Wharton

Snapshot – May 2000

Managing Catastrophic Risks:* *A Research Program and Industry Forum

Wharton Risk Management and Decision Processes Center
Wharton Financial Institutions Center

The Managing Catastrophic Risks research program held its Spring Advisory Board Meeting in Hamilton, Bermuda on May 15-16, 2000. Given the dramatic growth in size and expanded business dynamics of the Bermuda reinsurance markets, several members of our sponsoring group suggested that the research program would benefit from first-hand exposure to this important industry sector. With this in mind, the May 15-16 meeting was structured to include two specific panel discussions led by senior Bermuda-based executives. Some eighteen representatives from Bermuda firms participated in the meeting, adding an informed perspective to the general dialogue.

The meeting began on Monday afternoon with an overview of the Wharton project, led by Peter Burns and including brief descriptions of research directions from selected Wharton faculty. The remainder of the afternoon was devoted to a panel presentation on the evolution of the Bermuda reinsurance market and a discussion of new service directions. The panel, moderated by Neil Doherty of Wharton, included Larry Doyle, President of Annuity Life Re; Mary Hennessey, President of Overseas Partners; and Dan Malloy, President & CEO of Stockton Re.

Our dinner discussion was led by Frank Nutter, President of The Reinsurance Association of America. We were fortunate to have Frank join us and his remarks on industry trends and challenges were especially insightful, setting a provocative tone for individual table discussions.

Tuesday morning began with the second of our Bermuda panel discussions, this time specifically focused on catastrophic risk. The panel, moderated by Wharton's David Cummins, included George Rivas, COO of Tempest Re; Jim Stanard, CEO of Renaissance Re and David Malmquist from the Bermuda Biological Station for Research.

The remainder of the Tuesday sessions highlighted on-going Wharton research initiatives. Howard Kunreuther and his colleagues described their work in assessing the impact of mitigation, indemnity contracts and a parameterized index contact on a hypothetical insurance company in the face of hurricane and earthquake events. In the last session, Wharton's Paul Kleindorfer and his colleagues discussed latest findings from their analysis of industry supply and demand factors in the residential market for catastrophe insurance, including the impact of regulation.

What follows is a brief "snapshot" highlighting the meeting presentations. By all accounts this was one of our more engaging advisory board meetings with excellent dialogue throughout. The success was in no small part due to the active participation of our Advisory Board members and the contributions from our colleagues and guests from Bermuda. We are especially grateful to Renaissance Re and Stockton Re for their help in organizing the meeting and their generous hospitality in hosting a closing cocktail and dinner party on Tuesday evening.

Dinner Speech: "Trends in Reinsurance: Where Are We Going and Why"
Speaker: *Frank Nutter, President, Reinsurance Association of America.*

Our keynote speaker for the Bermuda conference was the president of the American Reinsurance Association, **Frank Nutter**. His remarks, presented prior to dinner on Monday night, reflected his views on the state of the industry and set a constructive tone for discussion over dinner and throughout the meeting.

Looking over the intermediate future, Nutter sees continued surplus depletion in the reinsurance industry with only modest growth in premiums. He challenged the group to consider whether problems in operating performance represent traditional cyclical behavior or perhaps more of a sign of systemic change.

He argued that due in part to the evolution of sophisticated scientific modeling capabilities, the gap between reinsurers and insurers is narrowing in terms of knowledge as well as underwriting skills. The lower demand from buyers comes in conflict with demands for growth by reinsurance owners, leading to more aggressive acquisition strategies to show growth. The role of the capital markets is also coming into play; although Nutter's position is that for the more progressive reinsurers, this is less of a threat and more an opportunity to redefine themselves to incorporate capital market capabilities into their business models.

Lastly, in describing the transitional state of the industry, he describes a period of experimentation as firms attempts to define an "optimal" business model. These structural approaches include: offshore holding companies, stand-alone reinsurers, connections with primary company groups, multi-line vs. single peril structures or pure capital market plays. At this point there are no clear dominant trends and for many firms, the definition of "optimal" will depend on assessing their own unique strategic capabilities.

