Discussion of Jung, Engle, Ge, and Zeng (2025)

"Physical Climate Risk Factors and an Application to Measuring Insurers' Climate Risk Exposure"

Discussant: Sangmin Simon Oh (Columbia Business School)

FIRS 2025

Two Types of Risks

[1] Climate Physical Risk

- Climate-driven hazards (hurricanes, floods, wildfires) that directly hit property and interrupts economic activities
- Example 1: Damage from rising sea levels to firms' production facilities close to sea
- Example 2: Destruction of real estate values due to rising physical risk

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- Risk of valuation losses that stem from the policy, technology, and demand shift toward a low-carbon economy
- Example 1: Introduction of a carbon tax that leaves fossil fuel firms with stranded assets
- Example 2: Technological advances and changing consumer preferences

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It is important to distinguish these two sources of risk!

At least three reasons why:

1. Measurement: Mixing them confounds differences in frequency and scope
2. Policy Relevance: Role of government insurance, tax, and regulation
3. Economic Channels: Implies different hedging tools

Two Types of Insurance Companies

[1] Property & Casualty (P&C) Insurer

- Business: homeowner, commercial, reinsurance lines; liabilities = catastrophe claims
  - In many cases, operations are state-specific: firms writing more policies in risky counties show higher physical betas
- First-order Risk: Climate physical risk
- Mitigation Strategy: Reinsurance & insurance-linked securities.
- Key Interactions: State-level rate-setting and price regulation

Commissioner Lara unveils next steps in his strategy to expand coverage options for Californians in areas of high wildfire risk

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Media Calls Only: 916-492-3566
Email Inquiries: cdipress@insurance.ca.gov

Commissioner Lara unveils next steps in his strategy to expand coverage options for Californians in areas of high wildfire risk

First-ever wildfire risk map showing where insurance companies need to write more coverage

LOS ANGELES — Insurance Commissioner Ricardo Lara today released further details of his transformative plan to increase the writing of homeowners and commercial insurance policies in areas of the state with high wildfire risk. This action is the next step of his Sustainable Insurance Strategy that will help restore coverage options for Californians across the state while safeguarding the integrity of the state's insurance market. Commissioner Lara is keeping California on course for the most significant insurance reform in 30 years by releasing regulatory text outlining the commitments that insurance companies must make in order to use forward-looking catastrophe models for ratemaking. The release of this regulatory text and announcement of a June 26 public workshop is part of the package of regulatory language designed to incorporate the use of catastrophe models in California ratemaking.

Two Types of Insurance Companies

[2] Life Insurers

- Business: long-duration policies funded by large investment portfolios
- Hold >30 % of assets in corporate bonds; “brown” share averages ~15 %
- First-order Risk: Climate transition risk
- Mitigation Strategy: Asset-Liability Management
- Key Interactions: Capital and asset valuation rules

Recap

Question: What are the climate risk exposures of U.S. insurance companies?

[1] Construct climate risk factors

- Physical Risk Factor: Long-short portfolio of REITs sorted on exposure to high-risk locations
- Transition Risk Factor: "stranded-asset" portfolio (70 % KOL + 30 % XLE – SPY)

[2] Estimate time-varying insurer betas and translate into capital shortfall (CRISK)

- CRISK = Prudential capital – projected equity; Marginal CRISK isolates the climate component

[3] Compute insurers' expected capital shortfall in climate stress scenarios

- CCRISK: Joint tail dependence across market, physical, and transition risks

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- CCRISK: Joint tail dependence across market, physical, and transition risks

A very important and policy-relevant paper on a timely topic!

Plan for Discussion

1. Risk Exposures for Non-Traded Firms
2. Benchmarking to Regulatory Disclosures

Point 1. Risk Exposures for Unlisted Firms

How do authors extend the approach to unlisted insurers?

As the authors note, the market-based approach only applies to listed financial firms.

- 21 P&C insurers (2011 to 2021) and 18 Life insurers (2000 to 2020)

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Current Approach (for physical climate risk only):

1. Map the climate β onto a set of observables
    - Observables: Policy portfolio, size, leverage, reinsurance intensity, RBC ratio
2. Impute climate β for each unlisted insurer

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Suggestion 1a. Two suggestions for expanding the set of observables

1. Herfindahl of state premiums to capture capture tail clustering that size cannot pick up
2. Interaction between reinsurance × size (small insurers buying quota-share treaties may have lower net exposure than large insurers using excess-of-loss covers)

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Suggestion 1b. How can we extend the imputation to transition betas?

