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Swiss Institute for International Economics
and Applied Economic Research

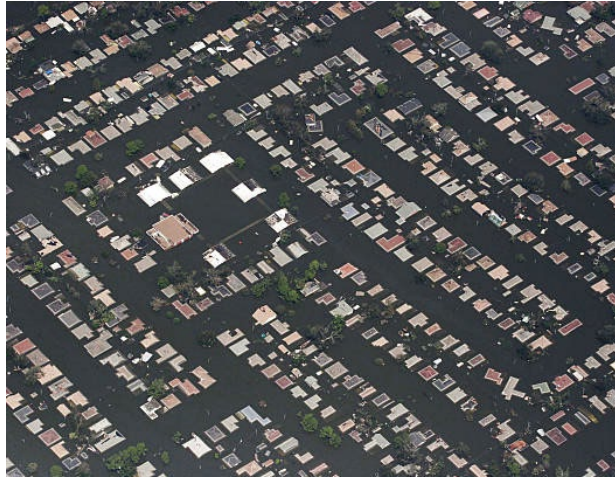
Who monitors climate risk of financial institutions?

Evidence from catastrophe risks in insurance

Christoph Basten and Anastasia Kartasheva

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Post-Katrina Shake-Up



Top 10 Costliest Hurricanes In The United States* (\$ millions)

