Macroeconomic Implications of Catastrophe Bond Adoption

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Fiscal impacts of climate change : Four main strand of literature

1. Examines how past climatic events have affected government budgets, spending, and debt.
2. Assesses how future climate scenarios could shape fiscal risks.
3. Evaluates whether public borrowing costs are affected by climatic risks using both empirical and model-based frameworks
4. **Introduces climatic risks into quantitative macro-fiscal models to gauge the welfare impacts**

Table 1 Climate risks and public borrowing costs

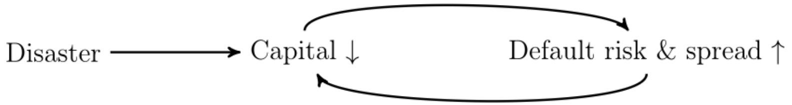
Study	Geography	Climate risk	Risk measure	Impact
Borensztein et al. (2009)	31 countries	Past windstorms	Windstorm disaster in EM-DAT (= 1)	↑ Emerging markets bond index spread +40%
Klomp (2017)	115 countries	Past storms, floods, droughts	Count of top 10% wind speed, flood, drought events (normalized by country area)	↑ Probability of debt crisis: storms +4%, mixed/ insignificant for drought, floods
Kose et al. (2022)	103 countries	Past disasters	Natural disaster in EM-DAT with direct damages at least 1% of GDP (= 1)	Failure to detect significant impact on sovereign debt rating index
Jerch et al. (2023)	US municipalities	Past hurricanes	+1 std. dev. hurricane wind speed	↑ Share of bonds rated high risk +10–12%
Auh et al. (2022)	US counties	Past disasters	Meteorological disaster of at least \$3 per capita costs in SHELDUS data (= 1)	↓ Bond returns −0.31% (4-month average)
Damette et al. (2024)	7 Latin American countries	Past El Niño/La Niña events	Strong El Niño event (= 1) Strong La Niña event (= 1)	↑ Spreads 15% (6 months), then ↓ ↓ Spreads 10% (5 months), then ↑
Painter (2020)	US counties	Future sea-level rise	+1% GDP loss (from 40-cm sea-level rise)	↑ Issuance costs +23.4 bps
Goldsmith-Pinkham et al. (2023)	US municipalities	Future sea-level rise	+1 std. dev. in fraction of homes exposed to 6-foot sea-level rise	↑ Spreads +5.3 bps (in 2015)
Acharya et al. (2022)	US counties	Future heat stress	+1% GDP loss (by 2080–2099) +1 hot day (max. temperature >37.8°C, by 2080–2099)	↑ Spreads +17.2 bps (in 2019) ↑ Spreads +0.29 bps (in 2019)
Jeon et al. (2024)	US municipalities	Future wildfire risk increase	+1 std. dev. future wildfire housing stock exposure increase	↑ Spreads +23 bps (average 2014–2020)
Mallucci (2022)	7 Caribbean countries	Future hurricane risk increase	Frequency +29.2% Damages +48.5%	↑ Spreads +95 bps on average ↓ Welfare −6.81% to −1.12%
Phan & Schwartzman (2024)	Mexico	Future hurricane risk increase	Intensity +10% (scale parameter of Weibull distribution)	↓ Welfare −0.95%
Kling et al. (2018), Beirne et al. (2021), Cevik & Jalles (2022)	Cross-country	Climate index such as ND-GAIN	+1 p.p. vulnerability index +1 p.p. resilience index	↑ Spreads ↓ Spreads

This table summarizes studies on climatic risks and public debt.
Abbreviations: bps, basis points; EM-DAT, Emergency Events Database; GDP, gross domestic product; ND-GAIN, Notre Dame Global Adaptation Initiative; SHELDUS, Spatial Hazard Events and Losses Database for the United States; std. dev., standard deviation.

Source: Barrage (2025)

What this paper does...

