Non-Diversification Traps in Catastrophe Insurance Markets

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The Common Failure of Private Markets for Catastrophe Insurance

- Most private markets for catastrophe insurance have recently failed, line by line, country by country.
  - "Imperfect capital markets" are generally considered the core problem (Jaffee and Russell 1997, Cummins 2005).
  - But most theoretical models imply high premiums, not a near-zero supply of private coverage.

- Governments are increasingly called on to fill the gap.
  - Understanding the basis for the market failure would help determine if and how governments should provide catastrophe coverage and reinsurance.

Reinsurance Markets Also Fail

- Reinsurers also often withdraw from the cat lines, even when capital capacity exists (Cummins, Doherty, and Lo 2002).
- When reinsurance is available, it is often used to cover the "smaller" risks, contrary to theory (Froot etal. 1993, Froot 2001).
- Insurers and reinsurers alike enthusiastically support government backstops to the cat lines, even when the fiscal subsidy actually appears to be low (TRIA).

Non-Diversification Traps as an Alternative Explanation

- We develop a multiple equilibrium model, in which:
  - Diversification equilibria may occur, in which insurers offer catastrophe coverage and reinsure their risks.
  - Non-diversification equilibria may occur, in which there is no insurance or reinsurance activity for cat risks.
- A coordination problem must be solved to shift from the bad to the good equilibrium.
  - Government requirements to offer insurance may actually work to solve the coordination problem.
  - Or the solution may be well functioning capital markets (such that insurers are owned by large numbers of small equity holders, who in turn hold diversified portfolios.)

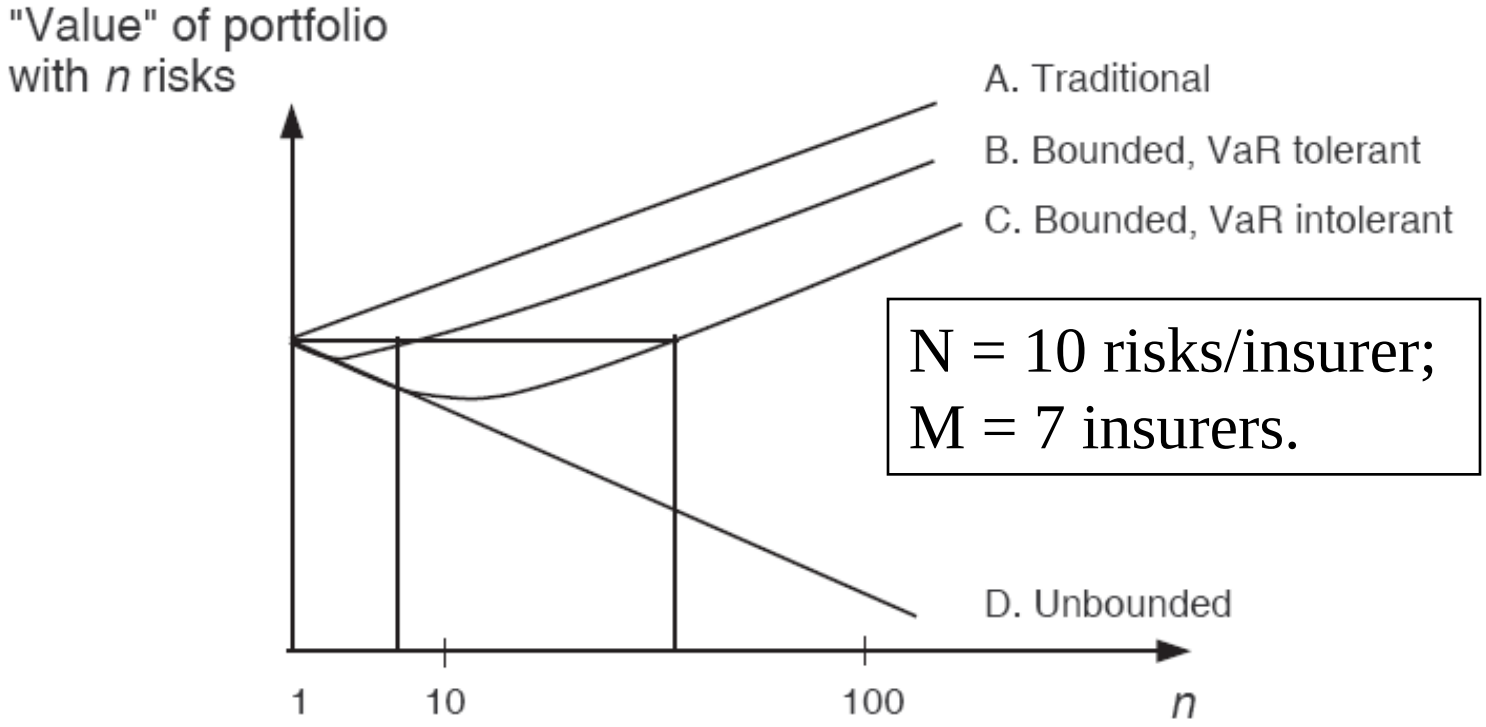
Power Laws Govern Sizes of Catastrophic Events

