The Influence of Climate Shocks on the Financing Constraints of Listed Enterprises

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Abstract. In the realm of global climate change, climate risk has emerged as a significant determinant influencing economic development. This paper utilises panel data from 2008 to 2022 to identify the occurrences of extreme high temperatures, extreme low temperatures, and significant precipitation events in Chinese prefecture-level cities as indicators of climate shocks, and investigates their mechanisms of action and effects on the financing constraints of publicly listed companies. The study reveals that excessive rainfall markedly exacerbates financial constraints but extreme high and low temperatures have a minimal effect. Heterogeneity study indicates that excessive rainfall significantly adversely affects the financial restrictions of firms in both the West and the East. Conversely, extremely low temperatures substantially damage businesses in the West, with a key observation being that non-public enterprises are more seriously impacted by climatic disruptions. The effect mechanism involves harsh climate intensifying financial constraints by harming fixed assets, impairing commercial operations, and obstructing technological advancement within enterprises. In light of this circumstance, it is advisable for firms to enhance their capacity to handle climate risk, for financial institutions to refine their climate risk assessment systems, and for the government to intensify climate risk management to alleviate adverse effects on enterprise financing.

Keywords: Climate risk; Financial restrictions; Listed companies; Severe weather

1 Introduction

The intensification of global warming, driven by accelerated industrialization and greenhouse gas emissions, presents persistent threats to economic growth and social stability. As confirmed by IPCC AR6, unprecedented climate disruptions—including sea-level rise, increased extreme weather events, and sea-ice decline—are amplified with each incremental temperature rise, necessitating urgent research on economic adaptation. Climate risk now critically informs credit management frameworks, evidenced by regulatory developments such as the Basel Committee on Banking Supervision's integration of climate risks into Basel III disclosures and the People's Bank of

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B. Siuta-Tokarska et al. (eds.), *Proceedings of the 2025 3rd International Academic Conference on Management Innovation and Economic Development (MIED 2025)*, Advances in Economics, Business and Management Research 348,
https://doi.org/10.2991/978-94-6463-835-6_68

China's incorporation of climate risk within macroprudential policy. Concurrently, commercial banks optimize asset allocation through industry-specific credit adjustments to maintain enterprise financing stability. This research examines the effects and mechanisms of climate shocks on listed firms' financing constraints, utilizing the frequency of three extreme climate events across Chinese prefecture-level cities as primary shock indicators.

2 Literature Review

2.1 Economic Impacts and Measurement Methods of Climate Risk Shocks

Research on climate shocks is gaining prominence amid climate change and sustainability awareness, with contemporary studies spanning three domains: macroeconomics, real industries, and capital markets. Climate risk assessment encompasses two critical dimensions: (1) physical risks including droughts, floods, and storms, quantified through meteorological data on extreme weather frequency; and (2) transition risks stemming from low-carbon policy uncertainty, widely quantified via indices such as China's Climate Policy Uncertainty (CCPU) model [1].

Research on climate risk impacts in finance primarily focuses on banking. Using extreme precipitation, high/low temperature as physical shock metrics [2], studies find extreme precipitation causes credit entity losses, elevating bank default rates and risk-taking. Refining climate indices reveals: while intensity of extreme heat/heavy precipitation insignificantly affects commercial bank risk levels, their frequency significantly impacts bank risk-bearing capacity; both intensity and frequency of extreme cold significantly increase bank risk levels [3]. Typhoon disasters elevate bank credit default risk, causing more cautious lending strategies that increase corporate financing costs [4].

2.2 Examination of Natural Factors Influencing Enterprise Financing

Enterprise finance restrictions are influenced by numerous factors. The existing literature has thoroughly examined the mechanisms of enterprise qualification, pertinent legislation, and finance avenues; nonetheless, there has been a dearth of climatic evaluations.

Enterprise output is influenced by financial limitations, which are exacerbated by inter-industry networks [5]. Recent studies on ESG indicate that improved ESG performance can mitigate financing constraints for enterprises [6] [7]. The introduction of new restrictions on asset management for shadow banks has intensified the financing constraints faced by firms and reduced their debt maturity [8]. The selling of financial products on online financial platforms might variably impact loan acquisition for businesses [9].

Small and medium-sized enterprises are intrinsically intricate and costly to finance [10]. Research indicates that digitisation [11], tax reform [12], structural monetary policy [13], and financial agglomeration in urban clusters [14] can substantially mitigate the funding restrictions faced by SMEs.

