Analysis of the Relationship Between Extreme Weather Disasters and Claim Ratio Volatility Under Global Climate Change

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Frequent extreme weather events cause significant loss of life and property, highlighting the link between "extreme weather risk – catastrophic loss – high claim ratio – insurer solvency." However, little research explores the mechanisms among these factors. This paper analyses the relationship between extreme weather and property insurance claim ratios, using data from 30 Chinese provinces (2012-2021). It constructs indices for high temperature, low temperature, and heavy precipitation, showing a strong correlation between extreme weather and claim ratios. Over 3- and 5-year periods, these indices significantly increase claim ratios, leading to complete or partial mediation effects on the solvency of property insurance companies.

Keywords: extreme weather, loss ratio volatility, solvency

INTRODUCTION

Background

The Earth is experiencing global climate changes characterised by warming driven by natural factors and human activities. This has severely impacted the environment that humanity depends on and significantly affected economic and social development, including financial stability (Zhang et al., 2022). One consequence of this warming trend is the increasing frequency and intensity of extreme weather events, particularly extreme heat and heavy rainfall (Hong et al., 2022). Studies have shown that natural disasters, especially weather-related ones, can significantly reduce economic growth in the short term (Baron et al., 1986). At the forefront of emerging risks, the insurance industry is critical in spreading risk across communities and sectors, helping them recover from natural disasters and improve societal resilience (Felbermayr et al., 2014).

Over the past few decades, frequent extreme weather events worldwide have placed enormous pressure on property insurance companies. Extreme weather events' increasing intensity and frequency are expected to result in more significant damage and additional financial liabilities for insurers (Xu et al., 2009). According to reports from the Financial Times, natural disasters in 2019 led to payouts totalling billions of dollars for the global property insurance industry. These payouts directly affected the claims-paying ability of property insurers, potentially impacting their solvency and placing financial and operational burdens on them. In 2003, the China Insurance Regulatory Commission issued the "Regulations on Solvency Margins and Regulatory Indicators for Insurance Companies," marking a substantial step in solvency regulation in China. In December 2021, the China Banking and Insurance Regulatory Commission issued the "Insurance Company Solvency Regulatory Rules (II)," which imposed stricter solvency requirements on insurers. Solvency regulation has become a core component of global insurance regulation, as ensuring solvency helps maintain insurers' ability to meet their payout commitments under insurance contracts, thereby fundamentally protecting the interests of policyholders (Zhu et al., 2008).

LITERATURE REVIEW

Research on the relationship between climate change and insurance can be traced back to Tucker's (1997) work, which first suggested that due to the uncertainty in the magnitude and timing of weather changes, the insurance industry could become a potential advocate for mitigating climate risks. The insurance industry can assess and price weather risks, playing a critical role in mitigating the impacts and losses caused by such risks (Patz et al., 2005; Thistlethwaite & Wood, 2018). However, with the increasing frequency of weather changes and the rising associated costs in recent years, climate change is expected to burden insurance companies with more significant losses and financial liabilities, potentially threatening their business models. Specifically, scholars pointed out that climate change can significantly impact both the short-term and long-term operations and investment decisions of insurers, such as potentially increasing claim ratios and payouts for property insurers, which exacerbates their losses in the short term (Collier et al., 2021; Kumar et al., 2022; Mills, 2009; Wang, 2020). Additionally, insurers are vulnerable to "intermediary channels" of risk, such as claims related to global supply chain disruptions in manufacturing or food security issues arising from climate change. As the risks associated with extreme weather events continue to rise, the insurance gap is also widening (Wang et al., 2021).

Regarding the solvency of property insurance companies, some scholars have found that the solvency of Chinese property insurers is significantly related to ten internal and external factors (Zhu et al., 2008). For instance, research indicated that the premium growth rate and claims ratio negatively correlate with a company's solvency, while the premium income ratio, return on assets, and reserve ratio correlate positively with solvency (Zheng, 2014). Most scholars' analyses of factors affecting insurance company solvency divide these into internal and external categories, comparing the different impacts of internal and external factors on the solvency of life and property insurance companies and finding significant differences in the influence of internal factors. In contrast, external factors had similar effects (Huang et al., 2011). Further discussion on company size, scholars selected large, medium, and small property insurance companies from China. They conducted a comparative analysis of solvency factors using the grey correlation method, finding that the impact of the same factor on different-sized property insurers varies significantly (Chen et al., 2013). Meanwhile, domestic scholars have also researched solvency regulation and adequacy in China, using empirical testing based on economic theories.

