role of climate risk in increasing the likelihood of stock price crashes.

Table 4: Robustness Tests

	Excluding 2020				Replace with CCPRI	
	(1)	(2)	(3)	(4)	(5)	(6)
	NCSKEW	DUVOL	NCSKEW	DUVOL	NCSKEW	DUVOL
ltd	0.0038***	0.0021***				
	(4.8188)	(3.9787)				
htd			0.0020***	0.0013***		
			(4.1740)	(4.0798)		
CCPRI					0.0038***	0.0023***
					(4.4926)	(4.0328)
lev	-0.0880	-0.0663*	-0.0769	-0.0604	-0.0724	-0.0539
	(-1.5662)	(-1.7686)	(-1.3710)	(-1.6169)	(-1.3477)	(-1.4965)
ppe	-0.0015*	-0.0012**	-0.0015**	-0.0013**	-0.0014*	-0.0012**
	(-1.9408)	(-2.4722)	(-1.9788)	(-2.5025)	(-1.9239)	(-2.5258)
roa	-0.0022*	-0.0027***	-0.0019	-0.0025***	-0.0018	-0.0026***
	(-1.7880)	(-3.2419)	(-1.5325)	(-3.0152)	(-1.5666)	(-3.3838)
size	0.0688***	0.0321***	0.0529***	0.0228***	0.0497***	0.0224***
	(5.3880)	(3.7488)	(4.1855)	(2.7007)	(4.1433)	(2.7726)
dturn	-0.0840***	-0.0590***	-0.0858***	-0.0598***	-0.0897***	-0.0631***
	(-15.6786)	(-16.6383)	(-16.1432)	(-16.9638)	(-17.8230)	(-18.7621)
tobinq	0.0249***	0.0050	0.0196***	0.0022	0.0195***	0.0027
	(3.9372)	(1.1362)	(3.1577)	(0.5059)	(3.3851)	(0.6823)
gdp	-0.0228	0.0220	-0.0655**	-0.0033	-0.0461*	0.0053
	(-0.8139)	(1.1969)	(-2.3559)	(-0.1821)	(-1.7435)	(0.3025)
_cons	-1.5995***	-1.1445***	-0.7749***	-0.6701***	-0.9339***	-0.7590***
	(-5.5432)	(-5.8987)	(-2.9518)	(-3.8303)	(-3.6983)	(-4.4837)
N	22007	22007	22007	22007	24148	24148
r2	0.1908	0.1865	0.1905	0.1865	0.1803	0.1771
F	42.9708	49.1117	42.1025	49.2123	49.5701	57.7199

Table 5: Robustness tests with including control variables

	(1)	(2)	(3)	(4)
	NCSKEW	DUVOL	NCSKEW	DUVOL
ltd	0.0040***	0.0024***		
	(5.2165)	(4.7064)		
htd			0.0024***	0.0016***
			(5.2462)	(5.1118)
sa	0.1401**	0.0641*	0.2214***	0.1155***
	(2.4122)	(1.6514)	(3.7925)	(2.9552)
indep	0.0048***	0.0029***	0.0049***	0.0029***
	(3.0767)	(2.8414)	(3.1581)	(2.9173)
board	-0.0045	-0.0051	-0.0034	-0.0045
	(-0.6979)	(-1.2089)	(-0.5336)	(-1.0605)
lev	-0.0820	-0.0596*	-0.0723	-0.0542
	(-1.5246)	(-1.6528)	(-1.3478)	(-1.5050)
ppe	-0.0015**	-0.0013***	-0.0016**	-0.0013***
	(-2.1069)	(-2.6773)	(-2.1804)	(-2.7473)
roa	-0.0022*	-0.0027***	-0.0020*	-0.0026***
	(-1.8958)	(-3.5987)	(-1.7537)	(-3.4708)
size	0.0713***	0.0342***	0.0588***	0.0266***
	(5.5436)	(3.9722)	(4.6326)	(3.1350)
dturn	-0.0868***	-0.0617***	-0.0877***	-0.0621***
	(-16.9679)	(-18.0296)	(-17.2539)	(-18.2118)
tobinq	0.0228***	0.0047	0.0177***	0.0018
	(3.8922)	(1.1636)	(3.0756)	(0.4402)
gdp	0.0242	0.0384*	0.0104	0.0299
	(0.7126)	(1.6827)	(0.3061)	(1.3163)
_cons	-1.7963***	-1.2022***	-1.1046***	-0.7804***
	(-5.7023)	(-5.6701)	(-3.7425)	(-3.9412)
N	24135	24135	24135	24135
R^2	0.1816	0.1782	0.1816	0.1784
F	38.8511	44.2486	38.7004	44.6506