- Energy release from earthquakes, $\alpha \sim (0.8,1.2)$
- Loss distribution from earthquakes, $\alpha \sim (0.6, 1.5)$
- Energy impact of extra-terrestrial impacts, $\alpha \sim 0.86$
- Size of landslides, $\alpha \sim (1.2,1.4)$
- Area covered by river floods, $\alpha \sim 0.43$
- Hurricane loss distribution, $\alpha \sim (1.56,2.49)$

Our Mechanism for Non-Diversification Traps

- A non-diversification equilibrium requires that diversification be suboptimal for each insurer.
  - When finite moments exist for the loss distribution, diversification is optimal (Samuelson 1967).
  - Parameter uncertainty is also unlikely to upset the traditional result (Froot and Posner 2002).
- We focus on heavy left-tailed distributions:
  - Diversification may be inferior in this case for any number of risks (Ibragimov 2004 and 2005).
  - Diversification may remain suboptimal with limited liability up to a fixed number of risks (Ibragimov and Walden 2005).

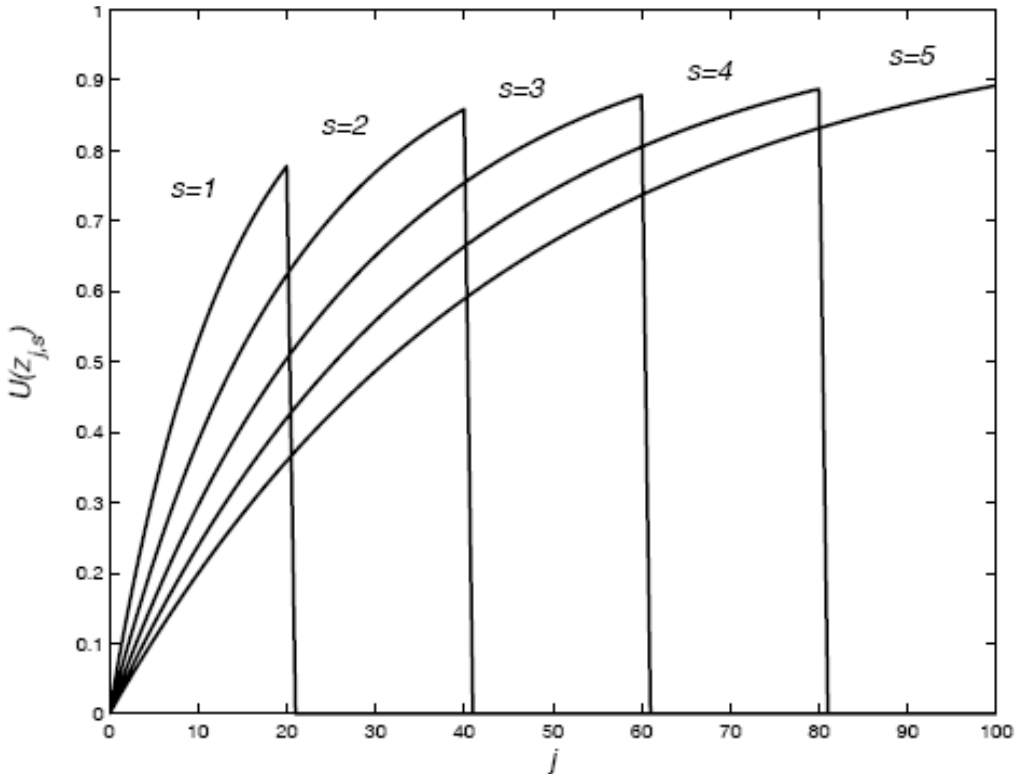
Individual Non-diversification Corners vs. Insurer and Reinsurer Equilibrium



N = 10 risks/insurer;
M = 7 insurers.

A. Traditional diversification pays. B-C: Bounded heavy-tailed distributions (Ibragimov and Walden 2005). D: Unbounded heavy-tailed distributions (Ibragimov 2004). Example with Lévy Distribution.