Meeting Introduction and Project Overview
***Peter Burns,** Managing Director, Wharton Financial Institutions Center*

The formal meeting began with **Peter Burns** introducing the representatives from our new sponsor, Tokio Fire and Marine Insurance Company Ltd. Mr. **Yuichi Takeda**, head of the integrated solutions group of Tokio Marine Management Inc. spoke briefly about his company's interest in the project and its recent entry into the Bermuda reinsurance market.

Afterwards, Burns outlined the origins of the project and its structure as an academic-industry partnership. Key features of the project are the "industry advisory group" (which meets formally twice a year) and a "technical advisory committee" (a group of well respected specialists that periodically review the technical underpinnings of our endeavor). Internally, the "CAT Project" is a joint venture between two Wharton research Centers; the Risk Management and Decision Processes Center and the Financial Institutions Center. For the purposes of this research endeavor, the Risk Management and Decision processes center, under the co-direction of **Howard Kunreuther** and **Paul Kleindorfer** has focused on matters related to catastrophe risk measurement and mitigation. The Financial Institutions Center, under the direction of **Anthony Santomero**, has focused on matters of financial risk management, catastrophe impact on financial institutions and the impact of capital markets in financing and managing catastrophe risk.

Several of the project's principal researchers: **David Cummins, Neil Doherty, Paul Kleindorfer,** and **Howard Kunreuther,** reviewed the research agenda, including the study of:

- The capacity of the insurance and reinsurance markets to handle the financial impact of large disasters.
- The effects that basis risk and moral hazard have on the CAT securities market.
- The role of technology and modeling in quantifying catastrophe risk.
- The potential for new capital market instruments to supplement traditional insurance and reinsurance.
- The nature and impact of regulation on catastrophe insurance and markets.
- The role of mitigation in hazard management strategies.
- The potential for public-private partnerships for managing catastrophe risk.

Finally, the session ended with a discussion of the Wharton/World Bank conference proposed for January 2001. The objective of the conference is to bring together leading academics, business executives, and public policy experts to examine the management of catastrophe risk in emerging economies. In particular the conference will assess the relevance of the new approaches for dealing with the effects of natural disasters such as:

- New capital market instruments and their application to emerging economies.
- The advantages that information technology and quantitative catastrophe models offer for risk assessment and management.
- The benefits of disaster mitigation and how they should be calculated.

The intended outcome of the conference is to foster dialogue with a diverse audience and to thereby clarify roles and opportunities for improving catastrophe risk management in emerging economies.

Panel Discussion:"The Bermuda Greenhouse - Trends and Opportunities"
Moderator:
***Neil Doherty**, Ronald A. Rosenfeld Professor of Insurance and Risk Management, The Wharton School*
Panelists:
***Lawrence Doyle**, President, Annuity & Life Re Holdings*
***Mary Hennessey**, President, Overseas Partners Reinsurance Ltd.*
***Daniel Malloy**, President and CEO, Stockton Reinsurance Ltd.*

The session's first panel discussion moderated by Wharton's **Neil Doherty**, provided an overview of the structure and dynamics of the Bermuda reinsurance market.

Larry Doyle opened with a description of the evolution of the Bermuda reinsurance market. He noted that Bermuda presented a unique constellation of attributes that have supported the industry's growth, including:

- Stability
- Established Infrastructure
- A Favorable Regulatory Environment (Effective but not Onerous)

- Relative Ease of Company Formation
- Income and Corporate Tax Guarantee
- Availability of Other Insurance Capacity
- Attractive Location and Favorable Image