5.4 Mediation Effect

The amplifying effect of climate risk on the risk of stock price crashes was verified in the preceding section. How, then, does climate risk increase the risk of stock price crashes? Based on the theoretical analysis presented earlier, this section examines the mechanism from two dimensions, the information asymmetry and corporate fundamentals, to reveal the underlying mechanism through which extreme temperatures affect the risk of stock price crashes.

5.4.1 Information Asymmetry

Following the approach of Hutton et al. (2009), we utilize the manipulable accruals indicator (DisAcc)calculated using the Modified Jones Model to examine the impact of extreme temperatures on the firm's information environment from the perspective of information quality. A higher value of manipulable accruals indicates lower quality of financial disclosure and a higher degree of information asymmetry. The test results are shown in Table 10. Columns (1) and (4) present the regression results for extreme low temperatures and extreme high temperatures on manipulable accruals, both showing a significant positive relationship at the 1% level. This indicates that extreme temperatures affect the quality of corporate financial disclosures and exacerbate information asymmetry. Columns (2) and (3), as well as (5) and (6) present the regression results after including mediating variables; the impact of extreme temperatures on the risk of stock price crashes remains significantly positive at the 1% level. This indicates that information asymmetry serves as a mediating variable in the relationship between extreme temperatures and the risk of stock price crashes, meaning that extreme temperatures exacerbate the risk of stock price crashes by influencing the degree of information asymmetry.

Table 6: Testing for Mediating Effects—Information Asymmetry

	(1)	(2)	(3)	(4)	(5)	(6)
	DisAcc	NCSKEW	DUVOL	DisAcc	NCSKEW	DUVOL
ltd	0.0002**	0.0041***	0.0024***			
	(2.5615)	(5.3708)	(4.7263)			
htd				0.0002***	0.0021***	0.0014***
				(4.3974)	(4.5919)	(4.5880)
DisAcc		0.2197***	0.1595***		0.2172***	0.1574***
		(3.9488)	(4.2351)		(3.8946)	(4.1714)
lev	0.0064	-0.0833	-0.0603*	0.0069	-0.0706	-0.0532
	(0.7142)	(-1.5505)	(-1.6737)	(0.7659)	(-1.3168)	(-1.4802)
ppe	-0.0001	-0.0014*	-0.0012**	-0.0001	-0.0014**	-0.0012**
	(-0.9828)	(-1.9511)	(-2.5452)	(-1.0013)	(-1.9791)	(-2.5720)
roa	0.0071***	-0.0036***	-0.0038***	0.0072***	-0.0032***	-0.0036***
	(40.3501)	(-2.9160)	(-4.7234)	(40.3928)	(-2.6361)	(-4.4619)
size	-0.0019	0.0625***	0.0299***	-0.0031*	0.0448***	0.0192**
	(-1.1220)	(5.1050)	(3.6290)	(-1.8409)	(3.7248)	(2.3692)
dturn	-0.0007	-0.0877***	-0.0619***	-0.0008	-0.0900***	-0.0631***
	(-1.1962)	(-17.2923)	(-18.3171)	(-1.2531)	(-17.9141)	(-18.8013)
tobinq	-0.0028***	0.0243***	0.0056	-0.0030***	0.0193***	0.0028
	(-3.3591)	(4.1667)	(1.3816)	(-3.6237)	(3.3623)	(0.6953)
gdp	-0.0336***	-0.0134	0.0255	-0.0369***	-0.0564**	-0.0013
	(-9.3738)	(-0.4950)	(1.4347)	(-10.0802)	(-2.1011)	(-0.0741)
_cons	0.4078***	-1.5639***	-1.1378***	0.4646***	-0.7011***	-0.6153***
	(11.6608)	(-5.5409)	(-6.0004)	(13.5537)	(-2.7330)	(-3.5904)
N	24148	24148	24148	24148	24148	24148
r2	0.3012	0.1812	0.1781	0.3016	0.1809	0.1780
F	313.1374	47.3298	54.2672	313.5195	46.1835	54.0392