- Map each bond's 3-digit NAICS industry to the industry-specific transition beta from Section 6 ⇒ Take the portfolio-weighted average to obtain a bond-portfolio transition beta for every listed and unlisted life (and P&C) insurer.
- Regress listed firms' market transition betas on this bond-portfolio beta plus controls; apply the coefficients to unlisted firms to impute

A Digression: A Fully Bottom-Up Approach

There is a parallel in the exercise of the authors: estimating interest rate risk of insurers.

Table 2.3: Risk Exposure of Variable Annuity Insurers

		By subsample		
Factor		1999–2007	2008–2009	2010–2017
Stock market return	1.36	0.56	2.56	1.11
	(0.19)	(0.15)	(0.22)	(0.08)
10-year bond return	-0.01	-0.38	1.14	-1.28
	(0.32)	(0.29)	(0.66)	(0.16)
Alpha (%)	-0.22	0.35	-1.14	0.41
	(0.46)	(0.47)	(1.70)	(0.29)
Observations	228	108	24	96

Source: Koijen and Yogo (2021)

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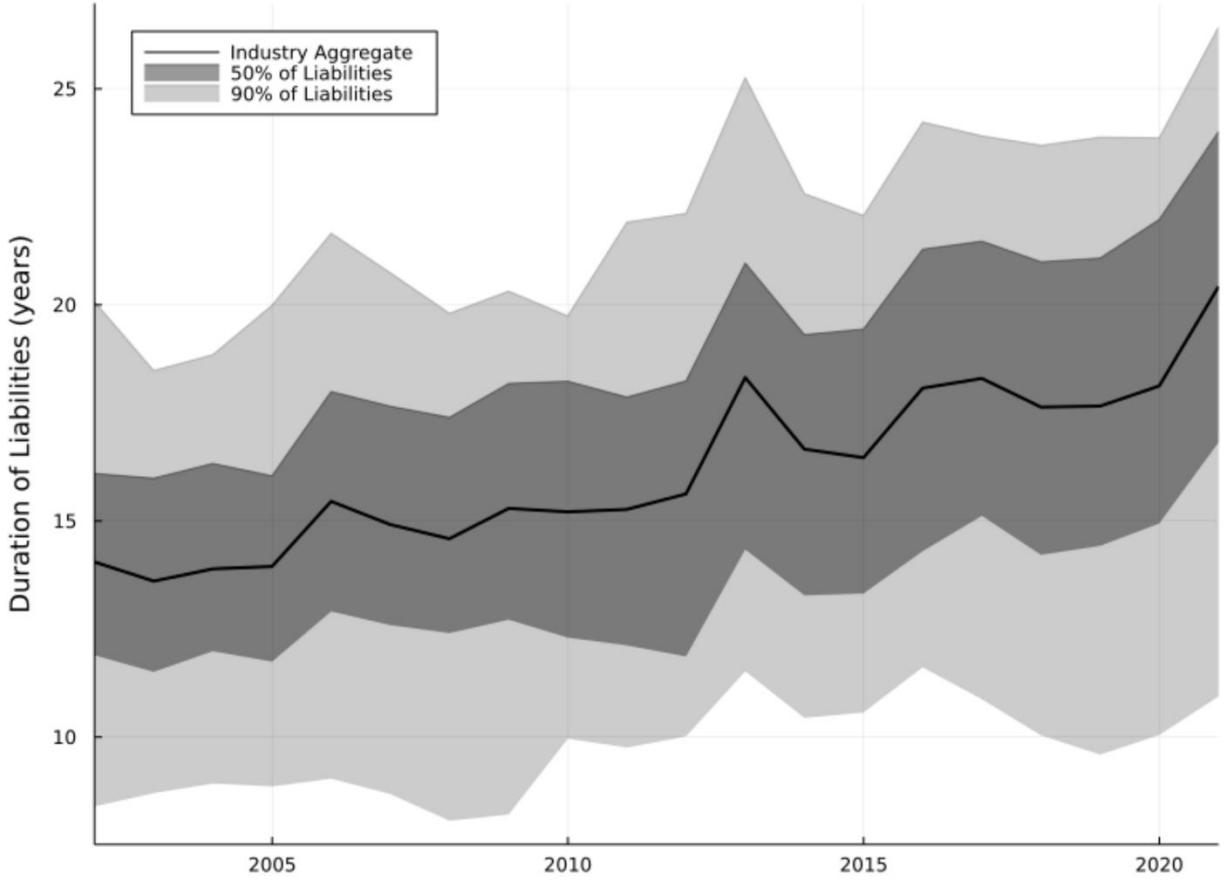