In summary, existing literature primarily focuses on the relationship between extreme weather and insurance companies or between claims ratios and solvency, with relatively few studies analysing the impact of extreme weather on insurers' solvency. Furthermore, studies analysing solvency factors have paid little attention to the connection between extreme weather, claims ratios, and solvency. Given the limited evidence on the effectiveness of insurance in encouraging risk reduction and the expected increase in insurance losses due to climate change, weather changes significantly impact insurance claims for natural disasters. However, the exact extent of this impact and how it affects the solvency of insurance companies still requires further research and empirical study.

Therefore, this paper constructs an extreme weather index and calculates claims ratio data for property insurers, to explore how changes in claims ratios due to extreme weather events have impacted the solvency of Chinese property insurance companies from 2012 to 2021. It focuses on the direct impact of extreme weather on claims ratios. It examines how these changes indirectly affect the overall financial health and risk tolerance of property insurers, providing a reference for economic management in the insurance industry in the context of climate change.

THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

Extreme Weather and the Claims Ratio of Property Insurance Companies

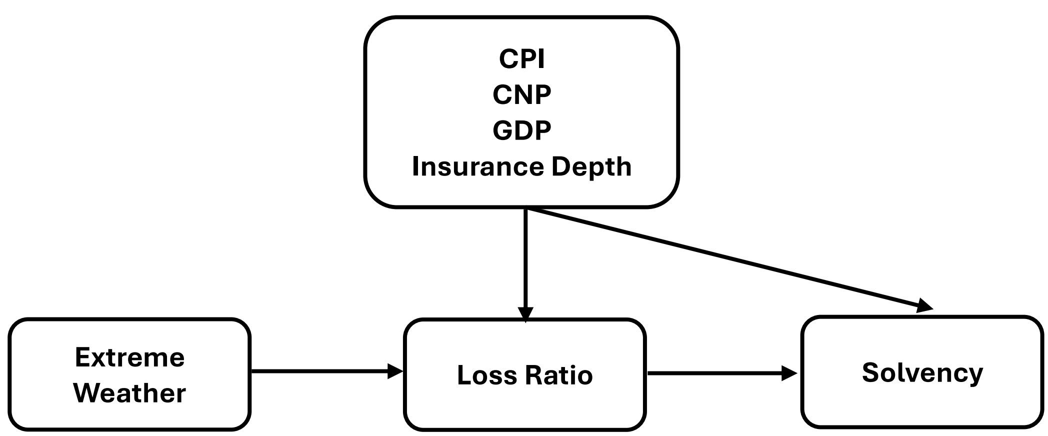
Based on gaps in previous research, this paper first explores the direct impact of extreme weather on the property insurance industry. Economic losses caused by global natural disasters have shown exponential growth, presenting severe challenges to the property insurance business (Yao et al., 2019). Extreme weather events directly threaten the safety of public property and assets (Kumar et al., 2022), leading to significant losses and an increase in corresponding claims for property insurers. In addition to directly affecting individuals and businesses, weather risks substantially impact sectors like agriculture, forestry, energy, and tourism. The business interruptions and property losses in these industries are reflected in claims ratio data, which directly relates to property insurance companies' profitability and risk management. Therefore, strengthening weather risk management has become a top priority for developing property insurance (Savitz & Gavriletea, 2019). To clarify the exact extent of the impact of extreme weather on claims ratios, the following hypothesis is proposed:

Hypothesis #1: *Extreme weather positively impacts the claims ratio of property insurers.*

Extreme Weather, Claims Ratios, and Solvency

Insurance serves as a "shock absorber" for the economy, playing a critical role in reducing risk burdens and enhancing economic resilience (Wang, 2020). The claims ratio of an insurance company is a crucial indicator of its financial stability and solvency, as it reflects the proportion of claims payouts to premium income. The claims ratio is directly linked to an insurance company's profitability. In the short term, a high claims ratio may lead to significant cash outflows, affecting liquidity and daily operations and potentially resulting in underwriting losses that erode profit margins. In the long term, a high claims ratio weakens the company's profitability and financial stability. Additionally, the claims ratio influences the capital adequacy of insurance companies, which need to maintain sufficient capital and reserves to meet future claims demands and regulatory requirements. A high claims ratio may rapidly deplete these capital buffers and reduce the company's capital adequacy, impacting its solvency and compliance with regulatory standards.

