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Research on the Impact of Climate Risk on Corporate Stock Price Crash Risk

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Abstract: Climate risk represents a significant financial threat for companies. This study uses a sample of Chinese A-share listed firms from 2007 to 2022 to empirically investigate how climate risk affects stock price crash risk and the mechanisms involved. The findings reveal a strong positive correlation between climate risk and the risk of stock price crashes, suggesting that higher climate risk increases the likelihood of stock price crashes. These results hold true across various tests. Analysis of underlying mechanisms indicates that heightened analyst attention and a stronger commitment to green transition can reduce the adverse effects of climate risk on stock price crash risk. Additionally, the study finds that the influence of climate risk on stock price crash risk is more significant in high-carbon industries and among non-state-owned enterprises.

Keywords: Climate Risk, Stock Price Crash Risk, Analyst Attention, Green Transition.

1. Introduction

Recently, global climate change has accelerated, resulting in more frequent extreme weather events like heavy rain and droughts. The uncertainty of the climate system is gradually becoming a new source of risk that affects the stability of economic activities. The World Economic Forum (WEF) pointed out in its *Global Risks Report 2023* that "climate action is key to addressing the supply-demand imbalance of resources." As a geographically vast country with diverse climate types, China is one of the countries most severely affected by extreme weather events. According to the *China Climate Change Blue Book 2023* released by the China Meteorological Administration, the rate of warming in China is higher than the global average, with frequent occurrences of extreme high-temperature events and heavy rainfall, indicating an increasing trend in the climate risk index. This brings significant uncertainty and risk to corporate production and business activities. The economic impact of climate risk has attracted considerable attention from academia. However, research on climate finance at the corporate level, especially concerning stock market performance, is still relatively scarce. The most relevant study is by Huynh et al. [1] , which found that when investors are highly concerned about climate change, climate risk can induce panic, significantly depressing bond and stock prices. However, the study did not further explore whether this could trigger stock price crash risk.

Stock price crash risk is a critical concern in the capital market, noted for its high level of concealment and potential for damage. It can significantly harm corporate assets and investor interests, threatening financial market stability and economic growth. Considering the effects of climate risk,

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it is important to explore whether corporate responses to climate risk are reflected in the capital market, thus affecting stock price crash risk. However, existing research has not adequately addressed the connection between climate risk and stock price crash risk. Corporate stock price volatility is affected by numerous factors, particularly external shocks. Therefore, investigating whether climate risk influences stock price crash risk and understanding the mechanisms involved is essential for ensuring stable operations and adapting to low-carbon development. This study uses Chinese A-share listed companies from 2007 to 2022 as the sample to empirically analyze the relationship between climate risk and stock price crash risk and to examine the roles of analyst attention and green transition in this context.

2. Theoretical Analysis and Research Hypotheses

Climate risk may increase corporate stock price crash risk, which can be analyzed from two perspectives: the information concealment hypothesis and the transmission of investor sentiment.

Firstly, climate risk strengthens the management's motivation to conceal bad news. Climate risk shocks can increase operational costs. On one hand, physical risks may damage fixed assets such as equipment and factories, leading to production interruptions, supply chain disruptions, and logistics obstructions, directly affecting business activities and increasing performance risk. On the other hand, higher carbon taxes, carbon trading costs, and low-carbon transition and upgrade costs increase transition risks. Furthermore, increased costs and asset losses negatively impact the financial condition of firms, reducing their credit ratings and financial resource accessibility [2] , thereby increasing financing constraints. Due to the separation of ownership and management, the management's goal is to maximize their own interests. Given that bonuses, promotions, and personal reputation are linked to corporate performance and stock prices, management has ample motivation to hide adverse information such as asset damage, performance decline, and transition stagnation. This can prevent further financing constraints, allowing the firm to obtain short-term loans to cover operational losses, and stabilize stock prices and investor confidence. Therefore, when climate risk occurs, management may be motivated to conceal negative news, triggering stock price crash risk.

Secondly, climate risk heightens investor sentiment volatility. In China's capital market, dominated by retail investors, emotional responses are prominent, especially in "chasing gains" and "panic selling." Research indicates that investor sentiment swings, driven by the "herding effect," can significantly influence stock price fluctuations and trading volumes. Climate events, which are sudden and unpredictable, impact the market and companies, affecting investors' risk perceptions and leading to concerns about future firm performance and profitability. This panic among investors can cause exaggerated market reactions. For instance, Choi et al. [3] observed that during extreme temperatures, retail investors often sell off stocks in carbon-intensive companies, resulting in stock price drops. Furthermore, the negative sentiment from climate risk prompts investors to shift their assets from high-risk investments like stocks to safer assets such as gold and government bonds, thereby increasing stock market volatility. Additionally, the market sentiment shifts caused by climate risk can have a ripple effect, where the emotions and behaviors of individual investors influence each other, creating collective reactions that amplify market volatility and heighten stock price instability. Based on this analysis, climate risk is likely to increase future stock price crash risk by intensifying management's incentive to hide negative news and boosting negative investor sentiment. Therefore, this paper posits the following hypothesis:

H1: All else being equal, climate risk will increase corporate stock price crash risk.