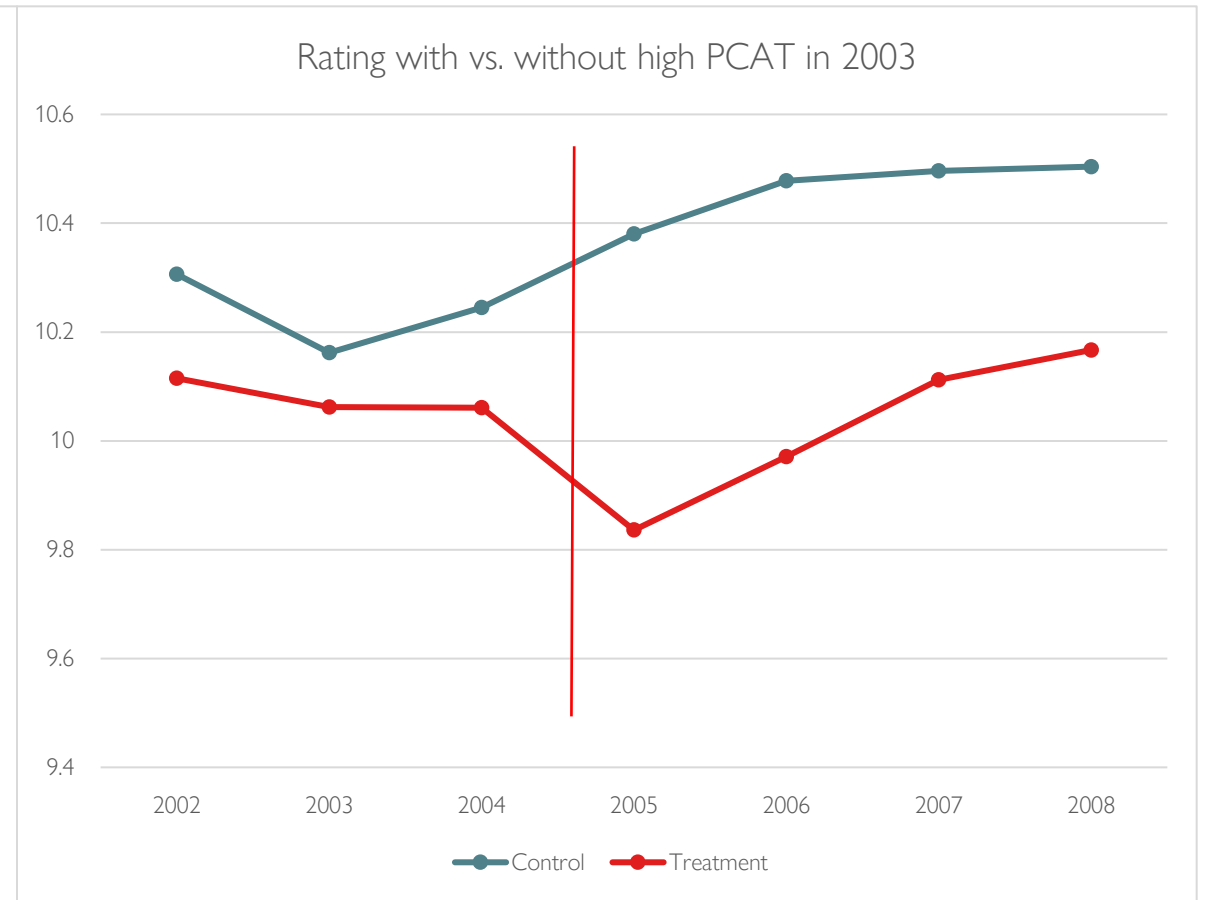
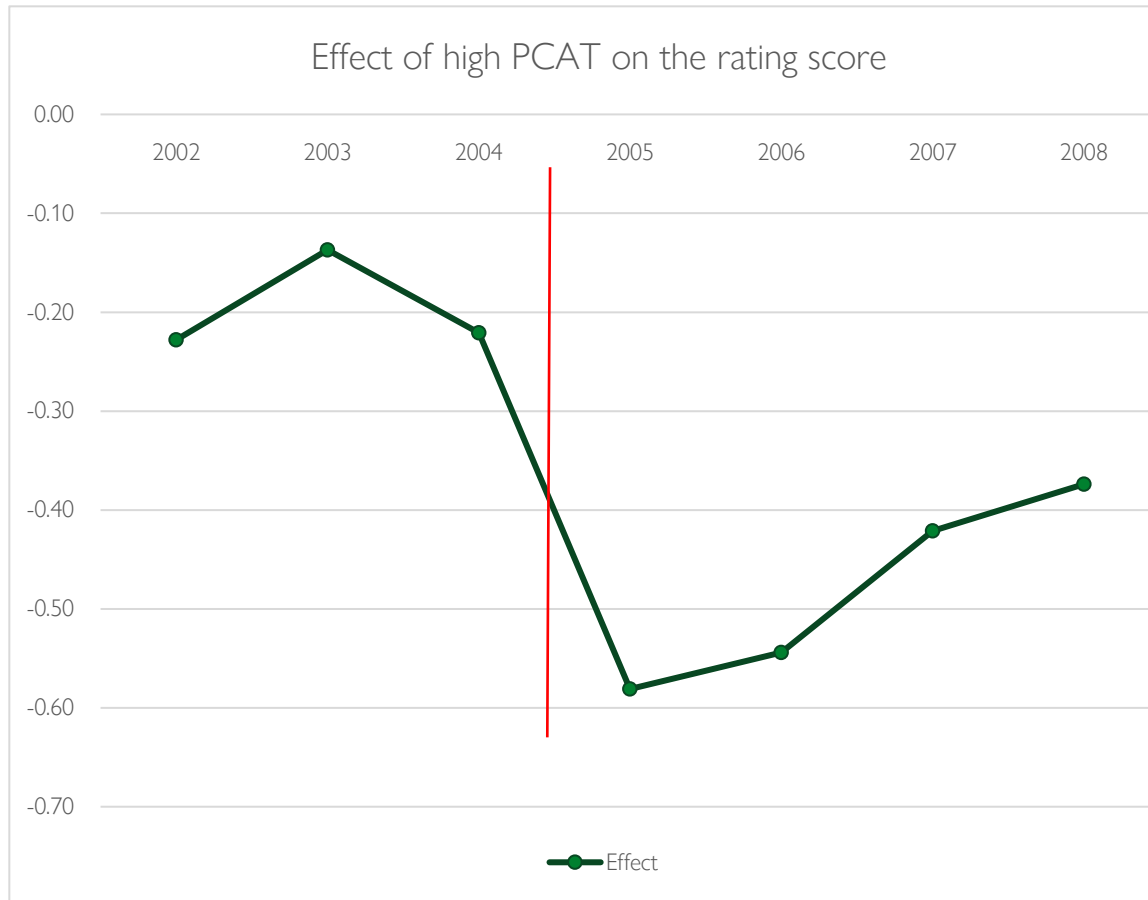
Rank	Year	Hurricane	<u>Estimated insured loss</u>	
			Dollars when occurred	In 2024 dollars
1	2005	Hurricane Katrina	\$65,000	\$104,471
2	2022	Hurricane Ian	54,000	57,231
3	2021	Hurricane Ida	36,000	41,540
4	2012	Hurricane Sandy	30,000	40,939
5	2017	Hurricane Harvey	30,000	38,571
6	2017	Hurricane Irma	30,050	38,432
7	2017	Hurricane Maria	29,511	37,743
8	1992	Hurricane Andrew	16,000	35,845
9	2008	Hurricane Ike	18,200	26,259
10	2024	Hurricane Milton	20,000	20,000

