

Measuring the Climate Risk Exposure of Insurers

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- ▶ Changes in climate conditions may adversely impact the **accuracy of the modelling tools** that we use to estimate our exposures to catastrophe events.
- ▶ **our loss exposure, pricing and reinsurance risks might be impacted by climate change.**

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- ▶ With frequency and severity of weather-related events on the rise, insurers have been impacted severely by related losses,
- ▶ and pricing based on past experience remains challenging as catastrophe models have not yet fully considered the new normal.
- ▶ Because of this and other considerations such as reserving and reinsurance, AM Best also views the industry as having **low readiness to the complex challenges climate change presents.**

Motivation

An important question for regulators and consumers:

How does climate change affect the financial stability of insurance companies?

Insurance companies can be exposed to climate risk:

- ▶ Physical risk can affect insurers' operations
- ▶ Transition risk can affect insurers' investments, e.g., in the fossil fuel industry, as economies shift to greener alternatives, causing prices for fossil fuel bonds to fall

Empirical Challenges

1. Analyses based on past climate events may not capture the change in the risk.
 - ▶ Our methodology is **market-based**, to incorporate changes in the market's expectations.
2. Climate risk & how insurers respond to the risk change over time.
 - ▶ We estimate a **dynamic model**, allowing variations over time.
3. Data gaps and timeliness.
 - ▶ Our methodology only requires **publicly available market data**. Using market returns allows for constructing plausible and sufficiently severe scenarios.
 - ▶ We estimate our model on a **daily** basis, allowing for a timely examination.

This Paper

- ▶ We use a **market-based approach** to measure insurers' exposure to climate risk.
 1. Construct **physical climate risk factor** (portfolio) using P&C insurers' stocks
 2. Construct **transition climate risk factor** (portfolio) using brown firms' stocks
 - ▶ Factors (portfolios) should ↓ when perceived climate risk ↑
 3. Estimate insurers' stock return sensitivities to these factors (beta)
 4. Compute insurers' expected capital shortfall in a climate stress scenario

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Physical Climate Risk Factors

Physical Climate Risk Factor

We construct a portfolio of P&C insurance company stocks designed to decrease in value as physical risk escalates.

- ▶ Form a portfolio of P&C insurers, with larger weights for insurers in riskier states
- ▶ Insurers in riskier states have a larger weight.

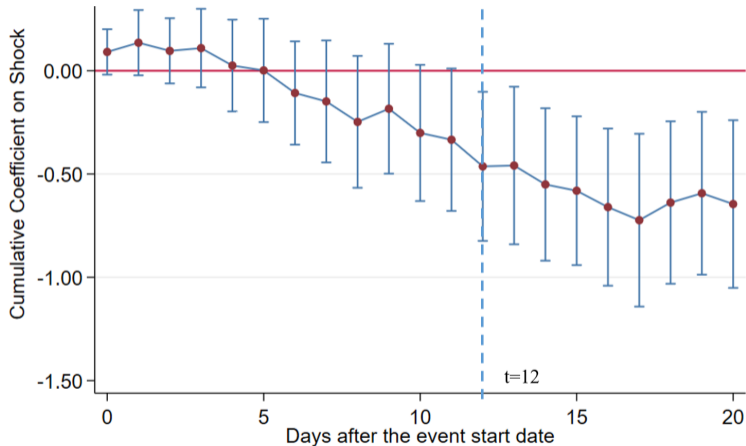
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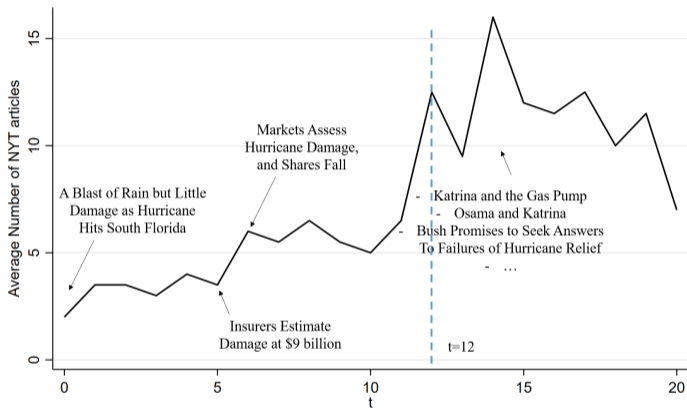
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$$Weight_{i,t} = \sum_s \left[\underbrace{\left(\frac{Premium_{i,s,t-1}}{\sum_s Premium_{i,s,t-1}} \right)}_{\text{Exposure to state } s} \times \underbrace{Property\ Damage_{s,t-1}}_{\text{Riskiness of state } s} \right] \times \frac{1}{MarketSize_{i,t-1}}$$