FIGURE 1
EXTREME WEATHER AND ITS IMPACT ON SOLVENCY PATHWAYS



According to theories on capital adequacy and risk management in insurance companies, insurers need to maintain sufficient capital reserves to address future uncertainties in claims, such as natural disasters or economic downturns. The volatility of the claims ratio can serve as a measure of risk exposure: the greater the volatility, the higher the company's risk exposure, requiring more capital to address these risks and maintain solvency. The Solvency II framework emphasises that insurers must hold adequate capital to cover their risk exposures, which include underwriting risk (claims volatility) and market risk for non-life insurers. Fluctuations in the claims ratio increase financial uncertainty for insurers, potentially impacting their solvency. Based on this, the following hypothesis is proposed to explore the comprehensive impact of extreme weather on the solvency of property insurers:

Hypothesis #2: *Extreme weather disasters affect the solvency of property insurance companies by increasing the claims ratio.*

RESEARCH DESIGN

Data and Research Sample

Due to incomplete data, this study focuses on 30 provinces (municipalities and autonomous regions) in China, excluding Tibet. The data span ten years, from 2012 to 2021. The original data for the variables were sourced from the China Statistical Yearbook, China Insurance Yearbook, China Meteorological Disaster Statistical Yearbook, the Chinese Ground Weather Daily Dataset V3.0, and the National Centers for Environmental Information (NCEI) under the National Oceanic and Atmospheric Administration (NOAA). Missing data were supplemented using linear interpolation. Outliers were handled, and data were standardised using max-min normalisation to reduce multicollinearity.

Variable Definitions

Dependent Variables

Claims Ratio (LOSS). In domestic and international literature, the claims ratio is often used to measure an insurance company's ability and efficiency in paying claims. The claims ratio reflects the company's financial health and risk management level, and it is an important indicator monitored by regulatory bodies. A high claims ratio may indicate significant pressure on the insurer, while a lower claims ratio may suggest more robust risk management capabilities or heightened market competition. Thus, this paper selects the claims ratio as the dependent variable, denoted as LOSS.

Solvency (SOL). There is a positive correlation between expenditure and premium income, which shows a steady annual increase. However, in the case of catastrophic claims, property insurance companies' premium expenditures may spike, causing significant fluctuations in the claims ratio. High volatility indicates unpredictable claims costs, and sudden high payouts can deplete the company's reserve capital, threatening its solvency and the ability to manage cash flow for long-term operations. More capital reserves would be required to address potential extreme events. Given the unavailability of region-specific solvency data for insurance companies, this paper uses the volatility of the claims ratio as a proxy variable for solvency. The proxy indicator should be closely related to solvency, reflecting property insurance companies' financial conditions, risk management capabilities, or capital pressures at the regional level. Thus, to study the impact of extreme weather on property insurance solvency, the volatility of the claims ratio is used as the dependent variable, denoted as SOL, and robustness checks will be performed later.

Independent Variable: Extreme Weather Index

He (2022) used 27 extreme weather indices recommended by the World Meteorological Organization (WMO) and the World Climate Research Programme (WCRP) in his study. These indices are characterised by low noise, vital significance, and weak extremeness. To assess the impact of extreme weather on claims, this study focuses on three dimensions of extreme frequency: high temperatures, low temperatures, and precipitation. Specifically, the warm day index (TX90P), cold day index (TX10P), and heavy rain index (R20) are selected to measure extremely high temperatures, extremely low temperatures, and extreme precipitation, respectively, and to analyse their impact on property insurance claims. The extreme weather indices were calculated using daily temperature and precipitation data from 456 weather stations across China. From 2012 to 2021, using RClimDex1.0 in R., the index for each city were derived by interpolating station data weighted by geographical coordinates (Liu & Jiao, 2022).

Control Variables

Based on existing literature and the selection of control variables, this paper considers factors related to regional development that may influence property insurance claims. In line with studies by Bernanke & Kuttner (2005) and Lu & Han (2013), the following control variables are included: insurance depth (DEPT), regional gross domestic product (GDP), regional consumer price index (CPI), and regional per capita income (CNP). Additionally, the model controls for fixed time effects (Year). TABLE 1 describes the specific variables used in this study.