* Includes Puerto Rico and the U.S. Virgin Islands and losses sustained by private insurers and government-sponsored programs such as the National Flood Insurance Program. Subject to change as loss estimates are further developed. As of January 2025 . 2024 dollars adjusted for inflation by Aon using the U.S. Consumer Price Index. **Source:** Aon.

A.M. Best Response: Higher capital requirements for NatCat exposures

- **A.M. Best Financial Strength Ratings** (95% coverage)
 - BCAR: Capital adequacy model score by the A.M. Best
 - **2006 change:** Dual-stress testing (two 1-in-100-year events)
- **State insurance regulators**
 - RBC capital requirements (100% coverage)
 - **2017:** NAIC introduced NatCat RBC charges (**11-year delay**)
- **Research Question: Have stricter ratings requirements made insurers more resilient?**
 - Compare insurers' responses to stricter rating standards vs. regulatory capital changes
 - Evaluate long-term effectiveness of each monitor

Downgrade pressure on insurers



Research Questions

1. Is rating agency A.M. Best more sensitive than regulatory capital requirements to NatCat risk exposure?
 - Yes
2. How do insurers respond to stricter capital standards?
 - Response only in one market segment – commercial insurance, but not in the other segment – personal insurance
3. What are the long-term effects of stricter monitoring by A.M. Best?
 - Insurance market fragmentation in terms of resilience to climate exposures

How do insurers respond to stricter ratings?

➤ Model assumptions

- Insurers differ in quality (q) and are subject to CRA ratings
- Insurers strategically invest effort (e) to improve rating
- Heterogeneous incentives based on:
 - Marginal cost of effort
 - Benefit of higher rating
 - Demand elasticity to ratings

➤ Predictions

- Insurers facing highly elastic demand are more likely to defend ratings
- By contrast, insurers facing low elasticity of demand are more likely to accept the downgrade and become more risky

Empirical Analysis

1. Institutional background and data
2. Analysis of the response of insurance prices and volume to regulatory and rating changes
3. Assessment of the rating downgrade pressure post-Katrina and adjustment channels
4. Evaluation of the long-term effects (2010-2022)

Institutional background and data

Insurance market segments: Personal and commercial insurers

Commercial insurers

- NatCat exposed: commercial multiple peril, inland marine
- Clientele: Sophisticated corporate buyers
- Market Features:
 - No state guarantee protections
 - Demand highly elastic to rating changes

Personal insurers

- NatCat exposed: homeowners multiple peril, private passenger auto physical damage
- Clientele: Retail households
- Market Features:
 - Protected by state guarantee funds
 - Demand inelastic to rating changes

Implication: Commercial insurance demand more sensitive to ratings → greater incentives to maintain high ratings

Segmented market: 32% of insurers specialize and write 90-100% of their premiums in commercial lines



Panel data on US insurers

➤ Data sources

- A.M. Best ratings
- NAIC statutory regulatory filings

➤ US property-casualty insurance companies between 2001-2022

- Include all insurers with A.M. Best rating
- Around 11,000 insurer-year observations at the individual company level