He went on to chart the evolution of the Bermuda reinsurance market, beginning with the establishment of captive companies in the 1980's. Of the nearly 4000 captive insurance companies in the world, some 1500 are domiciled in Bermuda, eclipsing the second highest concentration of 450 in Cayman. In 1985-86, the industry liability crisis led to the formation of ACE and Excel spawning the development of the Bermuda high excess liability business. In 1988 the foundation for the financial reinsurance sector was developed with the formation of Centre Re. Perhaps the largest influx of new capital occurred in the early and mid-nineties as the CAT business grew dramatically in Bermuda beginning with the formation of Mid-Ocean Re and Partner Re in 1992-93. More recently, the markets have expanded into broader ranges of insurance and related financial services. Capacity in the Bermuda insurance market has grown significantly with the property CAT market with some $150 million and the excess liability market with $375 million. Total premiums in the Bermuda market in 1998 were over $26 billion and capital surplus reached over $50 billion.

In his concluding remarks, Doyle described the market as being in a period of dramatic change, challenged by pressure from the lack of fundamental growth, the emergence of non-traditional competitors, and emerging new distribution channels. Doyle asserted that while it is clear that the Bermuda reinsurers will continue to play a valuable role as the primary insurance industry evolves, it is not at all clear what will define the "winners" in the new environment. Critical factors are likely to include underwriting expertise, experienced and innovative management, distribution strength, and critical mass.

Mary Hennessey outlined the history of Overseas Partners Limited (OPL) as an example of change and dynamics within the Bermuda Market.

OPL was founded in 1983 with $50 million in capital by United Parcel Service to reinsure the shipper's risk business. It expanded rapidly and by 1995 began to issue third party reinsurance. All this was to change abruptly however in August of 1999 with a US Tax Court decision against UPS that caused the shipper's risk program to be cancelled. This resulted in a significant underwriting loss in 1999.

In the wake of these developments, and after rejecting the option of selling the business, the OPL Board determined to regroup and rebuild the company. Their plans emphasize positioning themselves in the marketplace as a "specialist with clout" that is not part of a larger multi-line firm. This sense of market independence is perceived to offer particular advantages to a number of buyers. The critical determining factor for the OPL Board was their conclusion that if they were to re-deploy OPL capital in a new business, Bermuda was an ideal location for them to do so. In describing these advantages, Hennessey echoed a number of themes raised by Larry Doyle, while addressing several additional points. The flexibility and entrepreneurial focus of Bermuda firms offers particular advantages in an industry not necessarily known for such attributes. Speed to market is one outgrowth of this environment. New ideas move quickly and, unlike the US, there is no need to deal with fifty state regulators.

The final panelist, **Dan Malloy**, described the structure and activities of Stockton Re as a further example of innovation in the Bermuda market. The essence of the Stockton Re model links finite reinsurance activities with an aggressive and flexible investment strategy that incorporates sophisticated risk management techniques.

The defining capabilities or "resources" driving the business model are: liquidity, risk tolerance, and people. Transactions, on either side of the balance sheet, are evaluated across multiple dimensions. Among these "screens" Malloy discussed: consideration of profit and loss distributions, the analysis of credit and liquidity risks, correlation and diversification factors, impact on capacity and value at risk.

Reinforcing the themes developed by the earlier panelists, Malloy emphasized that this unique business model is greatly advantaged by its location in Bermuda. The model, which anticipates the growing convergence between the capital markets and the traditional insurance business could only be executed from Bermuda with its more flexible insurance regulatory environment and entrepreneurial culture.

Panel Discussion: "Catastrophe Risk and the Bermuda Market"
Moderator:
***J. David Cummins**, Harry J. Loman Professor of Insurance and Risk Management, The Wharton School.*
Panelists:
***George Rivaz**, Chief Operating Officer, Tempest Reinsurance Ltd.*
***James N. Stanard,** Chief Executive Officer, Renaissance Re Ltd.*
***David Malmquist**, Assistant Research Scientist, Bermuda Biological Station for Research*

The second Bermuda panel discussion focused specifically on the CAT market. The panel and subsequent discussion was moderated by Wharton's **David Cummins** and provided views from two prominent industry executives as well as a unique perspective from the scientific community.