TABLE 1
VARIABLE DEFINITION EXPLANATION

TYPE	NAME	SYMBOL	EXPLANATION
Dependent Variable	Loss Ratio	LOSS	Total payout in a region for the year / premium income
	Solvency	SOL	Rolling standard deviation of the loss ratio
Independent Variable	Heavy Rain Index	R20	Total number of days per year with daily precipitation ≥20mm
(Extreme Weather Index)	Warm Days Index	TX90P	Total number of days with daily maximum temperature greater than the 90th percentile
	Cold Days Index	TX10P	Total number of days with daily maximum temperature less than the 10th percentile
Control Variable	Insurance Depth	DEPT	Regional premium income / regional GDP
	Per Capita Household Income	CNP	Income / total population *100%
	Consumer Price Index	CPI	Regional consumer price index
	Gross Domestic Product	GDP	Natural log of regional GDP
	Year	Year	Year dummy variable

Model Setting

Time Effect Model

To analyse the direct impact of extreme weather events on the claims ratio, this study first constructs a panel regression model to test hypothesis H1. The model is specified as follows:

$$LOSS_i = \alpha_0 + \alpha_1 \text{Climaterisk}_{n,i} + \sum \text{CVs} + \sum \text{YEAR} + \varepsilon \quad (1)$$

where: $LOSS_i$ is the dependent variable, representing the claims risk of property insurance companies in the province at the time.

Climaterisk_i is the independent variable, indicating the weather risks each province faces.

CVs are control variables.

YEAR is the time-fixed effect.

ε is the random error term.

Mediation Effect Model

To investigate how extreme weather events indirectly affect solvency through claims ratio, a mediation effect analysis is conducted, combining the three variables as shown in Eq. (2) to Eq. (4). Here, for better understanding, the $LOSS$ is replaced with variable $Mediator$.

$$SOL_i = \theta_0 + \theta_1 \text{Climaterisk}_{n,i} + \sum \text{CVs} + \sum \text{YEAR} + \varepsilon \tag{2}$$

$$Mediator_i = \beta_0 + \beta_1 \text{Climaterisk}_{n,i} + \sum \text{CVs} + \sum \text{YEAR} + \varepsilon \tag{3}$$

$$SOL_i = \gamma_0 + \gamma_1 \text{Climaterisk}_{n,i} + \gamma_2 SOL_i + \sum \text{CVs} + \sum \text{YEAR} + \varepsilon \tag{4}$$

Empirical Results and Analysis

Basic Regression Analysis

After preliminary descriptive statistics and correlation testing, outliers are excluded, and the positive relationship between extreme weather and claims ratio is confirmed. Based on this, a basic regression is conducted. TABLE 2 presents the regression results for extreme weather's impact on property insurance claims ratio. Extreme precipitation (R20), high temperatures (TX90P), and low temperatures (TX10P) are all significant at the 10% level, with coefficients of 8.161, 28.216, and 21.523, respectively. For instance, for every unit increase in the extreme precipitation index (R20), the property insurance claims ratio increases by 8.161 units. These results demonstrate a positive relationship between extreme precipitation and temperature frequency on property insurance claims, supporting hypothesis H1. Additionally, the control variables show expected results.

TABLE 2
BASIC REGRESSION RESULTS

VAR	LOSS		
R20	8.161* (1.924)		
TX10P		28.216* (1.818)	
TX90P			21.523*** (3.426)
DEPT	4.13*** (2.573)	10.888*** (4.523)	3.059* (1.958)
CNP	27.024*** (8.88)	38.188*** (13.476)	26.394*** (10.549)
GDP	-6.556*** (-3.327)	-7.217 (-1.513)	-5.847*** (3.025)
C	-6.678** (-1.971)	-0.356*** (-3.668)	-16.963*** (-3.442)
YEAR	YES	YES	YES
Adj.R^2	0.626	0.492	0.572
F	25.311	63.204	63.36
NUM	330	330	330

Note: ***, **, and * respectively indicate significance at the 1%, 5%, and 10% levels, and the data in parentheses are robust standard errors. (Same below)

Robustness Check

While the basic regression provides initial evidence of a positive relationship between extreme weather and the claims ratio, this conclusion could be influenced by model transformation, sample selection, and variable choice. Thus, an endogeneity test is conducted to verify the relationship.

