JOINT RISK MANAGEMENT SECTION

Canadian Institute of Actuaries
Casualty Actuarial Society
Society of Actuaries

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Risk management

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Risk management

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ARTICLES NEEDED FOR RISK MANAGEMENT

Your help and participation is needed and welcomed. All articles will include a byline to give you full credit for your effort. If you would like to submit an article, please contact Sim Segal, editor, at *sim.segal@watsonwyatt.com.*

The next issues of *Risk Management* will be published:

PUBLICATION DATES	SUBMISSION DEADLINES
September 2009	July 1, 2009
December 2009	October 1, 2009

PREFERRED FORMAT

In order to efficiently handle articles, please use the following format when submitting articles:

- Word document
- Article length 500-2,000 words
- Author photo (quality must be 300 DPI)
- Name, title, company, city, state and email
- One pull quote (sentence/fragment) for every 500 words
- Times New Roman, 10-point
- Original PowerPoint or Excel files for complex exhibits

If you must submit articles in another manner, please call Kathryn Wiener, 847.706.3501, at the Society of Actuaries for help.

Please send an electronic copy of the article to:

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Let the Cash Flow

By Sim Segal

WE HAVE DONE IT AGAIN. For the third issue in a row, we have honored our pledge to bring you a balance of articles—at least one in each of our topic categories. This is not easy. To help us solicit articles in the toughest categories, we recently introduced a $500 prize for the best such article in each issue. On behalf of the Joint Risk Management Section (JRMS), I am pleased to announce that our first winner is Max Rudolph, for his article "Survey of Emerging Risks" in our March 2009 issue. Please join me in congratulating Max for an excellent article on this topic.

If you would like to help us with an article in one of the challenging categories (and help yourself to a shot at $500), below is a list of the three eligible categories and a partial list of topic ideas:

Risk Identification

- Emerging risks
- Risk categorization and definition
- Internal qualitative risk assessment

Risk Response

- Risk appetite and risk thresholds
- Making decisions with ERM, including strategic planning, pricing, etc.
- Managing within rating agency requirements and regulatory constraints

Risk Culture & Disclosures

- Risk governance
- Integrating ERM into incentive compensation
- Risk disclosures

You may have also noticed another enhancement in the past three issues. We have asked for, and our contributors have responded with, more tightly written articles—most are under 2,000 words. While this makes *Risk Management* easier to read, it is harder than it looks, so kudos to the authors for the extra effort.

We hope you enjoy this issue. We have received some positive feedback recently, so we are encouraged that we are headed in the right direction. However, we are continually looking to improve, so if you have any feedback on how we can better meet your needs, please let us know. I can be reached at *sim.segal@watsonwyatt.com*.

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INARM Yourself (in a Good Way)

By Donald F. Mango

FOR THOSE WHO DO NOT KNOW, the International Network of Actuarial Risk Managers (INARM) is the de facto international "arm" (ugh) of the JRMS. More appropriately, it was started by Dave Ingram as an international special interest group open to members of actuarial organizations around the world. It serves as a vehicle to allow members of all actuarial communities to connect in the risk management area and developments worldwide.

INARM is a 21st century virtual organization, consisting of a listserv run by the SOA and a blog site *www.inarm.org*. Those interested in joining the listserv can look under the Listservs link in the JRMS Web site. (It is worth noting that the JRMS is sponsoring the INARM blog Web hosting fees.) The listserv provides updates on INARM activities and allows participants to engage in e-mail discussion on topics related to Risk Management.

Donald F. Mango, FCAS, MAAA, is chief actuary at Guy Carpenter & Co, LLC in N.J. He can be reached at *Donald.F.Mango@guycarp.com*.

INARM's worldwide members have been very active during the financial crisis. Many INARM members were authors in the financial crisis essay collection, and others were speakers and attendees for the two international ERM webinars.

Until recently, the listserv was the most active part of INARM. Some of the recent e-mail discussion topics include:

- Securities valuation as an actuarial activity,
- Stress testing,
- Solvency systems worldwide,
- Actuaries as CROs,
- Engineering Control systems and ERM, and
- Conservation of Risk (an Ingram classic).

The blog is a newer undertaking, providing a standing electronic forum for longer form discourse on many critical ERM topics, such as Economic Capital Modeling, Emerging Risks, ERM and Actuaries, Financial Instability and Risk Margins. Everyone is encouraged to visit the INARM blog and contribute to the online discussions. If successful, this forum can provide a large base of intellectual content for the profession to build upon as we raise our profile in the ERM space.