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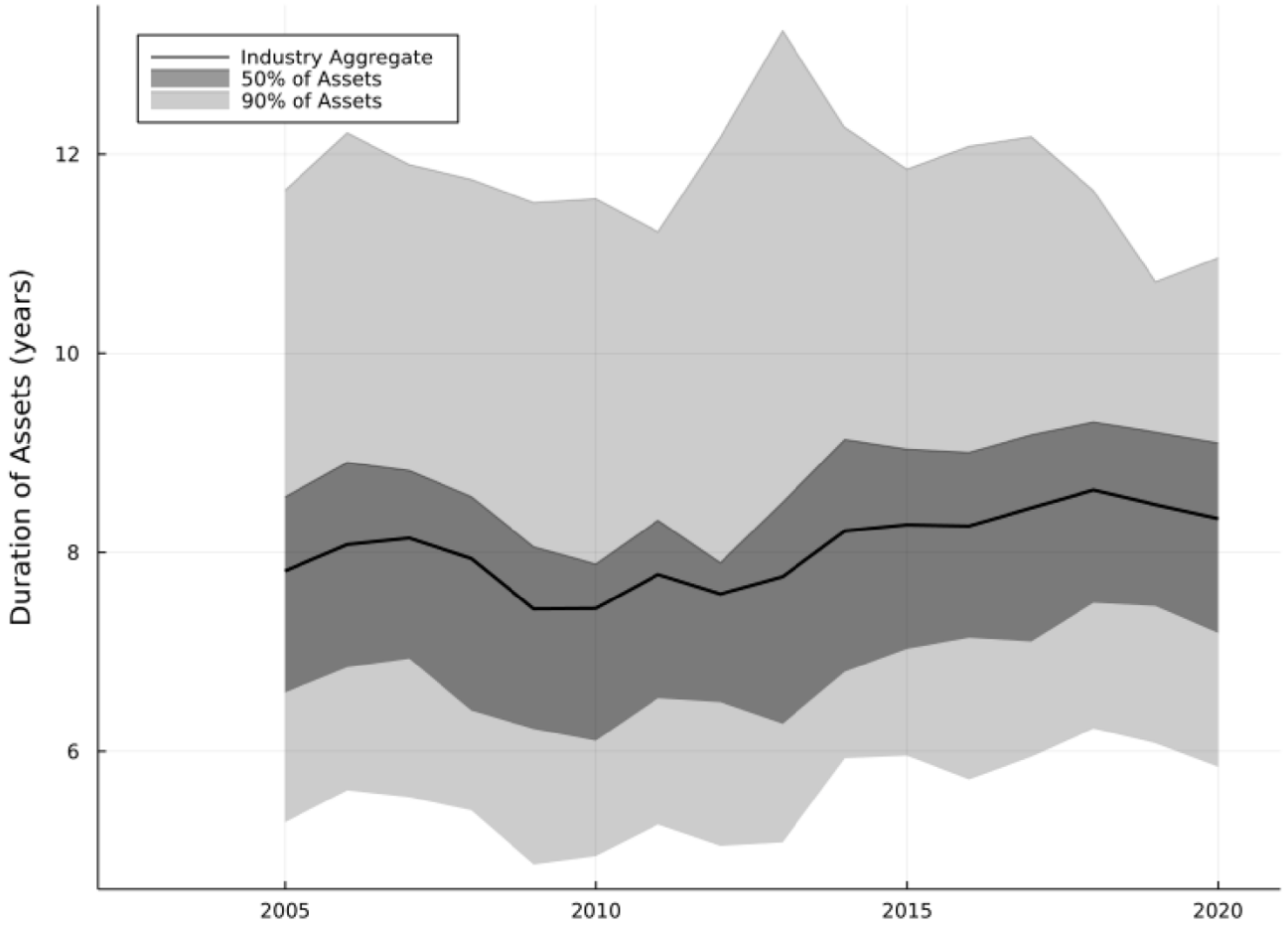

