

Wharton

Managing Catastrophic Risks: A Research Program and Industry Forum

Wharton Risk Management and Decision Processes Center

Wharton Financial Institutions Center

The Wharton *Managing Catastrophic Risks* research program and industry forum held its Fall 1999 Advisory Group meeting in Philadelphia on December 13 and 14.

The meeting opened with a dinner on the evening of the 13th. Alcira Kreimer, Manager of the World Bank's Disaster Management Facility, provided the dinner presentation describing current international efforts to improve global natural disaster risk management. There are strong links between poverty and vulnerability to natural disasters. Currently, the majority of disaster related lending goes to recovery rather than prevention which, according to Ms. Kreimer, is not a financially stable policy over the long term. As such, the Bank is taking the position that disaster risk reduction must be made an integral part of sustainable development. To this end the World Bank is launching a consortium intended to mobilize global resources to enhance the developing world's capacity to reduce the impact of natural disasters and more effectively manage disaster risk.

The formal meeting on the 14th began with the welcoming of a new research sponsor to the group. Hiroaki Tsubokawa of the Property and Casualty Insurance Rating Organization of Japan briefly outlined the role of his organization and the critical importance of managing catastrophe risks both for the Japanese insurance industry and the nation as a whole.

Next, an outline of a possible World Bank - Wharton conference was discussed. Partnering with the World Bank for such an event offers the opportunity to incorporate a global perspective to the research initiatives at Wharton and broadens the impact of our findings from the US to the emerging economies.

The morning's research discussions began with a presentation of the work being done on uncertainty factors with our partners from the CAT modeling community. The presentation based on a combined analysis of the Charleston, SC region was followed by comments from a member of the Technical Advisory Committee.

A discussion of a new initiative on the structure of the CAT insurance markets followed. This multi-faceted project is examining supply and demand characteristics for CAT coverage and will also assess the impact of regulation on catastrophe insurance markets.

The afternoon sessions focused on financing issues related to the CAT markets. The first session dealt with a review of a paper prepared by the American Academy of Actuaries on index-based insurance derivatives. This was followed by a presentation by colleagues from Goldman Sachs & Co. on the current state of CAT securitization markets. The globalization and consolidation of the re-insurance markets served as the final afternoon research discussion.

The meeting closed with a moderated discussion of the program's research agenda for the coming year.

What follows is a "snapshot" summary of the day's discussions, highlighting key elements of the presentations.

Roles and Tentative Structure for a Possible Impact Conference to be Held in Conjunction with the World Bank in Fall 2000

Howard Kunreuther, Professor of Decision Sciences and Public Policy, Wharton School

The proposed conference schedule would encompass four topic areas:

- The role of technology and modeling in quantifying the risks associated with natural hazards.
- The potential for new financial instruments to supplement traditional insurance and reinsurance coverage.
- The potential for public-private partnerships in developing additional layers of financial protection.
- The role of mitigation in efficient hazard management strategies.

• Suggested non-Wharton participants for this conference would include:

- Sponsors of the *Managing Catastrophic Risks* program and other selected industry executives
- Member's of the World Bank's Natural Disaster Consortium.
- Scientific, and private and public sector experts on hazards in the US and emerging nations.

Reaction from the group was favorable. It was emphasized, however, that the first step would be to clearly identify the target audience for such a forum. Additional suggestions included: expanding the role of insurance in the proposed agenda, and adding the role that financial institutions play in hazard management in requiring collateral protection. It was agreed that these and other issues will be addressed in future discussions with Alcira Kreimer and her colleagues at the World Bank. In the

meantime, sponsors were encouraged to provide Howard Kunreuther or Peter Burns with further suggestions and recommendations for topics and speakers.

Partnering with the World Bank on the proposed Fall 2000 conference offers the opportunity to add a global perspective to the project's research focus.

Uncertainty in Modeling Catastrophic Risks: The Charleston Study

Howard Kunreuther, Professor of Decision Sciences and Public Policy, Wharton School

Patricia Grossi, Ph.D. Candidate, School of Engineering and Applied Science, U. of P.