THE WAY FORWARD

Up until now, INARM has been steered to be more of a membership network, rather than an affiliation of organizations—that is, a network of individual practitioners, not of representatives of groups (the IAA already fulfills the latter role).

The expectation is if INARM really starts to succeed (early signs are good), there will be a need for a more formal structure. At such time, suggestions will of course be solicited from individuals and from groups that are represented in the participants.

So do your part to raise the profession's ERM profile around the world—INARM yourself today! ✦

SOA 09

ANNUAL MEETING & EXHIBIT

October 25–28, 2009
Boston Marriott Copley Place
and Westin Hotel Copley Place
Boston, MA

Visit www.SOAAnnualMeeting.org to learn more about the SOA 09 Annual Meeting & Exhibit, where you can expect fresh ideas, innovative seminars and top-notch speakers, plus plenty of networking opportunities.

BE SURE TO SIGN UP FOR THESE INFORMATIVE SESSIONS:

Session 37 - Panel Discussion

ERM BEST PRACTICES - A CASE STUDY OF CASE STUDIES

One of the research projects under the prevue of the joint risk management section is focused on researching best practices in ERM which, if implemented properly, could have prevented some of the high-profiled corporate failures of the past decade. In this session, experts will discuss WorldCOM, EnRon and others, with ample opportunities for a Socratic dialogue between you and the panelists.

Session 128 - Panel Discussion

PRUDENT ENTERPRISE RISK MANAGEMENT: IT STARTS AND ENDS WITH CORPORATE CULTURE

This session will cover how the actuarial profession can help balance incentive compensation that rewards returns with the need to reflect risk undertaken to achieve those returns.

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Increasing the Resilience of Insurance Companies

By Jean-Pierre Berliet

FINANCIAL CRISES are broadly recognized as an unavoidable aspect of capitalism. In the future, insurance companies and other financial institutions can do much to develop plans for mitigating, recovering from and preventing the disruptive effects of potential crises.

Because so many institutions came close to failure in 2008, it is important to ask why some companies could remain autonomous while others could not. The record suggests that companies that retained their autonomy had earned the confidence of investors as a result of superior performance over the long-term as well as by avoiding catastrophic losses during the present crisis. They were trusted with another chance, specifically the provision of additional capital to move forward (e.g., MetLife, Goldman Sachs and ManuLife); those that were not so trusted had to merge (Bear Stearns, Countrywide, Washington Mutual), were partially nationalized (AIG, Bank of America, Citigroup), or now face reorganization in bankruptcy (Lehman Brothers).

It is easy to blame chief risk officers (CROs) and enterprise risk management (ERM) for the impact of the crisis on companies, but such blame is often unfair and disingenuous. In few companies did CROs have the power to prevent the execution of strategies that, although fraught with risk, were pursued to deliver on investor profit expectations and management incentive targets. Regardless of this inherent tension between risk and profit, it also appears that certain weaknesses of ERM, value-based management (VBM) and management by objectives (MBO) processes fed off of one another to make companies more vulnerable to the crisis. The VBM process helps companies compare the value contribution of alternative strategies and select a course that would increase company value, while the MBO process translates business objectives into performance targets and drives incentive compensation awards.

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Weaknesses in ERM, VBM and MBO processes can derail strategies intended to mitigate, recover from or prevent future crises. These weaknesses must be corrected so that management can act on the signals they provide. Each of these three management processes is central to one particular phase of crisis management:

- ERM to mitigation
- VBM to recovery
- MBO to prevention.

Enhancing these processes, especially through the development and use of consistent risk insights and metrics, would help insurance companies become more resilient.

MITIGATING CRISES: ERM CENTRAL TO RESTORING CAPITAL ADEQUACY

The primary objective of crisis mitigation is to realign risk exposures with risk bearing capital and to improve capital adequacy. Realigning exposures with capital (and implied "risk capacity") enhances insurance strength ratings and the confidence of investors and customers. Without such confidence, a company's business and franchise would erode rapidly.

In this crisis, many companies improved capital adequacy by (a) cutting expenses, (b) decreasing dividend payments, (c) discontinuing share repurchase programs and (d) selling assets and non-strategic operating subsidiaries, all to preserve or increase capital. There are few buyers during a crisis, however, and so divestitures and asset sales are at lower prices than in normal times (e.g., sale of HSB Group by AIG) and are therefore very expensive sources of capital.