George Rivaz began the discussion with a presentation that outlined the state of the CAT industry and later described a proprietary model developed by Tempest Re which attempts to dynamically capture industry conditions and trends. Globally, they estimate that for the year 2000, the catastrophe reinsurance markets will collect $2.7 billion in premiums with an expected loss ratio of 89% (with substantial variability by market) and a combined ration of 109%. Based on a notional capital of $17 billion, the industry return on equity is expected to be 4.7% (and only 18% eliminating expected losses). The culprit, of course, is the compressed rate levels from the recent highs in 1994. In fact, his data demonstrated that based on the 1994 premium levels, the projected year 2000 performance would have produced on ROE of 26% rather than the expected 4.7%.

Rivaz went on to describe Tempest Re's dynamic market model, which is based on two assumptions: industry loss distributions and the price change/loss ratio relationship. Absent losses, prices reduce and converge. If losses are large, prices increase. In developing the model and calibrating formulas, they examined fourteen years of industry data. As on of the charts demonstrated, the modeled rate changes correspond reasonably well with the actual experience for the period 1989-1999. Extending the model predictions out through the period, with some, albeit low, probability that rates will return to 1994 levels.

As with all models there are restrictions which must be taken into account. Rivaz discussed how data issues, time sensitivity, and other drivers such as loss experience in other area of business asset performance might affect the outcomes. Additionally, he noted that the potential response from capital markets in this area could have important impact. Nevertheless, he argued that the dynamic market model provides real value to the firm's decision and planning process. Utilizing the model as a test-bed in developing capital management and underwriting strategies is one important application. Developing pricing time structures for multi-year contacts and options is another.

The second speaker on this panel, **Jim Stanard**, focused on the effective use of actuarial and catastrophe models in underwriting and managing risk. He outlined the characteristics of "bad" and "effective" models and then related these attributes to a series of organizational variables. His objective was to demonstrate that even effective models cannot by themselves produce the desired results if organizational processes are not properly aligned.

Although different types of models must be used to inform decisions on either the macro-level (strategy and capital allocation) or the micro-level (individual risks and claims) the characteristics of the sorts of problems that occur with these models are universal:

- Inappropriate application, such as using an earthquake model to price all perils covered (wind, fire, riot, etc.).
- A good model that simplifies out a key decision factor, or one not suitable to the decision at hand, e.g. using the same CAT model to select an optimal portfolio.
- A model that gives an unbiased estimate but with a high variance or estimator, especially when the variance itself is not estimated. This problem is often encountered in using models to determine long tail reserve estimates or in attempting to develop experience ratings with a small number of losses.
- Inability to link which assumptions are driving the conclusions in complex CAT models or in asset portfolio optimization models.
- Too much output, poorly organized, and/or delivered too late to inform the decision-at-hand.

By contrast, effective models:

- Are clear about key assumptions and what effect changing those assumptions will have on the output.
- Their "inner-workings" are understood by the decision-maker.
- Allow for the clear understanding of the relationship between micro and macro conclusions.
- In the end, provide reasonably unbiased estimates for the needed decision with results well organized and produced in the needed time frame.

Having presented the contrast between "good" and "bad" models, Stanard discussed the limitations posed by ineffective organizational processes. He asserted that the effective use of models by organizations depended on the presence of feedback loops to continuously evaluate results and the people implementing them. Desired results must be clearly stated and properly aligned with incentives. Moreover, while it must be remembered that models produce estimates, not facts, and therefore there is danger in placing too much trust in them, there is also danger in placing too little trust in them and thereby failing to utilize the competitive advantages they offer.