➤ Insurers' characteristics

- A.M. Best financial strength ratings and BCAR scores at the company level
- Key metrics utilized by rating agencies and regulators to assess insurers' capital adequacy, profitability, financial and reinsurance leverage, firm size, and capital market access

Measuring the NatCat exposure and business profile of insurers

➤ Business volume and incurred losses

- Direct premiums written by business line and by state
- Incurred losses by business line and by state
- Characteristics reported in the Core pages of insurers' NAIC filings

➤ Exposure to Katrina

- Percentage of premiums in NatCat exposed lines of business written in Katrina-affected states Alabama, Florida, Louisiana, Mississippi, South Carolina, and Texas

➤ Exposure to other NatCat regions

- Percentage of premiums in NatCat exposed lines of business written in NatCat exposed regions

➤ Definition of commercial insurers: Commercial insurers are those that write at least 50% of premiums in commercial lines

- Robust to alternative specifications: continuous measure, median (>82%), 75%, 90%

Is insurance demand sensitive to
regulatory or rating changes?

Methodology

- **Insurance price (Price Markup = Premiums/Expected loss):** ratio of DPW to discounted losses
 - **Insurance volume (Price × Quantity):** Direct premiums written (DPW)
1. Estimate the relationship between the growth of DPW and Price Markups and rating changes
 2. Assess whether the effect is stronger for commercial insurers
 3. Horse race the impact of ratings and the impact of capital requirements

Response to rating notch change

	(1) Markup	(2) Markup	(3) Markup	(4) Markup	(5) % Δ DPW	(6) % Δ DPW	(7) % Δ DPW	(8) % Δ DPW
Δ Rating	20.388 (20.073)	20.812*** (4.089)	-187.950 (242.898)	-163.480*** (38.404)	1.708* (0.964)	1.906*** (0.305)	-0.615 (1.217)	-0.356 (0.435)
I(commercial)			-135.340 (117.790)	-138.826*** (18.783)			9.020*** (0.870)	7.399*** (0.229)
I(comm)* Δ Rating			283.869 (324.237)	251.061*** (50.707)			3.529** (1.395)	3.438*** (0.498)
Observations	160,169	158,970	160,169	158,970	715,038	713,408	715,038	713,408
Cross-Sectional FE	Firm	Firm*State	Firm	Firm*State	Firm	Firm*State	Firm	Firm*State
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Std. Error Cluster	Firm	Firm*State	Firm	Firm*State	Firm	Firm*State	Firm	Firm*State

- Each rating notch change is associated with 1,7%-1.9% higher DPW growth and 20 bps higher markup
- The effect is insignificant or slightly negative for personal lines but are large (3.5% and 250 bps) for commercial lines
- Results are confirmed if one considers only the downgrades

Horse race: Response to regulatory RBC change and rating change

- Response to rating changes is stronger than response to RBC changes
- One standard deviation **increase in RBC** implies **6%** higher markup and **1%** lower demand
- One standard deviation **increase in rating** implies **16%** higher markup and **1.2%** higher demand



Do insurers experience rating downgrade
pressure post-Katrina?

How do they adjust to this pressure?

Downgrade pressure post-Katrina

➤ Baseline specification Difference-in-Differences (DiD)

$$(1) \text{ Rating}_{it} = \beta_1 (\text{Post} \times \text{PCAT}_{it}) + \beta_2 \text{Post} + \beta_3 \text{PCAT}_{it} + \varepsilon_{it}$$

$$(2) \text{ Rating}_{it} = \beta_1 (\text{Post} \times \text{PCAT}_{it}) + v_i + \tau_t + \varepsilon_{it}$$

➤ Variables

- Rating_{it} : Numerical conversion of a rating from 13 (A++) to 1 (C)
- Post : A time dummy equal to 0 for years 2001-5 and equal to 1 for years 2006-8
- PCAT_{it} : Exposure of insurer i in year t to Katrina-affected areas
- Fixed Effects: insurer and time
- Controls: insurer's capital, profitability, leverage, size, and corporate structure

➤ Prediction: $\beta_1 < 0$

Alternative specifications

- Baseline specification (2) with insurers' controls, Ordered Probit, Ordered Logit