TABLE 3
STAGE I OF 2SLS

VAR	R20	TX10P	TX90P
R5D	2.767*** (18.075)		
TNN		-1.050*** (-2.362)	
TXX			2.456*** (3.307)
CVs	YES	YES	YES

TABLE 4
STAGE II OF 2SLS

VAR	Basic	IV-2SLS	
	Coefficient	Coefficient*	P
R5D	8.161*	5.812	0.075*
TNN	28.216*	-7.136	-0.007***
TXX	21.523*	11.958	0.096*
CVs	YES	YES	YES
NUM	330	330	330

Appropriate instrumental variables are selected for the core explanatory variables to address endogeneity. The maximum consecutive five-day precipitation (R5D), minimum daily temperature (TNN), and maximum daily temperature (TXX) are used as instrumental variables for the heavy rain index, cold day index, and warm day index, respectively. These instrumental variables capture the intensity of extreme weather and are closely related to the frequency of extreme weather events. Since these indices are exogenous and fixed, they do not change in response to property insurance claims, fulfilling the theoretical requirements for relevance and homogeneity. A two-stage least squares (2SLS) regression is then performed, as shown in TABLE 3. The coefficients for R5D, TNN, and TXX are 2.767, -1.05, and 2.456, respectively, all significant at the 1% level, confirming the validity of the instrumental variables.

TABLE 4 shows that the second-stage regression coefficients remain consistent with the basic regression results, confirming that extreme weather indices positively impact the claims ratio. It should be noted that the TNN index has a negative coefficient in the second stage, which is opposite to the sign in the first stage. This is due to the significant negative correlation between TNN and TX10P. Therefore, the conclusions of this study are robust.

Further Analysis

The previous sections have confirmed that extreme weather events (such as hurricanes and floods) typically result in significant property damage, causing a surge in claims for property insurance companies, which leads to an increase in their claims ratio. This increase in claims puts short-term financial pressure on property insurers. It is worth noting that the frequency and intensity of extreme weather events are highly uncertain, which brings about fluctuations in the claims ratio. When faced with high and unstable claims ratios, property insurers will likely experience tremendous financial stress, making it challenging to meet large-scale claim demands, ultimately affecting their solvency.

Solvency refers to an insurer's ability to meet future obligations, which depends on its current asset-liability structure and anticipated future claims burden. If the claims ratio rises or becomes more volatile, insurers may need to increase capital reserves or reprice policies, though such adjustments take time. In the short term, this can exacerbate solvency pressures. High claims ratios can lead to cash flow stress, insufficient capital reserves, and increased financial leverage, impacting an insurer's ability to maintain long-term solvency. Therefore, using the claims ratio as a mediator for understanding the relationship between extreme weather events and the solvency of property insurers provides a deeper insight into the impact of weather risk.

To test whether extreme weather affects solvency through the claims ratio, this paper adopts the mediation effect testing method proposed by Wen et al. (2004). Based on Eq. (1) as the second step of the mediation effect test, Eq. (2) and Eq. (4) are constructed as the first and third steps:

$$SOL_i = \theta_0 + \theta_1 \text{Climaterisk}_{n,i} + \sum \text{CVs} + \sum \text{YEAR} + \varepsilon \tag{2}$$

$$Mediator_i = \beta_0 + \beta_1 \text{Climaterisk}_{n,i} + \sum \text{CVs} + \sum \text{YEAR} + \varepsilon \tag{3}$$

$$SOL_i = \gamma_0 + \gamma_1 \text{Climaterisk}_{n,i} + \gamma_2 SOL_i + \sum \text{CVs} + \sum \text{YEAR} + \varepsilon \tag{4}$$

Additionally, the impact of extreme weather may have a lag effect, with weather patterns and claims risks fluctuating over time. Rolling windows can capture these dynamic changes and reflect how regional risks shift over time. A typical window period is 3 or 5 years: a 3-year window can capture shorter-term fluctuations, making it suitable for analysing the short-term effects of extreme weather on solvency. In contrast, a 5-year window is better for capturing medium-term risk fluctuations. As shown in TABLE 5-7, the results indicate full or partial mediation effects. Extreme precipitation, high temperatures, low temperatures, and weather events increase the claims ratio, reducing insurers' solvency, supporting hypothesis H2.

Furthermore, when applying a 5-year rolling window, the mediation effect conclusions were revalidated. The results in columns (4) - (6) show that extreme weather still affects the solvency of property insurers through its impact on the claims ratio, consistent with the original findings, indicating that the conclusions are robust.

