Measuring the Climate Risk Exposure of Insurers

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- **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.
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
Validation for the Methodology

- P&C insurers with greater operational exposure to risky states have higher physical climate sensitivity.
Validation for the Methodology

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- Life insurers with higher brown bond exposure have higher transition climate sensitivity.
Key Findings

- P&C Insurers’ Physical Risk Exposure
  - Smaller insurers face greater & increased physical risk
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- Aggregate life insurers’ expected capital shortfall increased by over $70 billion (13% market cap)
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Physical Climate Risk Factors
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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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\[
\text{Weight}_{i,t} = \sum_s \left[ \frac{\text{Premium}_{i,s,t-1}}{\sum_s \text{Premium}_{i,s,t-1}} \right] \times \frac{\text{Property Damage}_{s,t-1}}{\text{Riskiness of state } s} \times \frac{1}{\text{MarketSize}_{i,t-1}}
\]
Physical Risk Factor’s Response to 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

\[ CRISK_{it} = E_t[\text{Capital Shortfall}_i \mid \text{Climate Stress}] \]
\[ = E_t [k(D_{it} + W_{it}) - W_{it} \mid \text{Climate Stress}] \]
\[ = kD_{it} - (1 - k) \left(1 - \text{LRMES}_{it}\right) W_{it} \]
\[ = \exp\left(\beta_{Climate}^{it} \log(1 - \theta)\right) \]

- **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):
  - $0.3 \cdot Energy\ ETF + 0.7 \cdot Coal\ ETF - S&P\ 500\ ETF$

- 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

- Study flood insurance rate reform that ↑ insurance rate for some homes
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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.
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