Robert Whitman, Emeritus Professor of Engineering, MIT

Howard Kunreuther began by describing this unique effort to analyze risk estimates from a series of CAT models. Patricia Grossi then presented results of the probabilistic seismic hazard analysis of the Charleston, South Carolina region, jointly undertaken by Applied Insurance Research, EQE International, Risk Management Solutions Inc., and Wharton. Robert Whitman, a member of the project's Technical Advisory Committee, commented afterwards on the technical merits of this analysis.

The first goal of this project was to discover the range of difference between results generated by each of the three firms' software packages. While the exceedance probability (EP) curves generated were dissimilar across the three firms, this was to be expected given the degree of uncertainty in basic model inputs for the Charleston region. Importantly, the analysis determines the range in which losses will most likely fall.

The second goal was to generate EP curves using the public domain software, HAZUS. Because HAZUS is a public domain package, sensitivity analysis may be undertaken by anyone to test the assumptions inherent in the seismic hazard analysis; i.e. hazard characteristics (magnitude, duration, attenuation) and database contents (soil factors, structure occupancy mapping).

After outlining the characteristics of the Charleston region and the common assumptions of the modelers, Grossi described the "composite" exceedence probability curves developed from the three proprietary software packages which includes a mean estimate as well as an envelope of the 5% and 95% EP curves based on the three modeling firms EP curves. She went on to describe the details of the HAZUS sensitivity results. The summary of results included:

- Conducting any seismic hazard analysis in the eastern US is a very uncertain process.
- The HAZUS sensitivity analysis shows that both hazard and database (soil and property) assumptions are influential in estimating the expected losses.
- A scenario-based sensitivity study of a "characteristic quake" centered near downtown Charleston showed that the rank order or parameter importance in calculating expected loss is:
 1. Event magnitude
 2. Soil amplification factors
 3. Attenuation relationship
 4. Exposure inventory database
 5. Earthquake duration.

In his comments, Whitman noted that this is the first time that rigorous assessment of just how good the models are had been

developed. In his opinion, "the science is good". However he went on to say that soil-data of appropriate detail and exactness remains a limiting factor.

In the group discussion it was pointed out that quake frequency/magnitude relationships will be important factors in loss estimation and that the symmetric ground motion assumptions in the models comprised a major source of uncertainty that was "passed through" to the insurers.

The session concluded with a discussion on the different ways that the reinsurance and capital markets will price this uncertainty. Contract renewal practices in the reinsurance markets provide the opportunity to re-price the effects of uncertainty, an option unavailable in the capital markets.

Robert Whitman, a member of the projects' Technical Advisory Committee, noted that this is the first time that a vigorous assessment of just how good the models are had been developed. In his view, "the science is good".

The Dynamics of the CAT Insurance Market: A Study of Supply and Demand.

Paul Kleindorfer, Professor of Decision Sciences and Economics, Wharton

Steven Nivin, Senior Analyst, USAA

Martin Grace, Professor of Risk Management, Georgia State University

Robert Klein Associate Professor of Risk Management, Georgia State University

James Ament, Vice President, State Farm Fire and Casualty Company

This session included introductions to the supply, demand, and regulatory analysis studies being undertaken, followed by comments from industry partners. The contributions of Michael Murray of Insurance Services Office Incorporated, and Ph.D. candidate Kiwan Lee, to these projects were acknowledged.

This multi-faceted research initiative is intended to address three fundamental questions:

1. What is the structure and performance of the catastrophe insurance market?
2. What is the nature and impact of regulation in this market as it affects pricing and risk coverage.
3. What is the current state of the market and what are possible future sustainable states under different scenarios?

First, the researchers shared initial empirical findings, based on their analysis of multi-peril homeowner's policies in Florida and New York. Second, they engaged the group in discussion of what should properly motivate future work. In particular, they requested comment on the appropriate areas for focus from the perspective of the industry and other stakeholders.

After describing the detailed ISO database being used, the major point of all

three presentations was to emphasize the essential role that accurate pricing plays in every facet of the project. Accurate understanding of pricing is required for correct model building, but importantly, pricing also provides signals to consumers with respect to their decisions on location and mitigation. Pricing similarly defines revenues to primary insurers and the means to support efficient risk pooling and transfer through reinsurance and capital market instruments. Thus, the precision and adequacy of rates for catastrophe insurance can be expected to be a determining factor of efficiency and viability of insurance in these markets.