5.4.2 Deteriorate the Firm's Fundamentals

Previous research has shown that a deterioration in a company's fundamental performance increases the likelihood that management will conceal bad news, which is a major factor contributing to the risk of a stock price collapse. Furthermore, extreme weather directly impacts a company's revenue and assets, thereby undermining its profitability and financial performance.

Evidence provided by Rao [48] indicates that following extreme rainfall, the market capitalization of rainfall-sensitive companies declines significantly. Managers have an incentive to manipulate earnings to conceal poor performance caused by extreme weather events. Stock prices are typically positively correlated with corporate earnings and profitability; therefore, deteriorating performance amplifies the risk of stock price declines and may even lead to a stock price crash. If this view holds, the relationship between extreme weather and corporate fundamentals is expected to be negative. Following previous literature [49], we use Altman's Z-SCORE as a proxy for corporate fundamentals. A higher Z-SCORE value indicates a lower probability of default, suggesting that the company has stronger fundamentals.

The test results are shown in the figure. Columns (1) and (4) present the regression results for the effects of extreme low temperatures and extreme high temperatures on the Z-SCORE, respectively. These results are significantly negative at the 1% and 5% levels, indicating that extreme temperatures may reduce corporate financial resilience through operational shocks, cash flow volatility, and financing constraints, thereby deteriorating corporate fundamentals. Columns (2) and (3), as well as columns (5) and (6), present the regression results after controlling for mediating variables. The impact of extreme temperatures on the risk of stock price crashes remains significantly positive at the 1% level, while the coefficient of Z-SCORE on the risk of stock price crashes is significantly negative at both the 1% and 10% levels. This suggests that extreme weather, by weakening Z-SCORE, indirectly amplifies the risk of stock price crashes by weakening ZSCORE and deteriorating corporate fundamentals..

Table 7: Mediating effects test based on deterioration in company fundamentals

	(1)	(2)	(3)	(4)	(5)	(6)
	ZSCORE	NCSKEW	DUVOL	ZSCORE	NCSKEW	DUVOL
ltd	-0.0088***	0.0041***	0.0024***			
	(-2.6920)	(5.3745)	(4.7958)			
htd				-0.0056**	0.0021***	0.0014***
				(-2.3495)	(4.6246)	(4.6793)
ZSCORE		-0.0068***	-0.0022*		-0.0068***	-0.0022*
		(-3.4173)	(-1.9136)		(-3.4484)	(-1.9139)
lev	-13.2629***	-0.1722***	-0.0887**	-13.2883***	-0.1597***	-0.0814**
	(-49.7632)	(-2.8867)	(-2.2691)	(-49.4168)	(-2.6840)	(-2.0874)
ppe	-0.0157***	-0.0016**	-0.0013***	-0.0156***	-0.0016**	-0.0013***
	(-4.3388)	(-2.1492)	(-2.6587)	(-4.3210)	(-2.1826)	(-2.6900)
roa	0.0203***	-0.0019	-0.0026***	0.0195***	-0.0016	-0.0024***
	(4.4870)	(-1.6333)	(-3.4857)	(4.2934)	(-1.3532)	(-3.2251)
size	0.5667***	0.0661***	0.0311***	0.6074***	0.0484***	0.0202**
	(10.2043)	(5.3760)	(3.7635)	(11.0928)	(4.0026)	(2.4868)
dturn	-0.0505**	-0.0881***	-0.0620***	-0.0465**	-0.0904***	-0.0632***
	(-2.4967)	(-17.3595)	(-18.3405)	(-2.2901)	(-17.9847)	(-18.8293)
tobinq	2.5848***	0.0413***	0.0108**	2.5950***	0.0364***	0.0079
	(46.4915)	(5.3422)	(2.1193)	(46.7578)	(4.7441)	(1.5648)
gdp	-0.7514***	-0.0256	0.0188	-0.6481***	-0.0688**	-0.0085
	(-7.1122)	(-0.9512)	(1.0570)	(-6.2883)	(-2.5683)	(-0.4791)
_cons	1.7865	-1.4691***	-1.0782***	-0.1941	-0.6041**	-0.5477***
	(1.3419)	(-5.2260)	(-5.7059)	(-0.1668)	(-2.3713)	(-3.2164)
N	24135	24135	24135	24135	24135	24135
R^2	0.7998	0.1813	0.1776	0.7998	0.1810	0.1776
F	664.9507	46.9886	52.9289	696.5087	45.7076	52.6387