Realignment strategies also involve retrenchment from businesses with substandard returns on capital. Typical outcomes are: (a) sales of blocks of business and renewal rights, (b) cessation of certain coverage types, (c) sales of entire subsidiaries, (d) changes in underwriting limits, terms and exclusions, (e) reinsurance strategies, etc. ERM risk analysis models provide a basis for assessing the relationship between capital needs and value contributions of various businesses. Without that assessment, it is hard to align risk exposures with available capital.

Estimates of capital requirements based on risk measures over a one-year horizon (typical of solvency regulations)

"Achieving superior shareholder returns is critical for a company to maintain access to affordable capital."

are not credible during a crisis because they assume that fresh "recovery" capital can be raised. Rating agencies, regulators and investors, however, know that many solvent companies cannot raise fresh capital during a crisis. Capital is only adequate if it can sustain the company's operations on a "going concern" basis in the absence of access to recovery capital, but with credit for capital generated internally.

Companies need robust insights from ERM to assess their capital needs (on or off balance sheet, including contingent capital) and to develop effective mitigation strategies. Their ERM must:

- Measure capital consumption by activity and risk type
- Identify the relative value creation of individual businesses, with appropriate recognition for differences in risk
- Demonstrate the impact and future value creation of alternative retrenchment strategies

Through such ERM informed views of capital utilization, capital adequacy and value creation, insurance companies can chart effective crisis mitigation strategies.

RECOVERING FROM CRISES: VBM CRITICAL TO CREDIBILITY FOR RAISING CAPITAL

Once confidence is restored, companies need to focus on growing again. They cannot achieve this without first restoring risk capacity through earnings retention, raising additional capital or both.

Access to capital is a critical strategic advantage during a financial crisis. Companies with a strong reputation for value creation can raise new "recovery" capital without excessive shareholder dilution (e.g., Goldman Sachs). Others find it more difficult, or impossible, to access the public market. This makes them vulnerable to inroads by competitors or unsolicited tender offers. The primary purpose of VBM frameworks and processes is to ensure that companies consistently meet investor value creation expectations and survive crises.

VBM frameworks help managers compare alternatives, so that they can direct capital toward uses that would support the achievement of a sustainable competitive advantage,

and also create value. This is challenging in the insurance industry because competitors can duplicate innovations in product features, service delivery or operational effectiveness relatively quickly and can redirect capital at the stroke of a pen. Such competitive dynamics call for companies to compete by developing organizational capabilities that (a) are tougher to duplicate by competitors and (b) provide a pricing or cost advantage based on service quality, underwriting insights, investment performance and risk and capital management

Because risk drives capital utilization in insurance businesses, the integration of ERM and VBM frameworks is required in order to develop strategies and plans that meet value expectations. Integration rests on (a) superior insights into risk exposures and capital consumption and (b) consistent risk metrics at the level of granularity needed to achieve a loss ratio advantage (possibly on the same level of granularity as loss ratios are calculated). In practice, these insights and metrics lead to decisions to reject businesses and strategies that will not create value. They provide a foundation for:

- Measuring capital utilization by line, by market and in aggregate
- Driving a superior, more disciplined underwriting process
- Optimizing product features
- Maintaining pricing discipline through the underwriting cycle

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Increasing the Resilience… | from Page 7

- Pricing options and guarantees embedded in products fairly
- Controlling risk accumulation, by client and distribution channel
- Managing the composition of the book of business
- Driving marketing and distribution activities
- Optimizing risk and capital management strategies.

Achieving superior shareholder returns is critical for a company to earn investor trust and maintain access to affordable capital. Having access to capital during a financial crisis may well be the ultimate indicator of success for a company's VBM framework. Anecdotal evidence suggests that insurance companies that consistently trade at significant premiums over book value have such insights about risk and maintain a highly disciplined approach to writing business.

The present crisis has increased the cost of capital dramatically, but not equally for all insurers. Capital remains most affordable to those with a strong record of value creation and adequate capital as a result of good risk management. Conversely, it has become prohibitive for those with a lesser record of value creation and who lost credibility as stewards of shareholders' interests. The latter are at risk of forced mergers or liquidation, which may be punishment for not integrating ERM and VBM processes more effectively.

