

### ***Managing and Financing Extreme Risks*** \* (Formerly known as *Managing Catastrophic Risks*)

A Research Program of Wharton's Financial Institutions Center *and*  
Risk Management and Decision Processes Center.

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The Wharton *Managing Catastrophic Risks* research project and industry forum held its May 2001 meeting in Philadelphia on May 10th and 11th. The meeting opened with a dinner on the evening of the 10<sup>th</sup>. Scott Belden, Chief Risk Officer of Traveler's Insurance Company, gave a thought provoking talk on the Financial Implications of the New Madrid Fault. It was his contention that despite all the modeling results available, the insurance industry in general, and underwriters in particular, are really unable to price insurance for this hazard in any plausible manner that relates to the market as it is actually constituted. As a consequence, sales practices essentially ignore this hazard, with agents (and thereby their companies) betting by default that a New Madrid "event" will not occur during their careers. This conceptualization provoked a lively discussion of the CAT markets in general and provided an appropriate departure point for the research presentations the next day.

The formal meeting on the 11<sup>th</sup> featured research updates from all of the project's research programs, plus a description of the joint conference held with the World Bank. The day ended with a general discussion on potential directions for future research. What follows is a "snapshot" summary of the day's discussions, highlighting key elements of the presentations.

**New Data and Results for the Supply and Demand Study of the New York and Florida Insurance Markets**

***Paul Kleindorfer, Universal Furniture Professor of Decision Sciences and Economics, Wharton School***

***Martin Grace, Professor of Risk Management, Georgia State University.***

Paul Kleindorfer started the session off with an update of the analysis of the Florida Homeowners Policy data and went on to describe how this analysis was being extended using Dwelling/Fire Extended Coverage (DFEC) data. He also described the plan for a report to be issued jointly with the Insurance Services Offices Inc. (ISO), which has supported the acquisition and analysis of the data underlying this study.

Dr. Kleindorfer's discussion of the Florida Homeowners study began with a description of the practices and interactions between the multiple agents operating in the catastrophe insurance markets (i.e. the reinsurance and insurance industry, financial institutions, insurance regulators, other legal and political institutions, the construction industry and real estate sector, and finally, the homeowners and businesses themselves with lives and property at risk). He then explained the data elements supplied by ISO and the questions addressed by the homeowners study. The two key questions being addressed in this study are:

- What factors affect the demand and supply of catastrophe coverages via various policy types?
- What price/premium structures exist in the homeowners market?

To address these questions, Kleindorfer, Grace and Robert Klein (GKK) have constructed a series of premium and price equations that model supply and demand. In doing so they make the assumptions that the quantity demanded is measured by the ISO indicated loss cost and that the price is measured by the percentage premium mark-up over this indicated loss cost. The GKK model estimates both the CAT related and non-CAT related demand.

There were four findings presented from the homeowners analysis of the Florida data.

1. The HO3 and HO3-5 markets are indeed somewhat different in character.

2. Catastrophic coverage exhibits negative income elasticity and therefore can be considered an inferior good
3. Non-Catastrophic coverage is a normal good .
4. The bundled demand (including both catastrophe and non-catastrophe coverage) for homeowners insurance is a normal good but not strongly so.

The Florida dwelling and fire analysis is not as far along as the Homeowners study, but preliminary analysis of this data for Florida yields two basic findings:

1. The homeowners and dwelling and fire markets are indeed somewhat different, with DFEC demand being the slightly more elastic of the two. Furthermore, the impact of policy features on demand/affordability is somewhat different for each.
2. Neither the CAT nor the non-CAT coverage is income sensitive in the DFEC market (although the selection of DFEC policies rather than homeowners bundled policies may be income sensitive).

Finally, the report to be issued jointly with ISO in the early fall of 2001 was described. The report will be based on the previous three years of research supported by the Project and will feature sections on policy bundling strategies, pricing strategies, exposure management, mitigation, and regulation. It is the authors intention that the findings in this report be used as a source for improving the efficiency and sustainability of the market.

### **Results from the Model Cities/Mitigation Study**

**Howard Kunreuther, Cecilia Yen Koo Professor of Decision Sciences and Public Policy, Wharton School**

This session focused on the book now being written with our research partners Applied Insurance Research, EQE International, and Risk Management Solutions Inc. This book has several objectives:

1. To explicitly address uncertainty in the context of formal risk assessment models;
2. To bring together the collective wisdom of the three leading firms in this area (AIR, EQE, RMS) on how best to link science with policy;
3. To illustrate how uncertainty is to be addressed when constructing loss-exceedance probability curves;
4. To illustrate the linkage between risk assessment and risk management using concrete examples from Oakland CA, Long Beach CA, and Miami/Dade County FL;

In addition, it is the authors intention that the sophisticated risk managers who, will be the readers of this book, will gain greater understanding of:

- How insurers and other firms can bear risk against events that generate large losses;
- The role that uncertainty plays in estimating losses from natural disasters;
- How a firm can transfer portions of their risk to others through either indemnity or index-based contracts;
- What impact specific loss reduction measures have on the ability of a company to bear risk and their need to utilize risk-transfer contracts.