2.3 Research on the Correlation Between Corporate Finance and Extreme Weather

From the bank's perspective, Pan Min (2022) and Lv Yongbin (2024) confirm that extreme weather disruptions have a financing constraint-inhibitory effect [2] [4]. Li, Zeguang, Huang, and Yuanbiao developed a distinctive climate risk indicator by analysing data from China's industrial enterprise database from 2004 to 2013 [15]. Their findings corroborate that corporate finance credit is impeded by exogenous climate risk. Additionally, they identify two impact channels: the acceleration of collateral depreciation and the reduction of industrial output and sales revenue.

Current literature lacks firm-level empirical studies quantifying extreme weather's impact on corporate funding, particularly regarding physical-level economic repercussions and transmission mechanisms to financing constraints.

This study employs Pan's framework to assess physical climate impacts—using extreme rainfall, high/low temperature indicators—and analyzes their effect on listed firms' financing constraints (SA index) via 2008–2022 panel data. Heterogeneities across regions/ownership structures and underlying mechanisms are examined through moderation-mediation analysis.

3 Research Design and Data Sources

3.1 Data Sources

3.1.1. Climate Shock Data.

This paper's climate shock data primarily draws from Pan Min's study, utilising extreme high temperature (Htd), extreme low temperature (Ltd), and extreme heavy precipitation (Ipd) as indicators of extreme climate for empirical analysis. This study uses Ren Guoyu's methord, regarding the thresholds of extreme climatic events. The method employs the relative threshold, a widely accepted percentile approach, to establish thresholds while accounting for significant regional climate variations in China [16].

3.1.2. Enterprise Financing Indicators.

This study assesses enterprise financing using core indicators, excluding sectors with heterogeneous extreme weather shock responses: service industries, low-physical-production, and low-marketisation sectors per national industry classifications. Excluded categories are information transmission, software and information technology services (I), finance (J), leasing and business services (L), education (P), health and social work (Q), and culture, sports and recreation (R). The SA value serves as the primary explanatory variable, with the FC index employed for robustness testing in remaining industries.

SA Value Sourced from the Guotai An Database and computed per Hadlock & Pierce (2010, RFS):

$$SAi,t = -0.737 \times Sizei, t + 0.043 \times Size2i, t - 0.04 \times Age$$

where Size denotes log total assets and Age is firm existence duration. Higher absolute SA values indicate stricter financing constraints.

3.1.3. Control Variables.

The control variables pertain to the standard firm-level control variables identified in the literature. This paper first eliminates Size, Lev, Cashflow, TobinQ, ListAge, FirmAge, and other variables directly associated with corporate finance measures to mitigate serious covariance issues. The study employs individual and time-fixed effects to control for remaining variables, considering their correlation with extreme weather and financing constraints, thereby enhancing the accuracy and reliability of the research findings. The control variables selected include the proportion of inventory (Lnv), the proportion of fixed assets (Fixed), the occurrence of loss (Loss), the number of directors (Board), the duality of the Board Chair and CEO roles (Dual), and the proportion of shares held by the top five shareholders (Top5). The data is derived from the annual reports of listed companies.

3.2 Impact Mechanism

3.2.1. Direct Impact Mechanism.

Extreme weather reduces firm valuations by lowering expected cash flows and eroding collateral. This diminishes investor appeal (harming equity financing) and makes banks more cautious due to reduced asset backing (tightening debt financing). Higher risk ratings prompt banks to restrict credit or recall loans early, risking firms' capital chains due to information asymmetry. This forces firms to seek costly alternative financing, increasing their burden.

Among them, climatei,t refers to the climatei,t shock risk indicator, namely extreme high temperature (HTD), extreme low temperature (LTD) and extreme heavy precipitation (IPD); Controlsi,t means all relevant control variables; αi represents all the fixed effect of individual enterprises; λi is the fixed effect of the year.

3.2.2. Indirect Impact Mechanisms.

Extreme weather events induce depreciation of fixed assets, diminishing firm valuations and impeding financing capacity. This impairs the capital factor in production functions, inevitably decreasing output when labor inputs remain constant. Production disruptions cause order fulfillment failures with associated penalties, market share erosion, and reduced future revenue projections. Therefore, this paper proposes Hypothesis 2: Extreme weather intensifies business financial limitations by impacting fixed assets. To evaluate Hypothesis 2, the subsequent model is constructed:

$$SAi,t = \beta 1 Climatei,t + \beta 2 Fixedi,t + \beta 3 Climatei,t \times Fixedi,t + \beta 4 Controlsi,t + \alpha i + \lambda t$$

$\beta 3$ denotes the regulatory influence of fixed asset value on financing limitations induced by climatic shocks.