PREVENTING FUTURE CRISES: REVAMPING MBO TO REDUCE MORAL HAZARD

Senior management usually takes pride in its tough and disciplined approach to managing performance. This involves setting stretch objectives, rewarding managers who deliver and punishing those who fall short. It is argued that a "greed and fear" approach is necessary to motivate managers and align their interests with those of shareholders. It is not widely recognized, however, that this approach can increase moral hazard and induce managers to make decisions that reduce resilience.

In this culture, managers are incented to exceed management expectations by using all means available. This may include:

- Reducing or postponing spending on product or service quality, product leadership, process productivity or customer service responsiveness
- Under-pricing risks to increase business volume and earnings
- Taking on higher investment risks to increase current investment yields
- Under-investing in market growth, thereby increasing short-term earnings but losing market share.

Actions like these can enhance short-term earnings, but they can also undermine a company's competitive capabilities and value creation potential. This, in turn, can reduce the company's ability to raise capital and thus its resilience. The introduction of risk adjusted performance metrics into a company's control framework can help reduce the incidence of actions taken inappropriately to "game" the incentive compensation system. However, it is hard to detect moral hazard because the effects of actions taken can remain latent for years to come.

Moral hazard of this type tends to affect decisions where senior management focuses on reported financial results rather than on underlying operating success factors. Excessive, and sometimes exclusive, emphasis on financial results gives operating managers overly broad discretion to "make the numbers". In many instances (e.g., AIG, Bear Stearns, Citigroup, Lehman Brothers) such an approach to oversight invited moral hazard with serious consequences. When combined with financial leverage and risk leverage, decisions tainted by moral hazard can result in enormous shareholder losses.

Insurance companies need to revamp their MBO frameworks to reduce the risk of moral hazard. They need to establish corporate cultures in which discussions about objectives, strategies and results, while never informed by perfect knowledge and foresight, are guided by "high road" values of trust and loyalty. Revamped MBO frameworks should explicitly include consideration of risk insights produced by ERM and verification of the alignment of actions taken with approved plans and strategies.

To accomplish such a transformation of their cultures, insurers may need to link their ERM and MBO processes through the implementation of:

- Risk-adjusted financial performance metrics
- Risk-adjusted performance benchmarks, related to expectations of capital market investors
- Incentive compensation awards linked to long-term measures of business value, including indicators of operational performance, and current profits.

Since no company operates with perfect foresight, boards of directors need to grant adequate discretion and flexibility to senior management for performance management. Adjusting objectives and targets can be of critical importance when business conditions change unexpectedly. In an uncertain world, rigid enforcement reinforces greed and fear elements of corporate cultures, undermines trust, breeds cynicism and "gaming the system" and increases moral hazard by inducing behavior that can, in time, fatally weaken an insurance company.

CONCLUSION: ERM, VBM AND MBO, PILLARS OF RESILIENCE

In the aftermath of the present crisis, insurance companies need to integrate insights about strategic risks and capital adequacy produced by ERM into VBM and MBO so that these three processes can work together as pillars of resilience. Enhancing and aligning these processes is an important "defensive" step toward ensuring continuing viability as a going concern— in short, resilience. Expect investors to demand that. ✦

Note: See "Lessons from the Financial Crisis for Directors and CEOs of Insurance Companies" by Jean-Pierre Berliet, in "Risk Management: The Current Financial Crisis, Lessons Learned and Future Implications," published jointly by the Society of Actuaries, the Casualty Actuarial Society and the Canadian Institute of Actuaries, December 2008 and at: http://www.soa.org/library/essays/rm-essay-2008-berliet.pdf.

Sailing and Insurance Risk Management Are One and the Same

By David Schraub

WHAT SAILING IS ALL ABOUT

The Vendee Globe is an awesome adventure with great sailors, hefty risks and a finish line many weeks later. This race around the globe is without stop or external help. The sailor is alone with his/her boat for months and is exposed to all the elements. Michel Desjoyeaux won the 2008/2009 race, with a time of 84 days, 3 hours, 9 minutes and 8 seconds, at an average speed of 12.3 knots on the theoretical route and 14 knots over the 28,303 miles actually covered on the water. The last of the sailors finished the race 42 days later while 18 competitors retired.