Kunreuther was very pleased to announce that the Casualty Actuary Society has offered to help edit this book and will consider adding portions of it to its exam preparation list.

**New Results and Implications from the Basis Risk Study**

*David Cummins, Harry J. Loman Professor of Insurance and Risk Management, Wharton School*

In this session David Cummins presented a paper ( Allocation of Capital in the Insurance Industry ) that he delivered with David Lalonde (Applied Insurance Research) and Richard Phillips (Georgia State University) at the NBER Insurance Project meeting in February. This paper is available for download at <http://papers.ssrn.com/paper.taf> (Abstract ID 230044).

The objective of this study was to measure the potential effectiveness of traded CAT loss derivatives in hedging the risk of catastrophic property loss for individual insurers. In particular, the study focused on derivatives where payoffs depend on industry losses or event characteristics rather than the losses of a specific insurer. Importantly for this study, insurers were assumed to be risk neutral but motivated to hedge by market frictions such as the direct and indirect costs of financial distress, and convex tax schedules.

The study proceeded through the following stages:

1. Construction of a database of insurer exposures (255 of the 264 insurers operating in Florida in 1998);
2. Simulation of 10,000 years of loss experience using the A.I.R. Windstorm Model;
3. Measure against this simulated loss experience basis risk and hedge effectiveness for several hedging strategies and indices;
4. Test hypotheses about insurer characteristics associated with hedging effectiveness;
5. Develop a parametric index that unlinks option payoffs from monetary losses reported by insurers.

Cummins began by explaining rational-option spread (layer) contracts that have

dominated practices up until the present time. Examples include:

- Excess of loss reinsurance
- CBOT call spreads
- CAT bonds
- Pareto optimal contracts that include a deductible when insurance is costly

These strategies hedge an insurer's loss distribution using a layer of insurance that minimizes objective criteria subject to a cost constraint. This study compared the ability of index-linked contracts to replicate the risk reduction of a similarly constructed insurer specific contract. Several choices of index were examined, a perfect hedge (i.e. a company's losses), industry losses over a defined geographic area (such as a statewide or intra-state regional area), and parametric indexes (such as those based on the Richter Scale, the Saffir-Simpson Scale, or a Regression Model).

The hedging objectives examined for each of these indices were reductions in Variance of Net Loss (Volatility), Value at Risk (VAR) at a given probability level, and the Expected Exceedence Value (i.e. the expected value of loss above the VAR).

A large number of curves describing the efficiencies of the various combinations of objective and hedges were described and explained in detail by Cummins. At the end of this discussion he drew a series of conclusions from this analysis. They were:

- Most insurers in the three quartiles can hedge effectively using regional (intra-state) index options.
- A liquid market in Florida CAT options based on regional contracts is a possibility because there is sufficient exposure in the state to support an options market with only four contracts.
- Only large and well-diversified insurers can hedge effectively using statewide contracts.

- A high proportion of the exposures in a state can be hedged effectively using either statewide or regional contracts.
- Conditional hedging (conducted on industry losses exceeding a threshold) is somewhat less effective than Unconditional hedging (conducted over the entire CAT loss distribution).
- Small insurers can use index-linked contracts, but their distribution of exposures must be carefully managed.
- The development of a parametric index would be worth pursuing.

Cummins concluded his session by announcing that the next phase of this project would be a comparison between Florida and New York.

#### **New Areas of Research in the Financing and Management of Extreme Risks** **Neil Doherty, Ronald A. Rosenfeld Professor of Insurance and Risk Management, Wharton School**

This talk focused on risk in the tail of the loss distribution (tail risk) and examined the joint nature of risk and capital management in addressing this risk. The starting point of the analysis is a summary of the mechanisms by which tail risk compromises firm value. This risk can destroy value in insurance firms as it can in firms producing other goods and services. The mechanisms by which tail risk affects value center on the costs of financial distress, including the transaction costs of actual distress and the impact of prospective distress on insurance demand and upon moral hazard. Since these costs can be mitigated either by controlling risk or by controlling the insurer's capital structure, these two strategies become interchangeable.