Extreme weather events impact businesses, therefore leading to heightened finance constraints. Extreme weather events may adversely impact demand, leading to dimin-

ished company orders and heightened operational expenses, including transportation and labour costs. This consequently deteriorates profitability and amplifies funding constraints. Therefore, this paper proposes Hypothesis 3:

Extreme weather exacerbates corporate financing constraints by reducing corporate profitability. In order to test hypothesis 3, this paper establishes the following model:

$$SAi,t = \beta 1 Profiti,t + \beta 2 Controlsi,t + \alpha i + \lambda t$$

$$Profiti,t = \pi 1 Climatei,t + \pi 2 Controlsi,t + \alpha i + \lambda t$$

In this model, $\pi 1$ represents the impact of climate shocks on profitability, and $\beta 1$ represents the impact of profitability on financing constraints.

Severe weather events influence the trajectory of technical advancement among area enterprises, subsequently impacting the degree of financing constraints. Technological advancement inside a company is influenced by temperature and climate, whereas recurrent extreme weather events may hinder technological progress or impact the geographical positioning of high-tech enterprises. Therefore, this paper proposes Hypothesis 4:

Extreme climate shocks affect the level of financing constraints by influencing the direction of firms' technological development.

This paper formulates the subsequent model to evaluate Hypothesis 4.

$$SAi,t = \beta 1 Htechi,t + \beta 2 Controlsi,t + \alpha i + \lambda t$$

$$Htech = \pi 1 Climatei,t + \pi 2 Controlsi,t + \alpha i + \lambda t$$

In this model, Htech is a binary variable denoting whether the firm qualifies as high-tech, $\pi 1$ represents the effect of climate shocks on the enterprise's technological level, and $\beta 1$ signifies the influence of technological level on finance limitations.

4 Regression Results

4.1 Climate Shocks and Corporate Financing Constraints

Table 1 regression results demonstrate that extreme rainfall significantly exacerbates corporate financing constraints, reflected in lower SA values indicating heightened constraints, whereas extreme high and low temperatures exhibit no statistically significant impact. This disparity arises as heavy rainfall primarily induces physical repercussions—such as logistics disruption and asset destruction—which directly impair corporate profitability and asset valuation, thereby tightening financing conditions.

Table 1. Baseline Reyression Results.

	(1)	(2)	(3)
	SA_Rain	SA-htemp	SA-ltemp
lnRain	-0.0283***		
	-0.00488		
Inhtemp		0.00594	
		-0.0106	
Inltemp			0.00017
			-0.0107
Controls	Yes	Yes	Yes
	-0.00489	-0.00483	(0.0048H)
IT FE	Yes	Yes	Yes
adj. R^2	0.093	0.091	0.091
N	34744	34752	34750

Table 2. Robustness Test Results.

	(1)	(2)	(3)
	FC_Rain	FC_htemp	FC_ltemp
lnRain	0.0203***		
	-0.00423		
Inhtemp		-0.00433	
		-0.00998	
Inltemp			-0.0260**
			-0.011
controls	yes	yes	yes
yes			
IT FE	Yes	Yes	Yes
adj. R^2	0.145	0.144	0.145
N	34744	34752	34750

4.2 Robustness Test

Substitute the dependent variable. Utilise another prevalent indicator, FC, to assess corporate financing restrictions, where a higher FC value signifies a greater extent of such constraints. The findings are presented in Table 2. The findings indicate that excessive rainfall markedly exacerbates company funding limitations, hence reinforcing the study's robustness. It's also tested by crossed fixed effects as presented in Table 3.

4.3 Heterogeneity Analysis

Table 4 regional subsample regressions reveal that extreme rainfall significantly exacerbates financing constraints for firms in both Western and Eastern China, but exerts

no material impact on the Central region. The Eastern coastal monsoon zone faces heightened typhoon and rainfall intensity, while Western provinces' complex topography amplifies secondary disasters like landslides, causing severe asset losses.

Furthermore, Western China's complex mountainous terrain impedes cost-effective infrastructure development and increases vulnerability to extreme cold. Persistent low temperatures cause transportation disruptions through snow and ice blockage, hindering supply chains and interrupting production cycles. This reduces corporate revenue, weakens solvency, and heightens financing barriers.

Table 4 ownership subsample regressions reveal extreme precipitation and high temperatures significantly exacerbate financing constraints for non-public enterprises, while public firms show only marginal sensitivity to rainfall. This disparity stems from state-owned entities' stronger government affiliations, superior resource access, and operations in strategic sectors (e.g., energy, transport), reducing climate vulnerability.

Table 3. Robustness Test of Crossed Fixed Effects.