The initial results focused on explaining observed variability in the premium structures and pricing of multi-peril homeowners policies in Florida and New York. Results on the demand side provided insights into the likely subsidization of catastrophe insurance by non-cat insurance portions of the bundled policies studied. On the supply side, initial results suggest interesting differences between the supply of catastrophe insurance for low and moderate valued structures

versus higher valued structures. The regulatory results provided additional support for the hypothesis of rate compression in the Florida markets.

The industry commentators and the group discussion that followed focussed on how the analysis could capture a variety of potentially important factors not directly related to premium structures. Examples discussed were mortgage lender activity, differential perception on the part of the public on the level of risk, size of the

The multifaceted study will provide better understanding of demand and supply interactions across the multiple products interacting with catastrophe risk coverage as well as an empirical assessment of the impact of regulation on market structure.

residual market, differential tax burdens, and stock vs. mutual companies. Also noted was the dataset "time-slice". It was suggested that care be taken to note that the time period in question was actually a period of "major industry re-education" and that the data might reflect the state of market flux rather than an accurate picture of long-term characteristics.

These caveats aside, the group discussion provided strong support for the research effort. The dataset being constructed is by far the largest, most detailed and comprehensive of any used in this area to date. The conclusions to be drawn will provide a better understanding of demand and supply characteristics across the multiple products interacting with catastrophe risk coverage. The impact of regulation on market structure and profitability of insurers will add further value to the analysis.

Evaluating Effectiveness of Index-Based Insurance Derivatives

David Lalonde, Vice President, Applied Insurance Research, Member of the AAA Index Securitization Task Force

Neil Doherty, Professor, Insurance and Risk Management the Wharton School

John Major, Senior Vice President, Guy Carpenter, Inc.

At the request of the National Association of Insurance Commissioners (NAIC), the American Academy of Actuaries (AAA) prepared a report on index-based securities. The intent of this session was to present the paper and elicit reaction from participants in the meeting. The report's authors were interested specifically in obtaining thoughts on the appropriate mix of tests and parameters to be used for regulatory analysis. The session began with David Lalonde, one of the authors of the report, presenting a brief review. Next, Neil

Doherty and John Major delivered prepared reactions leading to group discussion.

The securitization working group of the NAIC requested the AAA to provide technical assistance in determining appropriate accounting treatment for index-based insurance derivatives. Specifically, the AAA was asked to provide input on the hedge effectiveness of index-based insurance derivatives. The lack of "insurance" treatment for derivatives creates barriers for insurers interested in index-derivative products to provide supplemental CAT capacity. The framework used for evaluating hedge effectiveness in the paper consists of four steps:

- Define the risk exposure.
- Identify the structure of the derivative.
- Identify the causal relationship between index and exposure (a qualitative criterion).
- Show hedge effectiveness through statistical testing (a quantitative criterion).

The lack of insurance treatment for derivatives creates barriers for insurers interested in index-derivative products to provide supplemental CAT capacity.

In describing the research team's assessment of quantitative measures, they focused on:

- Risk Reduction Statistics: Changes in expected policy holder deficit (EPD) -a measure of the amount losses exceed amounts to fund them across the full probability distribution of losses and recoveries. Changes in value-at-risk (VAR). Changes in standard deviation
- Exposure/index relationship statistics: Coverage Ratio, Correlations.

In discussing the strengths and weaknesses of the suggested tests, Lalonde noted that the research team as yet has been unable to reach consensus on how regulators might best use these tests. In some sense the best measures may be too complex for regulatory treatment and no single measure accounts for all relevant factors.

In his remarks, John Major urged caution in comparing index hedges to reinsurance as the standard. He argued that reinsurance does indeed carry basis risk, and as such should not be "grandfathered in" as a standard. A more fruitful focus would be on the loss-reduction characteristics of index hedges.