The rest of the talk addressed the following questions

- How much capital do insurers need?
- How to measure risk capital?
- What is the hurdle rate of return?

- How to allocate capital across divisions and lines of business?

The question of how much capital was discussed in general terms but there is little concrete research on this issue. Some research possibilities were discussed. On the question of how to measure risk capital, applications of the Merton and Perold analysis to the insurance business were presented. This analysis shows how the cost of providing shareholder guarantees, the cost of reinsurance, the cost of asset insurance, as well as the price sensitivity of policies to default risk, all should be accounted for in measuring risk capital.

Doherty also discussed the two recent capital allocation models by Merton and Perold and by Myers and Read, and presented illustrations showing how capital could be allocated in terms of its marginal impact on the default value of the firm. The main point of these illustrations was to show that, in general, models which allocate 100% of capital across business lines will lead to incorrect capital budgeting decisions. For example, if models allocate all capital, the capital charge allocated to each business line or activity will fail to account for the benefits of diversification. New projects will face a hurdle rate that is too high and some projects which will add value to the firm would be rejected.

Thus, models which provide the correct information for divisional resource allocation do not allocate all of the firm's capital. Strictly, only when there is an infinite number of business lines, should all capital be allocated. However, approximation models with full application of capital can be used when capital is allocated over a large number of uses; e.g. in pricing the capital use on individual policies within a very large portfolio.

The remaining question addressed related to the cost of capital for insurers and how this is affected by in firm risk. Doherty discussed the two models commonly used for

reflecting risk in the cost of capital, the Capital Asset Pricing Model and its derivatives (CAPM), and the Risk Adjusted Return on Capital (RAROC). The former model suggests that only *undiversifiable* risk is priced, whereas the latter adjusts the costs of capital for *total* firm risk. There is a debate over which of these two methods is correct. For example, many insurers reject the CAPM since, if betas are zero, there is a zero risk charge. On the other hand, a simple RAROC model ignores the evidence that total risk is not priced in the capital market. Doherty showed that the choice is not one of mutual exclusion. While the CAPM shows the impact of risk when filtered through to the capital market and therefore to investors, the RAROC can be used to adjust for the impact of frictional risk costs within the firm. Both mechanisms are important and a cost of capital method (based partly on a study by Doherty 1991) was presented which combined both.

### **Report on the January World Bank Conference and New Area of Research on International Matters**

***Howard Kunreuther and Paul Kleindorfer***

In January the project co-sponsored and co-organized a workshop with the World Bank and the ProVention consortium (an group of influential international agencies and corporations) entitled *Innovations in Managing Catastrophic Risks: How Can They Help the Poor?* The themes of this two-day conference held at the WorldBank Headquarters in Washington DC were:

- Mitigation strategies for reducing disaster risk;
- The role of insurance/reinsurance and the capital markets in managing catastrophic risks;
- Regulation and public-private partnerships;
- Reducing the vulnerability of the poor to natural disasters;

- New instruments for managing catastrophic risks.

Discussion focused on identifying the key features of an effective disaster strategy:

1. Identifying and appropriately characterizing the hazards and risks.
2. Reducing those risks that can be reduced either by avoiding the hazard or by building structures that can withstand hazard impact.
3. Transferring the risks that cannot be eliminated.

Mitigation and risk transfer instruments for hazards in emerging economies is an area that connects directly with the project's previous work and should prove to be a fruitful area of future research by the project in conjunction with the World Bank and other universities, notably Columbia and Princeton.

### **Directions of Future Research**

**David Cummins**

**Neil Doherty**

**Paul Kleindorfer**

**Howard Kunreuther**

A general discussion was held about the future direction for project research. Two broad themes of research have emerged from recent activities. One is the area of natural catastrophe risk and the modeling of losses, the predictive management of those losses, and the mitigation of such risk through a variety of policy tools. The other broad area relates to the financial management of low-probability-high-consequence risk as it relates to natural hazard and other events with catastrophic potential. Sovereignty risk, climatic change, industrial accidents, environmental incidents, and financial market events may have dramatic consequences for companies and their balance sheets; the potential of such events presents a continuing challenge for management and for research. With these new areas of research in mind, and knowing that the general term catastrophic risks is generally associated with that of

natural disasters such as earthquakes and hurricanes, it was therefore been decided to change the name of the project to Financing and Managing Extreme Risks. Future research will continue to focus on managing catastrophic risks arising from natural hazards. However, the Project will also build on the foundations developed in the past three years on insuring and managing catastrophic risks to explore related issues in risk management and finance of a more general character that may affect the solvency or earnings of firms in a significant way.

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