Many followers focus on the race itself and how to get the boat going faster and faster. Student sailors[1] are thrilled about the way one can push the boat, fine tune the sail positions to maximize speed, all while preventing mechanical breakdown. They also know how to time a turn to avoid rocks and other direct threats. More advanced players know about tides,[2] currents, seasonal weather and other elements that impact floatability. Very few know anything about aerodynamics, hydrodynamics and other mechanical resistance theories that come into play when designing the shape of a boat. Without second-guessing engineers, top sailors need to have: (1) a working knowledge of these mechanical fluid theories to be able to understand where the breaking point is; (2) a deep knowledge in marine currents and wind seasons around the globe; and (3) perfect navigational skills.

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THE THREE HORIZONS

THE FIRST CHOICE IS STRATEGIC.

For the sailor, this means what type of gear for what type of race: whether monohull or catamaran, small and light or strong and heavy, these choices will have a strong impact on future decisions. You don't just take your canoe through Cape Horn. These decisions have to be made very early, up to five years before the race.

For the insurance CEO, this means deciding what type of business model for what type of industry using a horizon of five years or longer. For instance, he must know which line of business the company is in and how it makes its money. Health insurance business profits from charging a higher premium to the policyholder while managing health-care costs that are paid to health providers. Risks associated with health insurance business are mainly strategic (with the Obama administration currently rewriting the rules of the game). Spread business profits from earning a good return on invested assets and passing only part of it to the customers (thus the company earning the spread between earned and credited rate).Risk here is mainly market risk. The P&C and life insurance business model is based on risk aversion,[3] while the risks truly lie in pricing and underwriting. Again, the decisions have to be made very early.

THE SECOND CHOICE IS PLANNING.

For the sailor, this means which route he should take with a time horizon measured in weeks. These itinerary choices are bound by the type of boat chosen previously. All available routes are not created equal: some have better winds in some seasons; others have stronger currents. Depending on his boat structure and his own skill set, he may prefer wind over current, a smoother ride than a high risk and high speed route. In the 2008/2009 race, Guillemot took a better route than Davies close to the Brazilian coast, but he had more adventures (he was chased by some angry fishermen as his boat was caught in their fishing lines).

For the insurance CEO, this means capital allocation to business unit, reinsurance and other planning decisions with a time horizon of one year. He will allocate capital to a business unit that has a high ROE or a low risk pro-

FOOTNOTES:

[1] Unfortunately, I am well below this stage (but ready to be taught).
[2] Except in the Great Lakes area.
[3] Customers are ready to pay a certain amount in excess of their variable expected losses to be able to remove uncertainty.

"For risk management purposes, most of this debate is irrelevant. All metrics should produce consistent risk profiles."

file, and enter reinsurance agreements to reduce risks or to manage capital. This allocation is made possible by the capital level of the company (strategic level), which impacts tactical decisions later. Entering and exiting a distribution channel is another decision that needs to be made at this level, as well. Such a decision is either in compliance with the business model choice previously made or is reshaping it. The same decision will impact the universe of tactical possibilities.

THE THIRD CHOICE IS IMPLEMENTATION.

For the sailor, this means actually riding with a time horizon in minutes. He needs to pull the right rope to get the sail where it needs to be. Also, he has to understand where the sail needs to be. A one-quarter winch can lead to two additional knots per hour. Maneuvering room depends on the boat structure and the route chosen; decisions will be challenged if skills are misestimated.

For the insurance CEO, this means implementation with a horizon of a month or less. Value sharing between sales force, customers and company[4] needs to be sorted out in order to sell enough profitable business just as private placement underwriting has to be performed properly to limit potential default.

INTERACTION BETWEEN HORIZONS

An upstream decision shapes possible choices down stream. A downstream choice must either comply with the upstream decision or force a shift from the upward decision.

For the sailor, this could mean

- Stop, fix the boat and go back to it—implementation issues may force him to rethink gear choice (Desjoyeaux did just that on day one); and
- Turn around and change route if the shortcut is not worth facing the storm—implementation issues force one to rethink the route (for instance, Thompson was forced to turn back to shelter to wait for the Cape Horn storm to weaken).

FOOTNOTES:

[4] This includes sales incentives, expense structures, product design and apparent value for customers.

For the insurance CEO, this could mean:

- Sales expenses are framed by the choice of distribution channels—previous choices constrain tactical decisions; and
- Distribution economics may lead to exiting a line of business—here tactical issues challenge the planning decisions.