5.5 Heterogeneity Analysis

Previous studies have shown that alleviating information asymmetry and improving corporate fundamentals are the mechanisms through which extreme temperatures influence the risk of stock price crashes. However, different geographical environments, firm characteristics, and corporate transparency levels have varying effects on the manifestation of information asymmetry and the improvement of corporate fundamentals. This paper conducts a heterogeneity analysis of the relationship between extreme temperatures and the risk of stock price crashes from three perspectives, which is geographical location, firm characteristics, and corporate governance.

5.5.1 Geographic Location

This study divides the sample into two groups (Eastern and Central-Western regions) based on the geographic location of the companies' headquarters. The results of the group-specific regression in Table 12 show that for the Eastern region group (columns 1, 3, 5, and 7), the coefficients for extreme temperatures are all significantly positive at the 1% level. In contrast, for the Central-Western region group (columns 2, 4, 6, and 8), although the coefficients for extreme temperatures are positive, they are not highly significant or are not significant at all. This suggests that, compared to the Midwest and West, listed companies in the East are more susceptible to the impact of extreme temperatures on the risk of stock price crashes. Possible reasons may be that the eastern region has a more concentrated industrial chain and higher-value assets, making it more sensitive to temperature fluctuations. Furthermore, its mature financial markets can interpret and price climate risk information more rapidly, whereas the information environment in the central and western regions is relatively lagging, and negative news may be concealed.

Table 8: Heterogeneity analysis based on geographic location

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Eastern	Midwest	Eastern	Midwest	Eastern	Midwest	Eastern	Midwest
	NCSKEW	NCSKEW	DUVOL	DUVOL	NCSKEW	NCSKEW	DUVOL	DUVOL
ltd	0.0047***	0.0024	0.0024***	0.0025**				
	(5.4093)	(1.5318)	(4.2208)	(2.3763)				
htd					0.0020***	0.0022**	0.0013***	0.0016**
					(3.9039)	(2.4575)	(3.8297)	(2.5826)
lev	-0.0424	-0.2111**	-0.0219	-0.1686**	-0.0283	-0.2014**	-0.0150	-0.1574**
	(-0.6662)	(-2.0614)	(-0.5117)	(-2.4696)	(-0.4450)	(-1.9819)	(-0.3519)	(-2.3230)
ppe	-0.0024***	0.0003	-0.0017***	-0.0004	-0.0024***	0.0003	-0.0017***	-0.0004
	(-2.6271)	(0.2586)	(-2.8946)	(-0.4724)	(-2.6040)	(0.2131)	(-2.8807)	(-0.5374)
roa	-0.0023*	-0.0010	-0.0027***	-0.0024	-0.0020	-0.0007	-0.0026***	-0.0021
	(-1.7233)	(-0.3956)	(-3.1532)	(-1.4959)	(-1.5049)	(-0.3063)	(-2.9626)	(-1.3507)
size	0.0627***	0.0599**	0.0285***	0.0316**	0.0426***	0.0498**	0.0174*	0.0223
	(4.3297)	(2.4697)	(2.9099)	(2.0097)	(2.9792)	(2.0966)	(1.8010)	(1.4509)
dturn	-0.0910***	-0.0788***	-0.0658***	-0.0516***	-0.0933***	-0.0805***	-0.0667***	-0.0536***
	(-15.5408)	(-7.6896)	(-16.7591)	(-7.7064)	(-16.0400)	(-8.0003)	(-17.0721)	(-8.0946)
tobinq	0.0243***	0.0212*	0.0058	0.0032	0.0177***	0.0199*	0.0026	0.0012
	(3.5848)	(1.7839)	(1.2452)	(0.3833)	(2.6650)	(1.6856)	(0.5567)	(0.1411)
gdp	0.0164	-0.1123**	0.0397*	-0.0305	-0.0377	-0.1406***	0.0088	-0.0538*
	(0.4933)	(-2.3113)	(1.7965)	(-0.9672)	(-1.1398)	(-2.8915)	(0.4015)	(-1.7071)
_cons	-1.9214***	-0.3924	-1.2820***	-0.5349	-0.8574***	0.0865	-0.6974***	-0.0954
	(-5.4694)	(-0.8141)	(-5.4395)	(-1.6365)	(-2.6953)	(0.1976)	(-3.2895)	(-0.3237)
N	18066	6077	18066	6077	18066	6077	18066	6077
R^2	0.1836	0.1797	0.1804	0.1749	0.1829	0.1803	0.1803	0.1751
F	42.2208	10.9705	47.9432	12.3647	40.3536	11.2609	47.7602	12.3271