Physical Risk Factor's Response to Natural Disasters

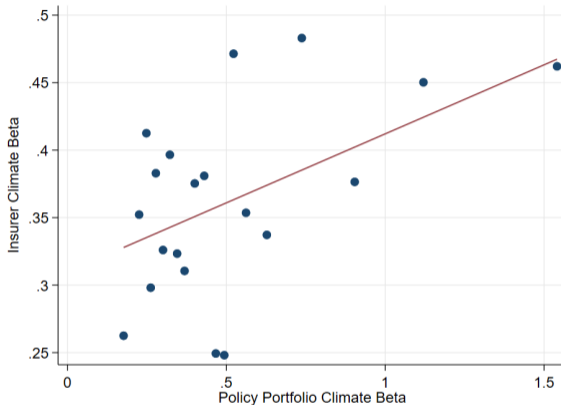


New York Times Articles Following Natural Disasters



- ▶ News articles respond to natural disasters with a few days of delay.
- ▶ Natural disasters' impacts are often not immediately clear.

Validation against P&C Insurers' Operations



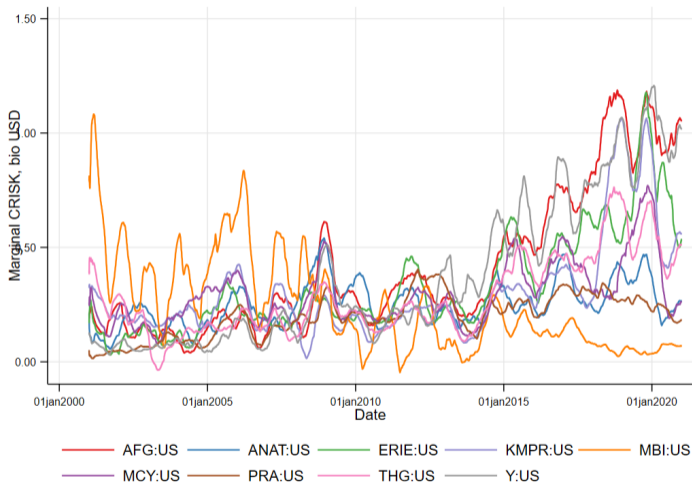
- ▶ Horizontal: based on insurers' operations in each state and states' muni bonds' sensitivity to our physical risk portfolio
- ▶ Vertical: insurers' sensitivity to physical risk factor

CRISK–Capital Shortfall under Climate Stress Scenario

$$\begin{aligned} CRISK_{it} &= E_t[\text{Capital Shortfall}_i \mid \text{Climate Stress}] \\ &= E_t [k(D_{it} + W_{it}) - W_{it} \mid \text{Climate Stress}] \\ &= kD_{it} - (1 - k) \underbrace{(1 - LRMES_{it})}_{=\exp(\beta_{it}^{Climate} \log(1-\theta))} W_{it} \end{aligned}$$

- ▶ D : Book value of debt
- ▶ W : Market capitalization
- ▶ LRMES: Expected equity loss conditional on the climate stress
- ▶ Prudential level of equity relative to assets $k = 0.08$ ($k = 0.055$ for Europe)
- ▶ Climate stress level $\theta = 0.2$
 - ▶ **1 percentile of 6-month return on the physical climate factor**