First Example: Full Risk Pooling with Normally Distributed Risks



Assume:

$1 \leq s \leq M$ (=5) insurers

N (= 20) risks/insurer

$1 \leq j \leq Ns$ total risks

X_i Normal (μ, σ^2)

CARA utility

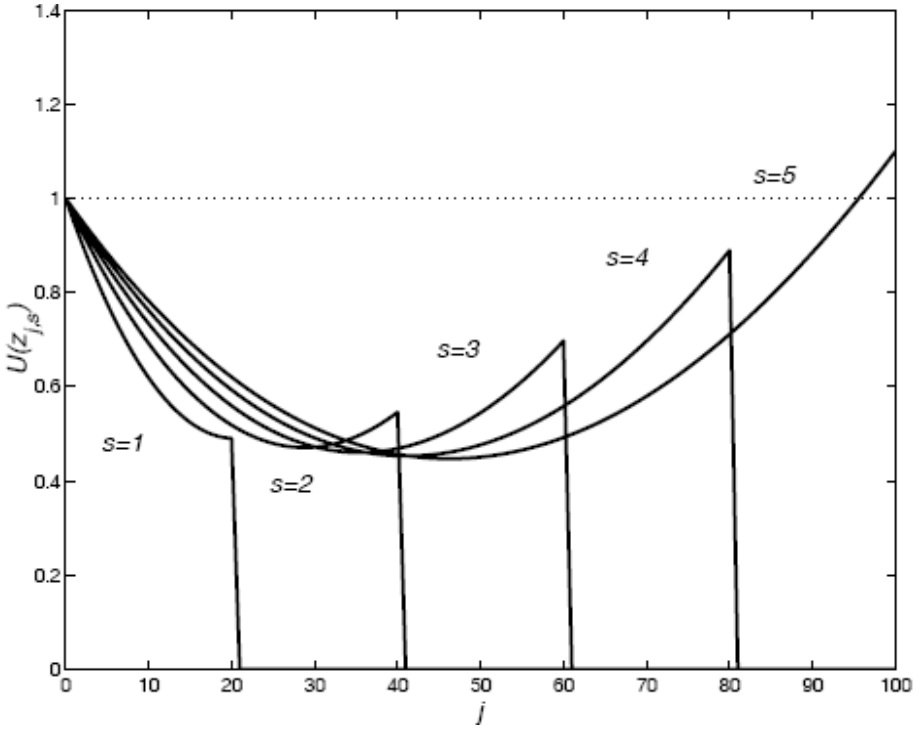
Unlimited liability

Results:

If M-1 insurers are pooling, so will M^{th}.

If no insurers pool, each still has N risks.

Second Example: Bernoulli-Cauchy Distribution with Limited Liability



Assume:
Limited liability: maximum loss (k = 80);

M = 5 insurers;
N (= 20) max risks/insurer;
$u(x) = (x + k)^{3/4}$

Results:
If insurers can coordinate, they can reach MN =100 reinsurance equilibrium.

But if not, each insurer reverts to the N = 0 corner.

Two-Stage Diversification Game: Assumptions

- Stage 1 Assumptions
  - There are at least M = 2 insurers;
  - Each insurer can take on up to N i.i.d. risks;
  - Insurers have limited liability up to *k* losses, $k \in (0,\infty]$;
  - Insurers have identical expected utility (risk averse);
  - Insurers taking on risks can also reinsure (pool risks).
- Stage 2 Assumptions
  - All insurers know the Stage 1 decisions;
  - Insurers with no Stage 1 risks can still join reinsurance.
- The 2 Stages represent the coordination problem.

Two-Stage Diversification Game: Equilibrium Classifications

- A diversification equilibrium is an equilibrium in which insurance against all risks in X is offered, i.e., N = NM.
- A diversification equilibrium is risk sharing if all risk insured is pooled in the reinsurance market.
- A non-diversification equilibrium is an equilibrium, in which no insurance against risk is offered, i.e., N = 0.
- A non-diversification trap exists if both a non-diversification and a risk sharing diversification equilibria exist.
- A genuine non-diversification trap requires there exist a M_0, such that for all $M \geq M_0$, there is still a non-diversification trap.

Results

- Absence of non-diversification traps:
  - Example 1 assumptions => no non-diversification trap.
  - Mean-variance model =>no non-diversification trap.
  - 2nd moment finite, no limited liability => no genuine non-diversification traps.
- Existence of non-diversification traps:
  - Example 2 assumptions => genuine diversification trap.
  - Genuine non-diversification traps can occur only with heavy tails (infinite 2nd moments) and limited liability.
  - Model also allows for “globally uninsurable” risks (Cummins 2005).

Concluding Comments

- Catastrophic risks have many features favorable to the provision of insurance:
  - Generally independent over risk types and geography;
  - Few issues of asymmetric information at the risk level.
  - So a complete failure of these markets is puzzling.
- We have shown that market failures (non-diversification traps) may arise when risks are heavy-tailed and there is limited liability.
  - Diversification may not be beneficial for the single insurer, although a full reinsurance equilibrium may exist.
  - Government programs (or diversified equity owners) may allow the system to reach the full diversification outcome.