Result 1: Downgrade pressure on Katrina-exposed insurers

	(1) OLS Rating	(2) OLS Rating	(3) OLS Rating	(4) OProbit Rating	(5) OLogit Rating
Post × PCAT	-0.196 (0.186)	-0.406*** (0.119)	-0.367*** (0.114)	-0.239** (0.114)	-0.382 (0.238)
Post	0.131*** (0.026)			-0.132*** (0.021)	-0.235*** (0.036)
PCAT	-0.194 (0.241)			-0.130 (0.166)	-0.136 (0.328)
Firm FE	No	Yes	Yes	No	No
Year FE	No	Yes	Yes	No	No
Controls	No	No	Yes	Yes	Yes
Observations	11,190	11,190	11,044	11,044	11,044

Katrina-exposed insurers → downgrade pressure

- Robust across main specifications, errors clustered at insurer level
- Economically large: costs about 40% of a rating notch

Impact on Personal vs. Commercial Insurers

➤ Differential downgrade pressure on personal and commercial insurers

- Triple interaction extension of the baseline specification

$$(3) \quad \text{Rating}_{it} = \beta_1(\text{Post} \times \text{PCAT}_{it} \times I(\text{Comm})) \\ + \beta_2(\text{Post} \times I(\text{Comm})) + \beta_3(\text{Post} \times \text{PCAT}_{it}) + v_i + \tau_t + \varepsilon_{it}$$

- If $\beta_1 \neq 0$ then commercial and personal insurers face different downgrade pressure for the same PCAT exposure
 - $\beta_1 > 0$ commercial insurers tend to get downgraded less for the same PCAT exposure

Alternative specifications

- Baseline specification (3) with insurers' controls
- Ordered Probit
- Ordered Logit

Result 2: Commercial insurers evade downgrade pressure

	(1) OLS	(2) OLS	(3) OLS	(4) OProbit	(5) OLogit
Post*PCAT	-0.414* (0.229)	-0.597*** (0.149)	-0.640*** (0.140)	-0.501*** (0.153)	-0.804** (0.320)
Post*PCAT*I(Comm)	1.060*** (0.396)	0.785*** (0.233)	0.864*** (0.217)	0.731*** (0.234)	1.352*** (0.507)
Post*I(Comm)	-0.031 (0.057)	-0.015 (0.036)	-0.041 (0.033)	-0.053 (0.039)	-0.096 (0.069)
PCAT*I(Comm)	-0.372 (0.538)	-0.000 (0.169)	-0.115 (0.158)	-0.280 (0.353)	-0.522 (0.727)
Observations	11,283	11,283	11,283	11,283	11,283
Firm & Year FE	No	Yes	Yes	No	No
Firm Controls	No	No	Yes	Yes	Yes

Downgrade pressure: personal but not commercial insurers

- $| \text{Post} \times \text{PCAT} \times \text{I(Comm)} | + | \text{Post} \times \text{PCAT} |$ is close to zero

What drives the downgrade pressure?

➤ Downgrade pressure factors

- Rating scale change
- Katrina impact on firm's characteristics: Incurred losses, increasing cost of reinsurance, etc

➤ Downgrade pressure decomposition

- PDGs: Propensity to be downgraded (PDG) due to the scale change

$$PDGs = \begin{cases} 1, & \text{if } (Rating_{\text{Post}}(X_{Pre}) < Rating_{Pre}(X_{Pre})) \\ 0, & \text{otherwise} \end{cases}$$

- PDG_x: Propensity to downgrade due to the change in insurer's characteristics

$$PDG_x = \begin{cases} 1, & \text{if } Rating_{Pre}(X_{\text{Post}}) < Rating_{Pre}(X_{Pre}) \\ 0, & \text{otherwise} \end{cases}$$

Factors driving the downgrade pressure

➤ Contribution of standard change and Katrina losses to downgrade pressure

- Run a horse race between PDGs and PDGx in explaining the downgrade pressure

$$Rating_{it} = \beta_s(Post \times PDGs_{it}) + \beta_x(Post \times PDGx_{it}) + v_i + \tau_t + \varepsilon_{it}$$