TABLE 5
MEDIATION EFFECT TEST - EXTREME HEAVY PRECIPITATION

PERIOD	3-YEAR WINDOW			5-YEAR WINDOW		
VAR	SOL (1)	LOSS (2)	SOL (3)	SOL (4)	LOSS (5)	SOL (6)
R20	0.123 (1.315)	0.417^{***} (2.776)	-0.021 (-0.263)	7.198^{***} (3.805)	16.976^{***} (3.217)	-7.78^{***} (-4.047)
LOSS			0.345^{***} (11.018)			0.034 (1.578)
C	0.223^{***} (2.919)	0.652^{***} (5.311)	-0.002^{***} (-0.027)	-5.16^{***} (-3.325)	-9.329^{***} (-2.155)	-5.480^{***} (-3.511)
Adj. R^2	0.210	0.195	0.449	0.265	0.037	0.272
NUM	330	330	330	330	330	330
OUTCOME	FULL MEDIATION			PARTIAL MEDIATION		
PROPORTION	100%			7.42%		

TABLE 6
MEDIATION EFFECT TEST - EXTREME LOW TEMPERATURE

PERIOD	3-YEAR WINDOW			5-YEAR WINDOW		
VAR	SOL (1)	LOSS (2)	SOL (3)	SOL (4)	LOSS (5)	SOL (6)
TX10P	0.421 (1.101)	0.061 (0.621)	0.057 (0.178)	0.094^{***} (3.348)	0.257^{***} (4.234)	0.074^{**} (2.624)
LOSS			0.341^{***} (10.941)			0.023^{**} (2.853)
C	-0.239 (0.718)	-0.607 (1.122)	-0.033 (0.117)	0.532^{***} (31.612)	0.131^{***} (3.575)	0.522^{***} (30.797)
Adj. R^2	0.21	0.195	0.449	0.109	0.208	0.132
NUM	0.232	0.203	0.466	330	330	330
OUTCOME	FULL MEDIATION			PARTIAL MEDIATION		
PROPORTION	100%			7.99%		

TABLE 7
MEDIATION EFFECT TEST - EXTREME HIGH TEMPERATURE

PERIOD	3-YEAR WINDOW			5-YEAR WINDOW		
VAR	SOL (1)	LOSS (2)	SOL (3)	SOL (4)	LOSS (5)	SOL (6)
TX90P	-0.193^{**} (1.411)	1.373^{***} (6.607)	0.319^{***} (2.621)	25.794^{***} (4.864)	31.44^{*} (1.679)	21.474^{***} (4.826)
LOSS			0.373^{***} (11.331)			0.042^{**} (2.404)
C	0.291^{**} (2.462)	1.487^{***} (8.297)	-0.264^{**} (-2.420)	-22.606^{***} (-5.063)	26.727^{***} (1.731)	-21.474^{***} (-4.826)
Adj. R^2	0.234	0.305	0.48	0.319	0.068	0.333
NUM	330	330	330	330	330	330
OUTCOME	PARTIAL MEDIATION			PARTIAL MEDIATION		
PROPORTION	15.54%			6.15%		

DISCUSSION AND CONCLUSION

This paper, based on daily precipitation and temperature data from meteorological stations across 30 provinces (including municipalities and autonomous regions) in China over the ten years from 2012 to 2021, constructs three extreme weather indices—extreme heat, extreme cold, and extreme heavy precipitation—and employs a time-fixed effects model to analyse their impact on property insurance companies' loss ratios. The robustness and validity of the conclusions are further tested through endogeneity checks. Additionally, using the loss ratio as a mediating variable, the study explores the indirect impact of extreme weather on the solvency of property insurance companies via changes in the loss ratio. The key findings are as follows:

1) Extreme weather events (extreme heat, cold, and heavy precipitation) correlate significantly positively with property insurers' loss ratios. Specifically, for each unit increase in the extreme

heavy precipitation index, the loss ratio rises by approximately eight units, which holds even after endogeneity testing. This finding aligns with existing literature on extreme weather events' negative economic and social impacts. For instance, extreme heat and precipitation directly threaten public property and assets, leading to increased losses and corresponding claims.

2) The mediation effect tests reveal that extreme weather events indirectly affect insurers' solvency by increasing the loss ratio, with the results holding across three- and five-year time windows. Specifically, in the three-year rolling window, the loss ratio fully mediates the impact of extremely heavy precipitation and extreme cold on insurers' solvency, whereas, for extreme heat, the loss ratio serves as a partial mediator, accounting for 15.54% of the total effect. This underscores the challenges insurers face regarding risk management and capital reserves.