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3. Research Design

3.1. Sample Selection

This study uses Chinese A-share listed companies from 2007 to 2022 as the research sample. After filtering, the final dataset includes 29,669 firm-year observations.

3.2. Variable Definition

Adopting the methodology from Du Jian et al. [4] a climate risk dictionary is created using textual analysis and machine learning techniques. Specifically: (1) Seed words are derived from annual report texts, data from the National Meteorological Science Data Center, and the China Meteorological Disasters Yearbook. (2) The seed word list is expanded using the CBOW model to identify related keywords. (3) The climate risk index is computed by dividing the total frequency of climate risk-related keywords by the total word count in annual reports. A higher index value indicates greater climate risk for the firm, and for ease of use, this index is scaled by 100. The detailed definitions and measurement methods for the main variables are provided in Table 1.

Table 1: Variable Descriptions

Variable Type	Variable Name	Symbol	Variable Description
Dependent Variable	Stock Price Crash Risk	NCSKEW	skewness of negative stock returns
		DUVOL	ratio of upside to downside volatility of stock returns
Independent Variable	Climate Risk	ClimateRisk	Number of keywords for climate risk/Total number of annual reports×100
Controls	Enterprise Size	Size	The natural logarithm of the firm's total assets
	Financial Leverage	Lev	Total liabilities divided by total assets
	Return on Assets	ROA	Net profit divided by total assets
	Shareholding Concentration	Share	The sum of the shareholding ratio of the top ten shareholders
	Market-to-Book Ratio	BM	Ratio of total book assets to total stock market value
	Average monthly Excess Turnover Rate	Dturn	The difference between the average monthly turnover rate of t-1 year and the average monthly turnover rate of t-2 years
	Stock Return	Ret	Average annual weekly stock returns taking into account reinvested cash dividends
	Stock Volatility	Sigma	Annual standard deviation of weekly stock returns considering reinvested cash dividends
	Corporate Transparency	ABACC	The absolute value of firms' manipulated accruals estimated by the modified Jones model

3.3. Model Specification

To verify the impact of climate risk on the crash risk of corporate stock prices, the following OLS regression model is established:

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$$NCSKEW_{it}/DUVOL_{it} = \alpha_0 + \alpha_1 ClimateRisk_{it} + \alpha_2 Size_{it} + \alpha_3 Lev_{it} + \alpha_4 ROA_{it} + \alpha_5 Share_{it} + \alpha_6 BM_{it} + \alpha_7 Dturn_{it} + \alpha_8 Ret_{it} + \alpha_9 Sigma_{it} + \alpha_{10} ABACC_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

Where $NCSKEW_{it}/DUVOL_{it}$ represents the crash risk of company i at time t, $ClimateRisk_{it}$ represents the climate risk faced by company i at time t, μ_i denotes industry fixed effects that do not change over time, δ_t denotes time fixed effects, and ε_{it} represents the random disturbance term. Additionally, the standard errors of the model are adjusted at the firm level using clustered standard errors to eliminate potential clustering characteristics in the sample data.

4. Empirical Results Analysis

4.1. Baseline Regression Results

Based on Model (1), OLS regression is employed to evaluate Hypothesis H1. The results are displayed in Table 2. In Columns (1) and (2), only industry and year fixed effects are controlled, without additional control variables. Here, the coefficients for climate risk are significantly positive at the 5% and 10% significance levels, suggesting an initial positive link between climate risk and corporate stock price crash risk. Columns (3) and (4) in Table 2 include additional control variables, showing regression coefficients for climate risk of 0.091 and 0.055, significant at the 1% and 5% levels, respectively. These results confirm that climate risk has a significant positive correlation with corporate stock price crash risk, thus supporting Hypothesis H1.

Table 2: Regression Analysis of Climate Risk and Stock Price Crash Risk

	(1) NCSKEW	(2) DUVOL	(3) NCSKEW	(4) DUVOL
ClimateRisk	0.074	0.030	0.091	0.055
	(2.11)	(1.69)	(2.67)	(2.43)
Controls	No	No	Yes	Yes
_cons	-0.326	-0.213	0.616	0.570
	(-41.26)	(-50.93)	(5.50)	(7.70)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	29667	29667	29667	29667
adj R^2	0.030	0.030	0.109	0.109

Note: , , and represent significance levels at 1%, 5%, and 10%, respectively; the values in parentheses are z-values or t-values adjusted for clustering at the firm level (same for the following tables).

4.2. Robustness Tests

Even after incorporating control variables related to corporate governance, industry, and regional factors, adjusting the sample period, controlling for year-industry and year-city fixed effects, applying propensity score matching, and using the instrumental variable method, the regression results continue to show a significant positive relationship, reinforcing the previous findings.