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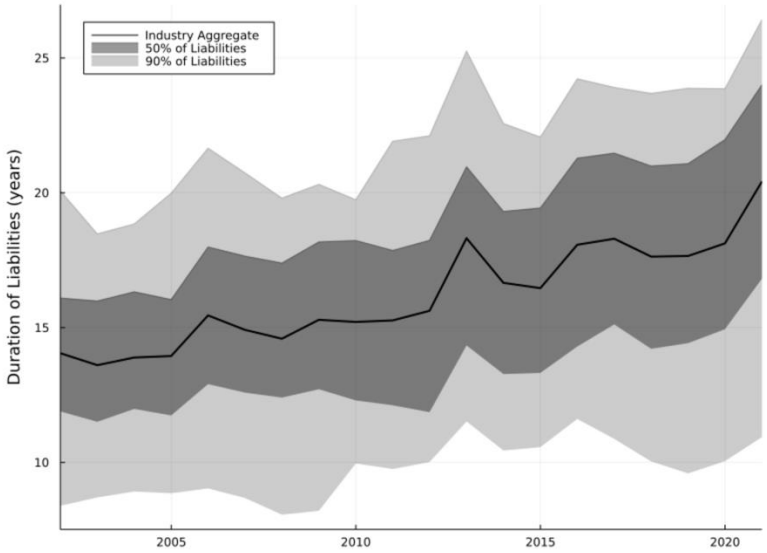

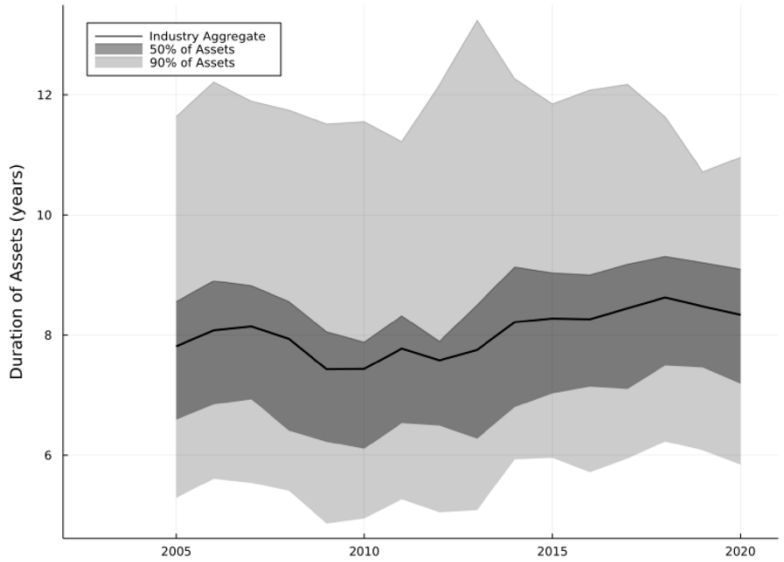

In the context of duration calculation, one can use information on coupon, maturity, and price to back out the duration. But this is not the case for climate betas.

Some practical routes to getting a security-level climate β:

- Map each CUSIP's 4-digit NAICS to the paper's traded-equity industry β.
  - Or adjust at the security level: $\beta_i = \beta_{industry} \times Carbon\_intensity_i$
- Asset-specific return regression
  - Asset returns or issuer equity returns

Point 2. Benchmarking to Regulatory Disclosures

NAIC Climate-Conditioned PML

Starting with YE2024 RBC filing, companies need to provide **climate-conditioned probable maximum loss (PML)** for YE24, YE25, ad YE26 filings

- Run the same catastrophe models under a forward-looking climate scenario and report the PMLs as extra “information-only” tables

Climate Conditioned PMLs – scenario assumptions

Book of Business	Year-end in-force at year-end as used for Baseline PML
Reinsurance Structure	As used for Baseline PML
Business Assumptions	No adjustment for exposure inflation and/or management actions
Perils in Scope	Hurricane and wildfire
Climate Conditioned View Methodology	Companies can use either a time-based approach or a frequency-based approach
PML threshold levels/Return Periods	50yr, 100yr, 250yr, 500yr, 1000yr

NAIC Climate-Conditioned PML

Stylized Example (Time-based Approach)

Start with a baseline PML from a traditional catastrophe model

- Use standard historical hazard catalog to simulate 100,000 hurricane years.
- Calculate 1-in-100 year gross loss: Baseline PML = $1.2 billion

Select RCP 4.5 scenario, 2050 projection and adjust hazard parameters

- Increased sea surface temperature ⇒ Higher hurricane intensity
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Run simulation under the new scenario ⇒. Climate PML = $1.8 billion

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Comparison to the Current Regulatory Metric

1. PML tells regulators how big the insured-loss tail could become; CRISK shows how fast equity capital evaporates when markets price that risk
2. PML is silent on transition risk and on valuation channels; CRISK brings both into one capital metric

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Suggestion 2. Highlight how the climate betas from the authors complement the current regulatory approach

Final Thoughts

- Important paper with nice methodological contribution
  - This is a paper that had to be written, and I'm glad that this team did
  - Currently R&R at RFS (and deservedly so!)

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- **Good luck with the revision!**