5.5.2 Information Disclosure

Poorly governed firms demonstrate significant deficiencies in information disclosure quality and investor relations management [50]. To examine the role of disclosure quality in the process by which extreme weather events influence the risk of stock price crashes, this paper categorizes the sample companies into different disclosure quality groups based on the disclosure assessment results published by the Shenzhen Stock Exchange and the Shanghai Stock Exchange. Specifically, companies with disclosure assessment results of "A" (Excellent) and "B" (Good) were classified into the high-quality disclosure group, while those with results of "C" (Pass) and "D" (Fail) were classified into the low-quality disclosure group. The higher the quality of a company's information disclosure, the higher its transparency.

The results in Table 13 show that columns (2), (4), (6), and (8) are significantly positive at the 1% level, indicating that the impact of extreme temperatures on the risk of stock price crashes is more pronounced in the high-quality information disclosure group. Companies with high-quality information disclosure have established a robust information environment, enabling them to convey climate risk-related information to the market in a timely and accurate manner. In this transparent information environment, investors can clearly identify the potential impact of extreme climate events on corporate fundamentals and generate a relatively consistent market reaction, leading to a significant association between climate shocks and the risk of stock price crashes. Conversely, the information environment for companies with low-quality disclosure is relatively opaque, and climate risk information is drowned out by noise, making it difficult for investors to form consistent expectations. This, in turn, weakens the systemic impact of extreme climate events on the risk of stock price crashes.