- Brings together climate disaster risk and sovereign default risk in one coherent quantitative model.
- Based mainly on Phan and Schwartzman (2024)
  - Vulnerable countries hit by a climatic disaster may see their sovereign bond spreads increase, reducing the government's ability to borrow exactly at the time when additional capital could be needed for reconstruction.
  - This exacerbates the GDP losses, which in turn, results in further declines in the countries's borrowing terms.
  - This generates the **amplification mechanism** in the model:



Source: Phan and Schwartzman (2024)

Differences from Phan and Schwartzman (2024)

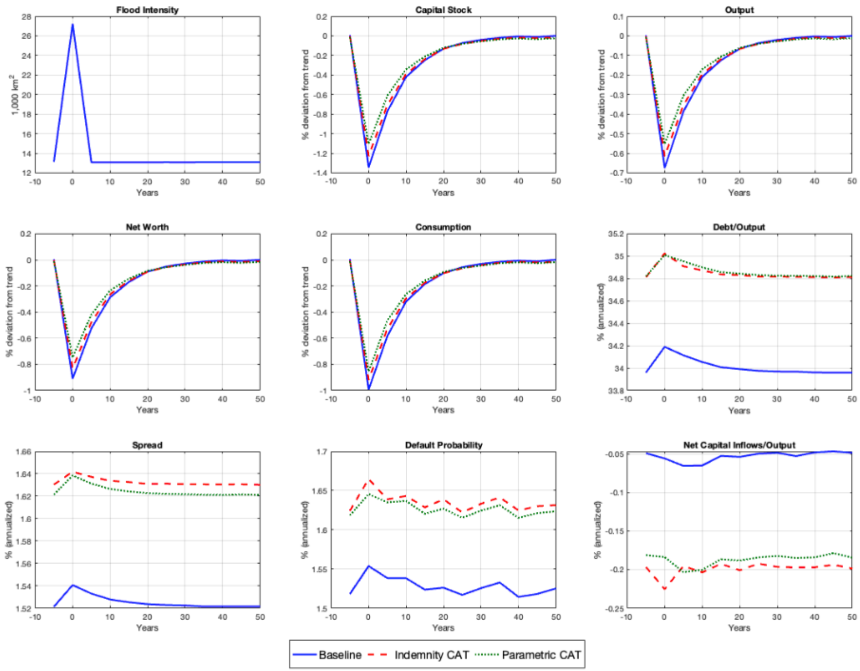
- Shifting attention to **more frequent, moderate-scale disasters** (floods) rather than infrequent extreme events like hurricanes.
- Trigger design comparison: it explicitly distinguishes between **indemnity-trigger** (which pays after verifying actual losses) **and parametric-trigger CAT bonds** (which pays a fixed amount immediately when an index threshold is met).
  - Providing insight into the **trade-offs** between a slower but precise indemnity payout versus a rapid parametric payout that comes with basis risk.
  - This novel comparison addresses how the speed of payout vs. accuracy of loss coverage influences outcomes.

Key findings:

1. Overall, the model simulations show that **pre-arranged disaster financing** via CAT bonds can materially reduce the macroeconomic impacts and welfare costs of severe floods.
2. Relative to an indemnity-trigger bond, a **parametric-trigger bond** delivers a stronger benefit.
3. Both types of CAT bonds are not a free lunch: the ex-ante cost of having disaster insurance means the government carries slightly higher public debt. But the paper finds this trade-off to be modest.
4. Policy insight – **layered financing**
   - The results support a “layered” disaster risk financing strategy. The authors suggest using a parametric CAT bond for the extreme tail risks (major floods) to provide quick liquidity when sovereign debt markets are most stressed, while relying on conventional fiscal tools for more moderate events.