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5. Further Discussion

5.1. Mechanism Analysis

5.1.1. The Impact of Analyst Attention

Compared to ordinary investors, analysts have deeper expertise and better financial analysis skills. Their continuous monitoring of a company's financial health and market performance allows them to apply "market pressure" on company managers, which can limit their behavior. For instance, analysts can reduce the likelihood of management concealing negative information and encourage better disclosure practices, thus reducing the risk of stock price crashes. In other words, analyst scrutiny diminishes the positive link between climate risk and corporate stock price crash risk. Following Zhou Kaiguo et al. [5], the number of forecasting institutions providing earnings predictions for listed companies during the forecast year is used to measure analyst attention (Anaattention), with a log transformation applied by adding 1. To assess the moderating role of analyst attention, both analyst attention and its interaction with climate risk are included in Model (1). Columns (1) and (2) of Table 3 show that the coefficient for the ClimateRisk × Anaattention term is significantly negative, indicating that increased analyst attention can alleviate the adverse effects of climate risk on corporate stock price crash risk.

5.1.2. The Impact of Green Transformation

Green transformation serves as a strategic approach for companies to address climate risks by reducing dependency on limited resources and minimizing their exposure to such risks. Zhou Kuo et al. [6] found that green transformation can lower the risk of stock price crashes. Specifically, companies with strong environmental performance are less likely to conceal information due to their informational advantages and are more likely to openly share their environmental achievements, thereby reducing information asymmetry. Additionally, green transformation serves as a positive signal, helping to stabilize investor confidence. In the event of a climate-related incident, green transformation acts as a form of reputation insurance, mitigating investor panic. Thus, adopting green transformation can prevent stock price crashes by decreasing information asymmetry and enhancing investor confidence, meaning green transformation reduces the positive link between climate risk and stock price crash risk. Drawing on Loughran & McDonald [7], the extent of corporate green transformation is assessed using textual data from annual reports. Based on the Environmental Protection Law, 113 keywords related to green transformation were identified in five areas: promotional efforts, strategic goals, technological advancements, pollution control, and monitoring practices. The frequency of these keywords in annual reports was used to create a green transformation word frequency count. The natural logarithm of this count plus 1 formed the corporate green transformation index (Gre). To evaluate the moderating effect of green transformation, this index and its interaction with climate risk were included in Model (1). The results presented in Columns (3) and (4) of Table 3 show a significantly negative coefficient for the ClimateRisk × Gre term, indicating that greater green transformation reduces the impact of climate risk on stock price crash risk.

Table 3: Climate Risk and Stock Price Crash Risk: Mechanism Analysis

	(1) NCSKEW	(2) DUVOL	(3) NCSKEW	(4) DUVOL
Climate Risk	0.246 (2.93)	0.173 (3.13)	0.134 (2.24)	0.053 (1.90)

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Table 3: (continued).

ClimateRisk×Anaattention	-0.068 (-1.99)	-0.050 (-2.08)		
ClimateRisk×Gre			-0.066 (-2.38)	-0.032 (-1.71)
Controls	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	21456	21456	29395	29395
adj R^2	0.081	0.085	0.109	0.109

5.2. Heterogeneity Analysis

Grouping tests were conducted based on industry sectors and ownership types, revealing that climate risk's effect on increasing corporate stock price crash risk is more significant in high-carbon industries and non-state-owned enterprises.

6. Conclusions and Recommendations

Using data from China's A-share listed companies between 2007 and 2022, this study investigates the economic impact of climate risk. The findings indicate that climate risk significantly raises the likelihood of corporate stock price crashes, and this relationship remains strong even after various robustness checks. The analysis also shows that higher analyst attention and greater corporate green transformation can mitigate the amplifying effect of climate risk on stock price crash risk. Additionally, the impact of climate risk on stock price crashes is more pronounced in high-carbon industries and non-state-owned enterprises.

Based on these findings, the following recommendations are proposed:

For the Government:

1. Enhance Climate Risk Disclosure: The government should establish a unified climate risk disclosure framework based on international standards like the Task Force on Climate-related Financial Disclosures (TCFD) and the Global Reporting Initiative (GRI). This framework should clearly specify what companies must disclose, such as carbon emissions, climate risk assessments, and mitigation strategies. Ensuring that companies provide comprehensive, transparent, and comparable information will reduce the likelihood of information concealment by management.

2. Develop Climate Risk Assessment and Rating Services: The introduction of third-party audit requirements and the promotion of professional rating services can help companies, especially non-state-owned enterprises, obtain specialized climate risk assessments. This will aid companies in identifying, quantifying, and managing climate risks more effectively.

For Companies:

1. Utilize Analyst Attention: Companies should improve communication with analysts by regularly updating them on climate risk management progress. Providing clear and detailed climate risk data can build trust and understanding among analysts, sending positive signals to investors and helping to restore confidence.

2. Accelerate Green Transformation: The study finds that green transformation can reduce the impact of climate risk on stock price crash risk. This is particularly crucial for high-carbon industries, where advancing green innovation and low-carbon technological upgrades can enhance climate risk management, improve environmental performance, and strengthen corporate reputation, thereby supporting sustainable development.

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