➤ Alternative specification

- Evaluate the impact of Katrina losses directly by replacing $PDGx_{it}$ with **the loss ratio** LR_{it} in Katrina-exposed states
- *Loss ratio* is the ratio of insured losses to premiums earned, reported for each insurer by line of business and state

Result 3: Contribution of rating scale and insurer's factors

	(1) OLS	(2) OLS	(3) OLS	(4) OProbit	(5) OLogit
Post*PDGs	-0.337*** (0.110)	-0.212** (0.090)	-0.161* (0.091)	-0.160* (0.092)	-0.230 (0.201)
Post*PDGx	-0.240* (0.124)	-0.266*** (0.053)	-0.055 (0.056)	-0.134 (0.088)	-0.289* (0.166)
PDGs	1.190*** (0.200)			0.203 (0.166)	0.516* (0.312)
PDGx	-0.214* (0.119)			-0.245*** (0.089)	-0.504*** (0.180)
Post	0.147*** (0.030)			-0.164*** (0.028)	-0.325*** (0.052)
Observations	9,086	9,436	9,436	9,086	9,086
Firm & Year FE	No	Yes	Yes	No	No
Controls	No	No	Yes	Yes	Yes

Both factors matter for downgrade pressure

- Each factor contributed about **a half** to the downgrade pressure

Result 4: Commercial insurers are more resilient

- Commercial insurers are more willing and capable to surmount the unfavorable impact of Katrina compared to personal insurers
- Commercial insurers had more flexibility to adjust in the aftermath of Katrina

Evaluation of adjustment channels post-Katrina

Results on capital and risk management policy adjustments

➤ Geographic exposure

- **Commercial insurers:** NatCat business relocation to North East, Earthquake and Tornado regions and reduce Gulf States Hurricane exposure
- **Personal insurers:** Some evidence on the growing exposure to Florida

➤ Regulatory monitoring impact

- **RBC standards remained insensitive** to NatCat risk: Personal insurers could still meet regulatory capital standards despite rising risk

➤ Capital policy and Reinsurance

- Increase in the propensity to pay zero dividends by 7%; No significant response in terms of capital issuance or dividend cuts
- Katrina-exposed insurers increase their reinsurance coverage by 4-7%

➤ Asset quality

- Higher rating scale pressure PDGs motivates insurers to reduce investment in risky bonds; but no response to PDGx or PCAT; PCAT-exposed insurers reduce investment in common stock

Long-term impact of rating standard changes in 2010-2022

Do stricter rating standards improve the financial resilience of insurers?

- Assess whether A.M. Best's 2006 rating methodology change had a **lasting impact** on insurers' risk-taking behavior.
- Have insurers that were under the downgrade pressure in 2006 improved their **loss ratios in subsequent years?**
 - Outcome: **Loss Ratio** = (Claims / Premiums) — proxy for risk exposure
 - Key variable: **Rating Downgrade Pressure in 2006**
 - Interaction with insurer type: Commercial vs. Personal
 - Control for insurer and year fixed effects

Key Findings

- **Commercial insurers** exposed to rating downgrade pressure in 2006:
 - Significantly lower loss ratios in the long run (2010–2022)
 - Indicates improved risk management and effective discipline
- **Personal insurers:**
 - **No evidence** of improvement in loss ratios
 - In some cases, NatCat exposure actually **increased**
- **Interpretation:**
 - **Only commercial insurers** responded meaningfully to stricter monitoring
 - **Guarantee fund protection** likely muted incentives for personal insurers

Conclusion

Conclusion & Policy Takeaways

➤ Contributions

- New evidence on how rating methodology disciplines firm behavior
- Extends climate finance and insurance regulation literatures
- Shows differential responses within a regulated industry

➤ Broader Implications

- Large segments of the market remain under-monitored
- Guarantee funds create moral hazard
- Regulatory inertia undermines climate resilience in insurance

➤ Policy Relevance

- Need to align regulatory frameworks with evolving climate risks
- Consider revising **guarantee fund structures to preserve incentives** for prudent risk-taking