Table 9: Heterogeneity analysis based on quality of information disclosure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Low	High	Low	High	Low	High	Low	High
	NCSKEW	NCSKEW	DUVOL	DUVOL	NCSKEW	NCSKEW	DUVOL	DUVOL
ltd	0.0008	0.0056^{***}	0.0017	0.0030^{***}				
	(0.4856)	(6.0878)	(1.5108)	(5.0058)				
Htd					-0.0006	0.0029^{***}	-0.0003	0.0018^{***}
					(-0.6525)	(5.3601)	(-0.4547)	(4.8954)
lev	-0.1910	-0.0755	-0.1075	-0.0821^{*}	-0.1835	-0.0665	-0.0949	-0.0773
	(-1.6304)	(-1.0735)	(-1.3974)	(-1.6974)	(-1.5810)	(-0.9451)	(-1.2449)	(-1.5976)
ppe	-0.0012	-0.0009	-0.0009	-0.0009	-0.0012	-0.0009	-0.0009	-0.0009
	(-0.7837)	(-0.9131)	(-0.8605)	(-1.3789)	(-0.7712)	(-0.9277)	(-0.8585)	(-1.3868)
roa	-0.0023	-0.0006	-0.0024	-0.0022^{**}	-0.0023	-0.0002	-0.0023	-0.0020^{*}
	(-1.0596)	(-0.3521)	(-1.6426)	(-2.1400)	(-1.0274)	(-0.0993)	(-1.5369)	(-1.9102)
size	0.0625^{**}	0.0484^{***}	0.0300	0.0237^{**}	0.0589^{**}	0.0225	0.0227	0.0089
	(2.1320)	(3.0623)	(1.5688)	(2.1950)	(2.0755)	(1.4397)	(1.2301)	(0.8394)
dturn	-0.0540^{***}	-0.0958^{***}	-0.0345^{***}	-0.0682^{***}	-0.0564^{***}	-0.0987^{***}	-0.0378^{***}	-0.0696^{***}
	(-4.8501)	(-15.3863)	(-4.5995)	(-16.4849)	(-5.2311)	(-15.9324)	(-5.1787)	(-16.8949)
tobinq	0.0029	0.0245^{***}	-0.0102	0.0083^{*}	0.0014	0.0175^{**}	-0.0132	0.0046
	(0.2108)	(3.5186)	(-1.0577)	(1.6985)	(0.0997)	(2.5335)	(-1.3809)	(0.9492)
gdp	-0.1712^{***}	-0.0095	-0.0948^{**}	0.0327	-0.1753^{***}	-0.0571	-0.1090^{***}	0.0049
	(-2.8868)	(-0.2499)	(-2.4243)	(1.2933)	(-3.0603)	(-1.5007)	(-2.8937)	(0.1937)
_cons	0.2750	-1.3185^{***}	0.2008	-1.0818^{***}	0.4503	-0.2346	0.5778	-0.4688^{**}
	(0.3749)	(-3.5747)	(0.4033)	(-4.3563)	(0.7158)	(-0.6739)	(1.3665)	(-1.9985)
N	6076	17509	6076	17509	6076	17509	6076	17509
R^2	0.2482	0.2203	0.2470	0.2133	0.2482	0.2199	0.2467	0.2133
F	6.1086	41.1591	7.5167	44.8556	6.1104	39.3255	7.3033	44.3973

5.5.3 Corporate property rights

Under China's distinctive institutional background, there are differences between state-owned firms and private firms in terms of resource acquisition capabilities, government support, and credibility [51-53].The sample was divided into two groups based on corporate property rights——the state-owned enterprises and non-state-owned enterprises. The results in Table 14 indicate that non-state-owned enterprises exhibit a more significant impact compared to state-owned enterprises. A possible reason is that state-owned enterprises possess inherent advantages in the credit market, enabling them to obtain bank loans and other financing support at lower costs. Following a climate shock, state-owned enterprises can readily access reconstruction funds to maintain normal operations. In contrast, non-state-owned enterprises face financing constraints. Therefore, a climate shock may exacerbate their financing difficulties and amplify operational risks.