The last of the panel presentations featured **David Malmquist** who outlined the activities and research results from the Bermuda Biological Station for Research "Risk Prediction Initiative" (RPI). This scientific partnership with industry was started in 1994 and incorporates approximately one hundred scientists from nine countries and fifteen industry partners. Its goal is to create links between the climate science and insurance communities so that the science of climate forecasting is available, understandable, and usable by insurers.

As such, the RPI serves as an information exchange medium between government, academia, insurers, and commercial risk modelers. It also convenes working groups, identifies and funds novel research, and creates decision-making tools such as the "Tropical Cyclone Prediction Model", global tropical cyclone contour maps, real-time hurricane tracking, and the "Wind Probability Model".

One key facet of current research of particular interest to the audience, was the RPI's work on extending the historical record of hurricane land-fall via proxies such as the sedimentary record found in lagoons and lakes. Here, sand layers interdispersed in what is normally a mud depositional environment record hurricane landfalls. Since organic material deposited in the mud layers can be carbon-14 dated, hurricane return periods can be directly obtained back for many centuries. Such an analysis of sediment cores from Lake Shelby, Alabama, for example, indicate a 1/600 probability of a category four or five hurricane striking that region of the United States each year.

Malmquist concluded his presentation by emphasizing that the cultural differences between scientists and insurers are important and need to be explicitly managed. Research results must be compatible with the risk models that insurers actually use, and the peer-review of research must remain as an essential factor in preserving academic objectivity.

Research Report: "Indemnity Contracts, Cat Bonds and Mitigation"
Presenters:
Howard Kunreuther, *Cecilia Yen Koo Professor of Decision Sciences, Public Policy and Management and Co-Director, Risk Management and Decision Processes Center, The Wharton School*
Patricia Grossi, *Ph.D Candidate, School of Engineering and Applied Science, University of Pennsylvania*
Jaideep Hebbar, *Undergraduate, The Wharton School*

Howard Kunreuther, **Patricia Grossi**, and **Jaideep Hebbar** have utilized the three model cities in the Managing Catastrophic Risk project (Long Beach, CA; Miami/Dade County, FL; and Oakland, CA) to examine the impact of mitigation, indemnity contracts, and parameterized index contracts on the performance of a hypothetical small insurance company. Working with Applied Insurance Research (AIR), EQECAT and Risk Management Solutions (RMS), they have generated exceedance probability curves for the three model cities that reflect the losses that insurers would experience from earthquakes and hurricanes of different magnitudes with and without structures being mitigated. In this analysis, insurers have an opportunity to purchase an indemnity contract (excess of loss reinsurance) and an indexed contract (a cat bond from the capital markets) to reduce their losses by truncating the tail of the exceedance probability curve.

The preliminary analyses of the performance of mitigation, reinsurance, and cat bonds on insurer performance in the three model cities revealed a number of interesting findings.

1. Impact of Mitigation. The analysis of the expected loss reduction for the three model cities reveals that the mitigation measures utilized for reducing earthquake losses (bracing the cripple walls and bolting the structure to the foundation) and reducing hurricane losses (partial roof mitigation) are cost-effective.

2. Impact of Indemnity Contracts (Reinsurance). As expected, reinsurance reduced the insolvency probabilities for all three model-cities. However expected profits were also reduced because the insurer is assumed to have 100 percent BOB. If the insurer had been able to write more coverage because it was less concerned with insolvency (because it had reinsurance) then profits could actually be higher. In other words, reinsurance would expand the insurer's capacity.

3. Impact of CAT bonds on insurer performance. For the three model cities hypothetical contracts were constructed by first computing the expected losses for hurricanes and earthquakes of different magnitudes. The expected losses were then set equal to the actual pay-out of the cat bond to the insurer for stated magnitude ranges (over 7.0 for Oakland or over 6.8 for Long Beach for example). Pay-out structures of this type will carry with them some basis risk. This is because there will be some events in the stated magnitude range that will produce either net claims larger than the amount provided by the indexed contract (positive basis risk) or smaller than the indexed contract amount (negative basis risk). However, from the point of view of insurer performance, although the hypothetical contracts produced only a small reduction of insolvency probability for the insurer, they did produce large reductions in worst case losses for all three cases studied.