Physical CRISK–Capital Shortfall under Climate Stress



Small insurers face larger and increased physical risk

Life Insurers' Transition Risk Exposure

Transition Climate Risk Factor

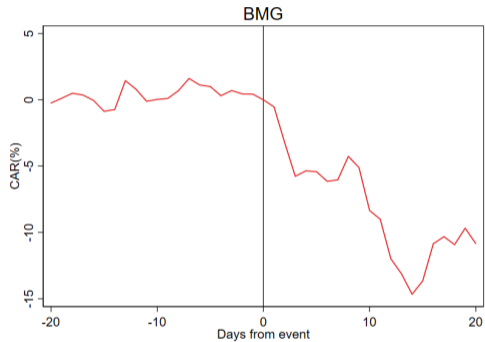
We use transition risk factors designed to decrease in value as transition risk escalates. (Jung, Engle, and Berner, 2021)

- ▶ Stranded Asset Factor (Litterman):

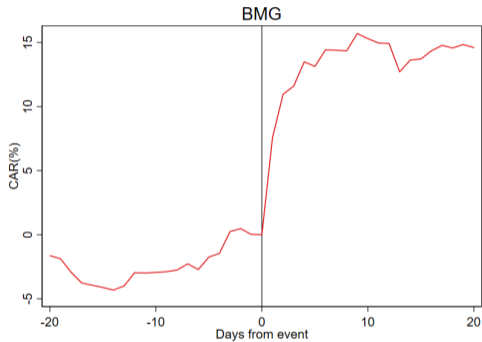
- ▶ $0.3 \cdot \text{Energy ETF} + 0.7 \cdot \text{Coal ETF} - \text{S\&P 500 ETF}$

- ▶ Brown minus Green Factor: Emission Factor - Clean Energy ETF

Transition Risk Factor Responses around Events



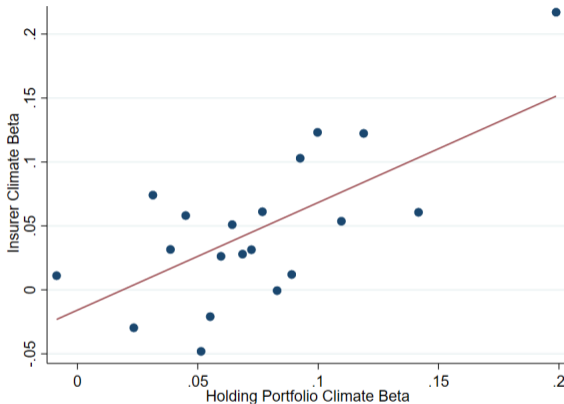
Paris Agreement



Trump Election

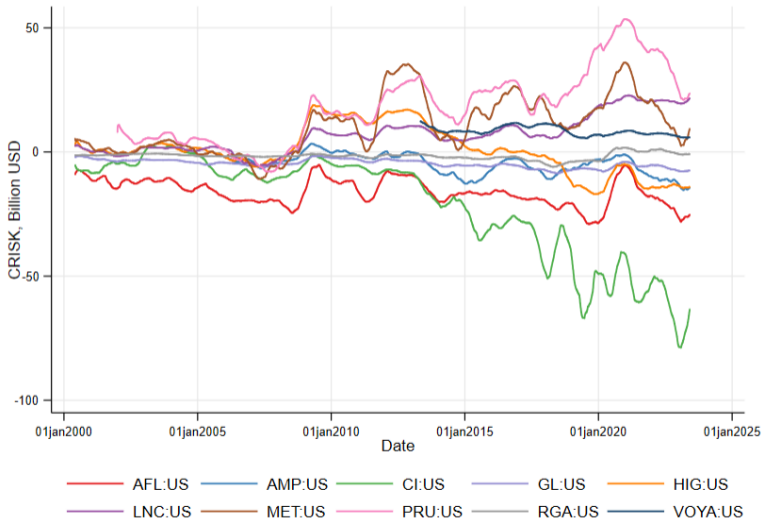
[Full Event Study](#)

Validation: Using Life Insurers' Corporate Bond Portfolio



- ▶ Horizontal: based on life insurers' asset holding
- ▶ Vertical: life insurers' sensitivity to our transition factor

Transition CRISK: Capital Shortfall Under Climate Stress



Related Work: How Does Insurance Affect Housing Market in a Changing Climate

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 - ▶ Update expectation of future premiums
 - ▶ Update perception of risk
- ▶ By aligning insurance with the actual risk, long-run climate risk can be better incorporated into home values today
- ▶ which can also discourage further development and migration in risky places