Robustness of the results: The risk of overstating the benefits of parametric bond

- While the results show that the parametric bond is superior, the gap vs indemnity is quantitatively small.
- For example:
    - Capital stock loss:
      ~ –1.35% (baseline)
      ~ –1.25% (indemnity)
      ~ –1.15% (parametric)
- Welfare gain in Fig 3 of the paper is also quite small (0.09 vs 0.01)



Robustness of the results: The risk of overstating the benefits of parametric bond

➔ How robust are these findings to changes in key assumptions (esp. in the expected compensation of the parametric CAT bond)?

$$\mu_p = \text{CAT Bond Coverage} \times \text{Trigger Threshold} \times (1 - \text{basis risk})$$

- Follow-up questions:
  1. What if **basis risk** in the parametric bond were higher?
  2. Would the parametric bond still dominate if **payout delays** in indemnity contracts were shorter or there is some delay in the parametric case?
  3. How sensitive are results to the **trigger threshold**?
  4. How would the results change if the **CAT bond share** (θ, a fraction of CAT bonds within the sovereign government's total debt portfolio) were larger?

1. What if the basis risk in the parametric bond were higher?

- In the model, the parametric CAT bond is assumed to pay a fixed amount when a disaster index (e.g. flood intensity) exceeds a threshold. While this design is simple and fast, but introduces basis risk — the possibility that the payout does not match actual damages.
- The authors assume a basis risk of 30%, meaning 70% of expected damages are covered by the fixed payout.
- What happens if basis risk rises to 50% or more, for example?
  - Under-compensating the government could undermine macro stabilization. That is, too small liquidity injection to prevent spread spikes or output loss.
  - The welfare advantage of the parametric bond would shrink (or potentially reverse?).
  - Meanwhile, indemnity bonds — which match actual losses — become more attractive?

2. Would the parametric bond still dominate if payout delays in indemnity contracts were shorter?

- The model gives parametric bonds a timing advantage: payout is immediate, while indemnity bonds are delayed.
- But in practice, indemnity CAT bonds could be improved via *digital* damage assessment
- What if indemnity payouts are only slightly delayed?
  - If the timing gap closes and so the advantage of parametric liquidity weakens
  - Given that indemnity bonds already match losses well, they may catch up or outperform in overall macro performance?

3. How sensitive are results to the trigger threshold?

- The model uses a 90th percentile flood threshold as the trigger for CAT bond payout — meaning the bond pays out only in extreme events.
- What if the trigger were set at, say, 80th percentile? ➔ More frequent payouts
  - Higher spread
  - Potential crowding out of capital in normal times
  - Could this diminish the net welfare benefit?

4. How would the results change if the CAT bond share (θ) were larger?

- In the model, CAT bond share θ is fixed (exact value not disclosed but inferred to be small). What if θ were increased?

(+) In disaster states:	• Government receives more liquidity • Greater macro stabilization (parametric likely looks even better)
(-) In normal states:	• Higher gross debt burden • Higher spreads • More crowding out of investment and capital inflows

- The model displays a ***CAT-bond Laffer Curve*** (as in Phan & Schwartzman)? If so, parametric CAT bonds may look better at moderate θ and excessive amount can result in unnecessarily higher borrowing costs.

Moral Hazard concern

- The primary function of a catastrophe bond is to provide **immediate liquidity for post-disaster recovery**.
  - While crucial, reliance on this "ex-post" financing mechanism could implicitly deprioritize "ex-ante" investments in risk reduction and prevention.
- My concerns are:
  1. Bailout mentality: focus on recovery over prevention
  2. Reduced incentive for proactive mitigation
- This raises an important institutional design problem.
  - Should we also consider the achievement of specific resilience outcomes, rather than just the occurrence of a hazard?
- What's about **resilience-linked triggers**?
  - OECD: Climate Resilience Scorecards, World Bank: Climate Bonds Resilence Taxonomy (CBRT). See also Motlagh et al. (2024).
  - Integrating this into the model could help analyze whether CAT bonds not only cushion disasters but also incentivize long-run resilience.

Final thought

- Very interesting paper!
- The paper provides a solid foundation for future research on macro impacts of disaster risk finance,
- …but stress-testing results and connecting contract design to real-world incentive problems will make the analysis even more policy-relevant.