These results should be viewed as preliminary and reflect a first step in the analyses of indemnity and indexed contracts and mitigation in evaluating insurer performance. Additional analyses to be undertaken will examine the impact of these cat bonds on positive and negative basis risks, show the sensitivity of insurer profits and insolvency probabilities to different pricing strategies for cat bonds, evaluate performance of mitigation measures, and evaluate the impact the uncertainty in the exceedance probability curves will have on the insolvency and cat bond returns.

Research Report: "Supply and Demand for Residential Property Insurance Catastrophe Perils and Coverages"
Presenters:
***Paul Kleindorfer**, Universal Furniture Professor of Decision Sciences, Economics, and Public Policy and Management and Co-Director, Risk Management and Decision Processes Center, The Wharton School*
***Robert Klein**, Associate Professor and Director of the Center for Risk Management and Insurance, Georgia State University*

***Martin Grace**, Associate Professor and Associate Director of the Center for Risk Management and Insurance, Georgia State University*

Paul Kleindorfer, **Bob Klein**, and **Marty Grace** reviewed recent progress in their analysis of supply-demand-regulation in the residential property insurance market for catastrophe risk. The objectives of this study are to add insight into improving efficient operations for the industry sector, addressing three fundamental questions:

1. What is the structure of the market?
   - Demand (structure, interdependencies)
   - Supply (profits, risk/exposures, distribution)
2. What is the nature and impact of regulation on this market?
   - Pricing (adequacy and precision)
   - Financial risk
3. What is the current state of the market? What are possible future (sustainable) states under different scenarios?

The database being developed to conduct these analyses includes 2.6 million homeowner records from 60 companies doing business in Florida and New York as provided by Insurance Services Office Inc. Supplementary data on policy features comes from A.M. Best, company characteristics from NAIC and socio-demographics from the Census Bureau.

The bulk of the presentation focused on the preliminary results examining demand for Florida homeowners insurance with a bundled catastrophe peril. Discussion centered on the major categories of variables influencing demand (contract terms, insurer characteristics, and demographic variables) and significant or interesting results of the regression analysis. The results showed significant variation in the premiums and prices insurers charge for comparable policies/insureds. In addition the demand analysis demonstrated that the demand for catastrophe coverage is highly price-elastic while the demand for non-cat coverage is relatively inelastic.

The discussion among the attendees that followed the report centered on questions concerning insurers' strategies with respect to policy design, cross-marketing of different types of insurance, geographic distribution of exposures, use of reinsurance and securitization of cat risk, and responses to regulatory constraints.

The next iteration of this study will develop a joint model of supply and demand for both Florida and New York, include dwelling fire and extended coverage, and add regulation as a more explicit model component.

Firms attending the meeting were:

ACE, Ltd.*
American Reinsurance Company*
Anuity and Life Reinsurance, Ltd.
Applied Insurance Research*
Bermuda Biological Station for Research
EQE International*
Ernst & Young, LLP*
Georgia State University
Glencoe Insurance
Insurance Services Office, Inc.*
IPC Re
Kyoto University
LaSalle Reinsurance, Ltd.
Osaka University
Overseas Partners, Ltd.

Partner Reinsurance, Ltd.
Property and Casualty Rating
Organization of Japan *
Reinsurance Association of America
Renaissance Reinsurance, Ltd.
Risk Management Solutions, Inc.*
Solomon, Smith Barney
State Farm Fire and Casualty Company*
Stockton Reinsurance Limited
Swiss Reinsurance Company
Tempest Reinsurance, Ltd.
Tokio Fire and Marine Insurance Company*
XL Mid-Ocean

* Denotes Industry Advisory Board Member

Visit the project website at: http://fic.wharton.upenn.edu/fic/wfic/catrisk.html

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