Despite considering both the direct and indirect impacts of extreme weather events on insurers' solvency, this study has limitations. For instance, the research primarily focuses on data from China, and further validation of these findings in other regions and countries is necessary. Future research could explore the effects of extreme weather events on insurers' solvency and how insurers respond to these challenges. Additionally, future studies could consider the impact of climate change on the long-term sustainability of the insurance industry.

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REFERENCES

Baron, R.M., & Kenny, D.A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182.

Bernanke, B., & Blinder, S. (1992). The federal funds rate and the channels of monetary transmission. *American Economic Review*, *82*, 901–921.

Chen, D., & Chen, X. (2013). A comparative analysis of factors affecting the solvency of property insurance companies. *Economic Mathematics*, *30*(2), 41–47.

Collier, S., Elliott, R., & Lehtonen, T. (2021). Climate change and insurance. *Economy and Society*, *50*, 158–171.

Felbermayr, G. (2014). Naturally negative: The growth effects of natural disasters. *Journal of Development Economics*, *111*, 92–106.

He, Q. (2022). Analysis of the role of insurance in responding to weather change risks under the dual carbon background. *Shanghai Insurance*, *0*(1), 7–9.

Hong, H., Karolyi, G., & Scheinkman, J. (2022). Climate finance. *Review of Financial Studies, 33,* 1011–1023.

Huang, Y., & Wang, H. (2011). A comparative analysis of factors affecting the solvency of property and life insurance companies in China. *Economic Forum*, *0*(1), 129–132.

Kumar, L., Chhogyel, N., & Gopalakrishnan, T. et al. (2022). Climate change and future of agri-food production. *Future Foods*, pp. 49–79. Academic Press.

Liu, W., & Jiao, S. (2022). Characteristics of extreme weather changes and its impact on NDVI in karst basins. *Journal of Soil and Water Conservation*, *36*(5), 220–232.

Lu, Z., & Han, F. (2013). How do macroeconomic policies affect the economic effects of corporate cash holdings? A study based on dual metrics of product market and capital market. *Management World*, *0*(6), 43–60.

Mills, E. (2009). A global review of insurance industry responses to climate change. *The Geneva Papers on Risk and Insurance-Issues and Practice*, *34*, 323–359.

Patz, J., Campbell-Lendrum, D., Holloway, T., & Foley, J. (2005). Impact of regional climate change on human health. *Nature*, *438*, 310–317.

Savitz, R., & Gavriletea, M.D. (2019). Climate change and insurance. *Transformations in Business & Economics*, *18*, 21–43.
Thistlethwaite, J., & Wood, M. (2018). Insurance and climate change risk management: Rescaling to look beyond the horizon. *British Journal of Management*, *29*, 279–298.
Tucker, M. (1997). Climate change and the insurance industry: The cost of increased risk and the impetus for action. *Ecological Economics*, *22*, 85–96.
Wang, X. (2020). Weather changes and the insurance industry: Impacts, adaptation, and mitigation. *Financial Supervision Research*, *0*(11), 46–61.
Wang, X., & Jiang, J. (2021). Weather-related financial risks: Differences and responses between the insurance industry in China and abroad. *International Economic Review*, *0*(5), 22–33.
Wen, Z., Zhang, L., Hou, J., et al. (2004). Testing procedures for mediating effects and their applications. *Acta Psychologica Sinica*, *0*(5), 614–620.
Yao, L., Xie, J., & Che, S. (2019). Amplification of catastrophe risk and its influencing factors. *Insurance Studies*, *0*(5), 31–43.
Ying, X., Gao, F., & Giorgi, F. (2009). Regional variability of climate change Hot spots in East Asia. *Advances in Atmospheric Sciences*, *26*(4), 783–792.
Zhang, S., & Lu, L. (2022). Assessment, pricing, and policy responses to weather risk in financial systems: A literature review. *Financial Review*, *14*(1), 99–120+124.
Zheng, L. (2014). A study on the factors affecting the solvency of insurance companies in China. *Scientific Decision Making*, *0*(5), 72–82.
Zhu, B., Wu, X., & Zhang, A. (2008). An empirical analysis of the factors affecting the solvency of property insurance companies in China. *Insurance Studies*, *0*(5), 33–37.