OLDER AND NEWER SETS OF METRICS

OLD RISK MANAGEMENT METRICS

For the sailor, this means feeling the boat hull to check for rough spots, climbing the mast to look for storms or land, looking at the compass, sextant and the sun's position to choose the route. Regardless of technology and new tools at their disposal, sailors will use some or all of these traditional approaches to feel comfortable with their decisions—either boat structure, route or their implementation. In other words, these old techniques draw a reliable picture in most cases.

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For the insurance CEO, this means looking at RBC factors, Solvency I factors, liquidity ratios, greeks and other formulaic approaches. These measurements are very useful and are familiar to everyone. As such, communication is enhanced, people know their usefulness and issues, and they can adjust the metric to compensate any perceived shortcomings. In today's crises, companies are short on capital, whatever the metric being used. As for old sailing techniques, these old metrics still correctly describe the risk faced in most cases.

NEW RISK MANAGEMENT METRICS

For the sailor, the new toolbox includes: night goggles, infrared goggles, radar, sonar, GPS positioning, depth finder and weather forecasts. At the start, sailors have healthy

EACH NEW METRIC HAS ITS PROS & CONS

Within the new set of metrics, there is a healthy debate regarding which metrics to use. For planning considerations, the candidates are:

- CTE on real world projection, advocated by the NAIC
- Risk neutral projection under stressed starting conditions
- Stochastic on stochastic
- Canadian approach
- Padded assumptions vs. conservative use of the end of the confidence intervals vs. best estimates

Differences are important in terms of:

- Robustness—prevention of gaming the measure / pre-approval of models / standard scenarios / auditability;
- Practicality considerations—compute time and shelf life of results / comparability of results / meaning;
- Shareholder vs. policyholder perspective—Shareholders are interested at VaR type of metrics due to their put option to walk away whereas regulators lean toward CTE measures as they have to pay off the policyholders in an untimely fashion;
- Percentile level—consistent across companies vs. linked to ratings with/without group support;
- Tail event measure vs. moderately adverse event measure; and
- Different workloads.

For risk management purposes, most of this debate is irrelevant. All metrics should produce consistent risk profiles. Comparison across risks should be identical when viewed either using a CTE(80) or a VaR(95) measure, and having a handful of CTE & VaR measures at different calibration points should cover most cases. For reserving, capital management and other applications, the choice of metrics carries more weight.

Life insurance metric	Drawback	Sail metric	Drawback
VaR	Stuffing the tail	Depth measurement	Miss floating tree trunk
CTE on major risks, PAD assumption on other	Insufficient PAD as non-modeled risk correlated with tail event of model risk	Goggles and binocular	Miss submarine
CTE on all risks	Computer time and other practicality considerations	Sonar, radar, binocular, depth measurer, …	Expensive
All metrics help avoid adverse movements in major risks (e.g., interest & equity risks)		All metrics will avoid wreckage on the seashore	

The concentration risk from buying bonds issued by an insurance group, which also happens to be a substantial reinsurance counterparty, is not captured by any of these metrics. Risk measurement will not be magically sorted out by regulators or rating agencies without any company efforts!

"The important thing is not which metric to use, but to know the shortcoming of the metric chosen and to be able to mentally compensate."

skepticism regarding the new tools but after some time the mistrust wears off due to measurement improvement and by uncovering both the usefulness and shortcomings of the new metric. Weather forecasts are used globally; we all know that the one-day forecast is trustworthy on land and close to the shore, but only generally accurate in international waters. We also know that a two-month forecast is not worth the paper it's printed on.

For the insurance CEO, the new toolbox includes cash flow testing, C3 Phases 1, 2, 3, PBA, Solvency II, daily VaR and 10-day VaR and FAS 157; all stochastic in nature. Some of these metrics have been field-tested longer than others and are beginning to gain acceptance. People know what the New York 7 (NY7) scenarios are, and what failing a couple of these scenarios means. They also know how to either game or prevent gaming the projection and how to audit the calculation (e.g., NY prescription around some assumptions, assumption review, single cohort recalculation, etc.). Other newer metrics are just starting to be articulated.

The important thing is not which metric to use, but to know the shortcoming of the metric chosen and to be able to mentally compensate.

EACH HORIZON NEEDS ITS METRIC

For a sailor, this means

- Strategic—Boat hull to check and computerized hydrodynamic simulation;
- Planning—Prior experience, GPS and weather forecasts; and
- Implementation—Bare eye vision and depth measurement.

For the insurance CEO, this may mean the same metric(s) but with widely different calibrations.