	(1)	(2)	(3)	(4)	(5)	(6)
	SA	FC	SA_IfeArea	FC_IfeArea	SA_IfeId	FC_IfeId
lnRain	-0.0283***	0.0203***	-0.0295***	0.0205***	-0.000932*	0.00124
	-0.00488	-0.00423	-0.00302	-0.00321	-0.000496	-0.00193
Inhtemp	0.00594	-0.00433	0.00631	-0.00678	0.00019	-0.00882**
	-0.0106	-0.00998	-0.006	-0.00638	-0.000899	-0.00348
Inltemp	0.00017	-0.0260**	-0.000637	-0.0259***	-0.00127*	-0.0021
	-0.0107	-0.011	-0.00436	-0.00463	-0.000747	-0.00285
controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Region xyear FE	Yes	Yes				
Firm xyear FE			Yes	Yes		
N	34127	34127	34127	34127	34127	34127

Table 4. Heterogeneity Analysis Results.

	(1)	(2)	(3)	(4)	(5)
	Western	Centrol	Eastern	Non-PSE	PSE
lnRain	-0.0426***	-0.000892	-0.0344***	-0.00846*	-0.0652***
	-0.00587	-0.00707	-0.00677	-0.00387	-0.0103
Inhtemp	0.0182	0.0111	0.00108	-0.0225**	0.0461
	-0.021	-0.0281	-0.0143	-0.00704	-0.0309
Inltemp	-0.0331***	-0.0412	0.0252	-0.00275	0.017
	-0.00651	-0.0209	-0.0148	-0.00411	-0.0264
IT FE	Yes	Yes	Yes	Yes	Yes
N	4322	6364	24065	20592	13563

5 Mechanism Examination and Comprehensive Analysis

5.1 Impact Mechanism Assessment

Capital assets. Initially, extreme climatic shocks are validated by regulatory impacts. Shocks will adversely influence the company's fixed assets, hence influencing corporate financial limitations. Column (1) of Table 5 indicates that the quantity of fixed assets does not influence corporate finance limitations; instead, it greatly intensifies the adverse effects of excessive rainfall on these restrictions.

Commercial circumstances. The Total Profit, following standard deviation normalisation, is utilised to indicate the firm's business condition. In column (1) of Table 6, the coefficient of TotalProfit_scaled on Sale_SA is 6.972 and is significant at the 1% level, suggesting that improved business conditions (TotalProfit) correlate with reduced financing constraints.

Advancement in technology. The variable Htech is established to classify enterprises as high-tech or non-high-tech. Column (3) indicates that high-tech companies substantially mitigate financial limitations. Simultaneously, column (6) indicates that both exceptionally high and extremely low-temperature conditions adversely impact regional enterprises, irrespective of their category.

Table 5. Moderating Effect Results.

	(1)	(2)	(3)
	SA_Rain	SA_htemp	SA_ltemp
FIXED_Rain_scaled	-0.186***		
	-0.048		
Rain_scaled	-0.0521**		
	-0.0204		
FIXED_ltemp_scaled		0.0809*	
		-0.0408	
ltemp_scaled		0.00449	
		-0.0338	
FIXED_lnltemp			0.0193
			-0.0121
lnltemp			-0.00406
			-0.01
controls	yes	yes	yes
IT FE	yes	yes	yes
adj. R^2	0.093	0.091	0.091
N	34751	34751	34749

Table 6. Mediating Effect Results.

	(1)	(2)	(3)	(4)
	TP_SA	Temp_TP	Htech_SA	Temp_Htech
Channels	6.972***	0.0538***		
	-0.678	-0.00104		
Rain_scaled	-0.00271***	0.0192***		
	-0.000413	-0.0062		
htemp_scaled	0.00145	-0.0308*		
	-0.00129	-0.016		
ltemp_scaled	0.00358***	-0.0531***		
	-0.00108	-0.0121		
controls	yes	yes	yes	yes
IT FE	yes	yes	yes	yes
N	33654	33654	34751	34743

6 Conclusions and Policies

6.1 Conclusion of the Research

This study empirically examines the effects of major climate shocks on publicly traded firms' financing using 2008–2022 panel data. Results demonstrate that heavy rainfall substantially exacerbates financing constraints through physical mechanisms including logistics disruption, fixed asset destruction, and inventory loss, which collectively impair profitability and asset valuation. In contrast, extreme high and low temperatures exhibit negligible effects. Heterogeneity analyses reveal differential regional vulnerabilities: both Western China, where constraints are compounded by low-temperature exposure, and Eastern coastal regions experience significant rainfall impacts, while non-public enterprises show greater climate sensitivity than state-owned counterparts. Mechanistically, rainfall-induced asset impairment elevates replacement costs and depresses asset prices, simultaneously hindering corporate R&D capacity. Technology enterprises notably mitigate such constraints through innovation capabilities.

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