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Risk Analysis of Catastrophe Bonds from the Perspective of Investors

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Scientific Assessment of Catastrophe Bonds

- Scientific assessment of catastrophe bonds as investments:
  - New asset class; "Pure Play" in insurance risk
  - Almost no correlation with ordinary asset classes
    $\rightarrow$ Possibility to shift portfolios' efficient frontier upwards
  - Special risk-return-characteristic
    - High returns for investors despite being "zero-beta" assets
    - Outperformance of Treasury bills and equally rated corporate bonds

"The historical evidence suggests the addition of cat exposures to investment portfolios is equivalent to a free lunch for investors and insurance consumers alike." Froot et al. (1995)

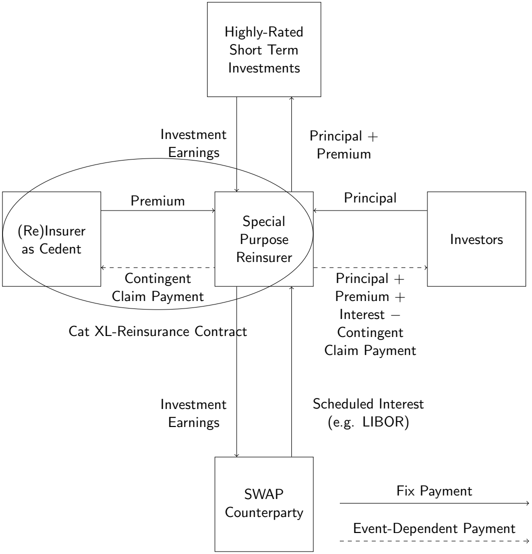
Warren Buffett Predicted in his 1997 Chairman's Letter:

"Catastrophe bonds may well live up to their name!"

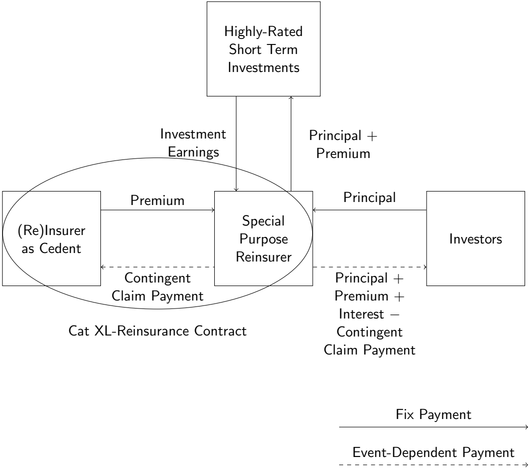
- The word "bond" is an Orwellian misnomer.
- Truly outsized risks will exist in these contracts if they are not properly priced. Mispricing may remain undiscovered for a very long time.
- Risk assessment of natural catastrophes is fuzzy.

→ Goal of Presentation: Investors have to be aware of risks and characteristics of catastrophe bonds

Traditional Risk Securitization Structure



Risk Securitization Structure after Lehman Brothers (†)



Investors' Situation at a first Glance

- Highly tailored investment products
- Classical insurer risks connected with holding catastrophe bonds:
  - Acceptance of a fix premium upfront for the coverage of an uncertain loss amount later
    $\rightarrow$ Investors bear underwriting risk
  - Investment of premium and principal
    $\rightarrow$ Investors bear investment risk (market, credit, liquidation value risk)
- Investment risk by embedded options (e.g. optional extension periods, call options)
- Investment risk by overestimating outperformance and underestimating correlation

Underwriting Risk of Catastrophe Bond Investors

- The underwriting risk of catastrophe bond investors consists of the uncertainty whether the calculated premium is enough to cover the upcoming claims expenditures.
- Investors' underwriting risk is specified by
  - errors in the risk assessment before investing,
  - changes in the risk's behaviour,
  - and the random character of insurance events during the holding period

  in the context of low frequency-high severity risks.

Insuring Low Frequency-High Severity Risks

- High uncertainty (epistemic and aleatory) in the assessment and prognosis of catastrophe risks
  $\rightarrow$ Caution with the results of catastrophe models
  $\rightarrow$ Possible risk assessment in favor of cedents
- Appearing misestimations may cause price adjustments
- Excess-of-loss contracts as instruments to transfer the risk of high random deviations

$\Rightarrow$ In summary, catastrophe bond investors carry the risk of a pure accidental, catastrophic, and difficult to assess reinsurance claim. This exceeds their premium by far and happens coincidentally in their holding period.

Outperformance and Correlation I

- Briys et al. (1998):
  - Standard deviation as inadequate risk measure for highly-skewed return distributions
  - Past performance of highly-non stationary investments as inappropriate estimator for the future one
  - Catastrophe bonds have a relatively high interest rate sensitivity
- Blum et al. (2002) argue that the joint distribution of insurance and financial risks is unlikely to be elliptical

  → Linear correlation coefficient is inappropriate to model dependency. Underestimates dependency in extreme scenarios

  → Classical portfolio theory is generally not suitable to justify the usefulness of ILSs for investors

Outperformance and Correlation II

- Diekmann (2011) shows a significant correlation between catastrophe bond returns, consumption rates, and traditional asset classes
  $\rightarrow$ diversification effect present but limited
  $\rightarrow$ catastrophes could bring investors to their subsistence level
- Gürtler et al. (2012) discover a positive dependency between coporate credit spreads and catastrophe bond premiums. This dependency rises significantly in extreme market conditions.

$\rightarrow$ Assumptions about outperformance and diversifying effect ("zero-beta" asset) have to be interpreted with care.

Catastrophe Bond Investors' Wealth Process

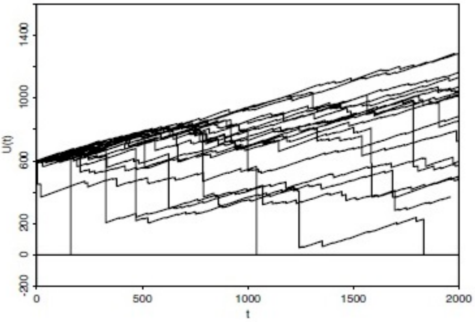
- The classical risk reserve process $(U(t))_{t\geq 0}$ is defined as

$$U(t) = u + ct - \sum_{i=1}^{N(t)} X_i, \quad t \geq 0,$$

  where $u \geq 0$ stands for the initial capital of an insurance company, $c > 0$ for its premium income rate, and $\sum_{i=1}^{N(t)} X_i$, as a compound Poisson process, for the insurer's random aggregate claim amount of the single claims $X_1 + \cdots + X_{N(t)}$ up to time t.
- Redefining $(U(t))_{t\geq 0}$ as wealth process for catastrophe bond investors
- Subexponential distributions (e.g. log-normal and Pareto) for modeling heavy-tailed risks

Characteristics of Investors' Wealth Process

- Assume the claims X_i to be subexponentially distributed. Then the wealth process of catastrophe bond investors has following characteristics:
  - Comparable high probability for a total loss
  - Total loss by one extreme event
  - Extreme events happen "out of the blue"



Conclusion

- Individually tailored investments
- High underwriting risk and uncertainty in the correct premium
- Investment risks and interest rate sensitivity
- Highly-skewed return distribution
- Key for successfully long-term investing is the ability to estimate fair premiums

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