Table 10: Heterogeneity analysis based on corporate property rights

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	nonstate-owned	State-owned	nonstate-owned	State-owned	nonstate-owned	State-owned	nonstate-owned	State-owned
	NCSKEW	NCSKEW	DUVOL	DUVOL	NCSKEW	NCSKEW	DUVOL	DUVOL
ltd	0.0051^{***}	0.0029^{**}	0.0029^{***}	0.0019^{**}				
	(4.9627)	(2.5443)	(4.2465)	(2.4824)				
htd					0.0025^{***}	0.0012^{*}	0.0016^{***}	0.0009^{*}
					(4.2382)	(1.6926)	(3.9304)	(1.9578)
lev	-0.0712	-0.0866	-0.0541	-0.0629	-0.0684	-0.0624	-0.0527	-0.0476
	(-1.0185)	(-0.8961)	(-1.1419)	(-0.9897)	(-0.9783)	(-0.6510)	(-1.1117)	(-0.7553)
ppe	-0.0005	-0.0033^{***}	-0.0008	-0.0023^{***}	-0.0005	-0.0033^{***}	-0.0009	-0.0023^{***}
	(-0.4813)	(-2.9791)	(-1.2048)	(-3.1409)	(-0.5278)	(-2.9668)	(-1.2492)	(-3.1223)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	nonstate-owned	State-owned	nonstate-owned	State-owned	nonstate-owned	State-owned	nonstate-owned	State-owned
	NCSKEW	NCSKEW	DUVOL	DUVOL	NCSKEW	NCSKEW	DUVOL	DUVOL
roa	-0.0018	-0.0043*	-0.0025***	-0.0037**	-0.0015	-0.0038*	-0.0024**	-0.0034**
	(-1.2769)	(-1.9074)	(-2.7226)	(-2.4768)	(-1.0850)	(-1.6765)	(-2.5492)	(-2.2533)
size	0.0951***	0.0350*	0.0432***	0.0172	0.0731***	0.0220	0.0302***	0.0087
	(5.7369)	(1.7148)	(3.8331)	(1.2765)	(4.4815)	(1.0967)	(2.7225)	(0.6560)
dturn	-0.0958***	-0.0721***	-0.0706***	-0.0461***	-0.0983***	-0.0747***	-0.0719***	-0.0477***
	(-14.1501)	(-8.8213)	(-15.6758)	(-8.3510)	(-14.6151)	(-9.2744)	(-16.0439)	(-8.7216)
tobinq	0.0218***	0.0250**	0.0050	0.0007	0.0152**	0.0218*	0.0013	-0.0012
	(3.0663)	(2.2249)	(1.0041)	(0.0909)	(2.1802)	(1.9537)	(0.2611)	(-0.1529)
gdp	-0.0731*	0.0141	0.0006	0.0379	-0.1249***	-0.0133	-0.0303	0.0189
	(-1.8020)	(0.3580)	(0.0226)	(1.4789)	(-3.0790)	(-0.3393)	(-1.1219)	(0.7404)
_cons	-1.5467***	-1.3055***	-1.1060***	-1.0374***	-0.4933	-0.7024*	-0.4879*	-0.6372**
	(-3.8004)	(-2.9663)	(-3.9911)	(-3.5361)	(-1.3074)	(-1.7631)	(-1.9070)	(-2.4271)
N	14176	9362	14176	9362	14176	9362	14176	9362
R^2	0.2083	0.1628	0.1998	0.1611	0.2078	0.1625	0.1997	0.1609
F	36.2897	14.2473	43.0372	15.4305	35.0697	13.7818	42.6733	15.1336

6. Conclusion and Implications

This study uses non-financial A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2010 to 2023 as the research sample to empirically examine the impact of extreme temperatures on stock price crash risk and its underlying mechanisms. The findings reveal that extreme temperatures can significantly exacerbate a company's stock price crash risk, with this effect being more pronounced in companies located in the eastern region, those with high disclosure levels, and non-state-owned enterprises. Furthermore, this conclusion remains valid after a series of endogeneity and robustness tests. The results of the mechanism analysis indicate that extreme temperatures exacerbate the risk of stock price crashes by increasing the degree of information asymmetry and deteriorating corporate fundamentals.

Based on the above findings, this paper offers the following policy implications. For regulatory authorities, it is essential to further strengthen disclosure quality requirements for listed companies, particularly regarding environmental risk-related information, to enhance the market's efficiency in pricing climate risks. Financial regulators may also collaborate with meteorological agencies to develop high-resolution, enterprise-level climate risk databases and early-warning platforms, helping small and medium-sized enterprises identify and quantify their climate risks at lower costs.

For companies, based on their level of climate risk exposure, they should prudently assess and maintain an appropriate level of precautionary cash reserves to address liquidity shocks caused by extreme weather events. Companies need to actively seek stable capital and recognize the "stabilizing" role of institutional investors. By improving corporate governance and strengthening communication, proactively attracting and retaining institutional investors with a long-term perspective and oversight capabilities can help stabilize stock prices during market turbulence and cushion external shocks.

Investors should place high importance on the quality of disclosure in investment portfolios and incorporate quantitative analyses of companies' climate risk exposure and adaptive capacity into valuation models and credit ratings to better manage climate risk exposure. They should also pay particular attention to companies' assets in eastern regions, their non-state-owned status, and the adequacy of their disclosures. Institutional investors should not merely passively avoid risks; rather, they should leverage their shareholder rights to urge companies to improve climate risk management and disclosure through shareholder proposals, voting, and dialogue with management.

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Conflicts of Interest

The authors declare no conflict of interest.

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