Neil Doherty argued that the debate might more productively focus on risk/return considerations relative to solvency, which is really the concern of regulators. The question then becomes when do basis risk hedges expand risk/return opportunities. This requires looking at correlations - or other risk measures that determine the quality of the hedge - and the market share of the hedger in the index. Thus a "good index" is one with high correlation and low market share.

In the general discussion that followed, it was generally agreed that the focus on loss-reduction potential of derivative hedges and their impact on solvency measures were more fruitful directions for argument. As such different standards may be required for assessing accounting treatments of derivatives than those used for insurance hedging.

Practical Challenges in Accessing the Capital Markets for Catastrophic Risk

*Andrew Kaiser, Managing Director,
Goldman Sachs & Company*

*Shiv Kumar, Vice President,
Goldman Sachs & Company
Vivek Bantwal, Analyst,
Goldman Sachs & Company*

The catastrophe bond market is beginning to make the transition from a series of unique deals to a more "flowing" market. Completing this transition will require both standards for structure and a broader investor base. Kaiser, Kumar, and Bantwal outlined how these challenges are likely to be met in a rapidly changing environment that will increasingly blur the boundaries of reinsurance and capital markets.

Increasing amounts of event-contingent risk will be placed in the capital markets while more financial risk will be transferred to the insurance/reinsurance markets.

In the past three years over \$9 billion in non-traditional risks have been placed in the capital markets. These risks have included catastrophes, credit default, mortality, and lease residual values. Lately, weather risk is being transferred in both derivative and security forms. While almost half of the risk-linked securities placed by Goldman Sachs have been sold through their offices in New York, there has also been strong interest out of Chicago, San Francisco, London, Frankfurt and Tokyo.

Issuers are generally pleased with the developing market and their increased ability to access alternative capacity, limit credit risk and innovate alternative financial structures. However, the legal complexity and resource intensive nature of the securitization process remain drawbacks for many issuers. Investors welcome the diversification that these securities offer and also value the rigorous risk disclosure in the offerings but are less enthusiastic about the

increasing complexity of transactions and limited diversification within the asset class.

The presenters expect continuing convergence of capital and reinsurance markets to be further aided by the Gramm-Leach-Bliley Act. Increasing amounts of event-contingent risk will be placed in the capital markets while more financial risk will be transferred to the insurance/reinsurance markets. In addition, we are likely to see corporate entities directly accessing the capital markets to transfer risk. Transactions will be simpler, longer term and of larger sizes. It is expected that capital and reinsurance markets will complement each other on reinsurance programs as securitization becomes increasing cost competitive. A word of caution was added at the end, however. The market has not yet experienced a serious loss event and therefore has not yet been seriously tested.

The Global Market for Reinsurance: Consolidation, Capacity, and Efficiency

J. David Cummins, Professor, Insurance and Risk Management the Wharton School

The global reinsurance market has undergone significant consolidation in recent years. What effect has this merger activity had on industry capacity and relative efficiency? The final session of the day was devoted to answering these questions based on recent published research by David Cummins.

Cummins began his presentation with a description of risk pooling, and Karl Borch's theorem (Pareto optimality in the reinsurance market occurs when each

reinsurer holds a net portfolio that is proportional to total losses). He then

The resulting story seems to be that while acquiring firms are attracted to the opportunities provided by less efficient firms, they also require these targets to have positive operating characteristics.

described the scale and scope of recent industry consolidation and his methodology for estimating its effects.

Using data from Standard & Poors, Guy Carpenter, Conning & Company, and others, Cummins described the changes in the global re-insurance market over the period 1989-1998. Data on merger and acquisition transactions, acquired assets, and market share all confirm the rapid industry consolidation. At the same time, his analysis demonstrated that consolidation has increased reinsurance capacity, i.e. shifted the response curve upwards, and improved firm level efficiencies.

Inefficient firms were found to be more likely to be acquired than efficient ones. Firms with high capital-to-asset ratios are less likely to be acquired but firms are more likely to be acquired if their investment yield is high, combined ratio is low and/or the standard deviation of ROE is low. The resulting story seems to be that while acquiring firms are attracted to the opportunities provided by less efficient firms, they also require these target firms to have other positive operating characteristics.

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