- Strategic —Unknown to me.
- Planning—The standard metric is Solvency II within Europe. This is a one-year VaR Cash Flow metric for various risks with results correlated ex-post. The underlying assumption is that issues can be dealt with by management on a strategic level given the company survives one year. In the United States, the standard metrics are the NY7 and C3 calculations, which are both statutory projections. These seven prescribed deterministic scenarios for interest rate movements have been around since the mid 1980s. Actuarial Opinion Memorandum readers must know how to judge the level of conservatism within the assumptions and how to adjust for the perceived realism of the scenarios. This current field test leads to a deeper audit. C3 Phases 2 and 3 are CTE calculations that suffer from problems similar to Solvency II:
- To model implies that there is model risk.
- To model implies that there is a historical data calibration risk.
- Shareholders/bondholders are not interested in the size of losses beyond their commitments and prefer VaR measures; regulators pick up the tab and want CTE.
  - Prescribed assumptions or prescribed economic scenarios sacrifice the company risk measurement for the convenience of comparability.
  - Solvency II—Using silo risk metrics implies that there is correlation risk. Again, a consistent measurement across all risk types means that there is comparability.
  - Solvency II—Underlying assumptions regarding that of modifying strategies in a stressed environment is now under review. For instance, raising capital or selling a large block of business under reasonable conditions has not been possible during the last 12 months.
  - C3—CTE measures the size of the catastrophic losses, where actual data is scarce and the modeling of behavior is even less accurate.[5]
- Implementation—The standard metric for an investment desk is either the daily or 10-day VaR Cash Flow metric for credit, market and operational risks. VaR models the frequency of losses above a threshold. The underlying assumption of that metric is that positions can be liquidated or hedged at any time without residual risk.

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FOOTNOTES:

[5] For example, actual to expected differences are already difficult to track for interest sensitive dynamic lapses on deferred annuities under normal conditions. The use of using the same formula at the tail to set the reserve is debatable. The joint distribution of equity and interest at the extreme tail is also another controversy.

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This metric is currently gaining ground, and various audiences are starting to understand its limitations:

- Again, to model implies that there is model risk.
- To model implies that there is historical data calibration risk.
- VaR provides no information regarding the size of losses above the threshold when losses happen.
- Silo risk management implies that there is correlation risk and consistent measurement provides comparability.
- Underlying the assumptions of instantaneous liquidable/ hedge-able positions is also under review, which may possibly negate the risk management purpose.

Yearly VaR vs. daily VaR. This is the same VaR tool calibrated at different levels. It also is impacted by other practicality considerations such as the shelf life of results or the scope. In the same way that sonar and radar are both based on the projection of sound or radio waves being broadcast and the echo being recaptured and analyzed to deduce what the shape of the environment is, calibration differences allow one to look under water while the other stay above water, differing VaR metrics allows to explore either sort term or long term horizons.

DON'T FORGET ANY HORIZON AND START MEASURING

Risk management should not be restricted to a single horizon. A company performing only implementation risk management is like a sailor who is very skillful at avoiding the icebergs surrounding his boat, but has no idea of why they are surrounding his boat in the first place.

Whatever is not measured is not managed. For each time horizon, measurement issues will arise. Management needs to be aware of any possible bias from the models, metrics and calibration *(http://www.wilmott.com/blogs/paul/index.cfm/2009/1/8/Financial-Modelers-manifesto)*. However, analysis paralysis should be avoided at all costs. Companies should pick one risk measurement framework and implement it for each horizon, i.e., business models (five plus years), capital allocations (one year) and tactical decisions (one month or shorter). Finally companies should refine their framework based both external input and the internal actuarial control cycle.

This is a learning process. It is not to be able to produce numbers, but to fully understand what the numbers both represent and miss. ✦

Simulating an Emerging Risk Project

By Beverly Barney, Shiraz Jetha, Frank Ashe, Evelyn Meierholzner and Dave Ingram

FIRMS NEED TO THINK ABOUT AND PREPARE FOR ADVERSE EVENTS and environments that have never happened before—the "unknown unknowns" of Donald Rumsfeld. In-depth exercises exploring emerging risks and their consequences for the firm provide a deep insight into the organization's activities and vulnerabilities, while helping to better prepare to survive and thrive when these occur. This is the real value of these emerging risk exercises. If this value was ever unclear, the financial market events of the past 18 months have certainly highlighted the value of such work.

However, few firms, and few people, have systematically approached this topic. Most management practices are organized around areas where there is information that, with varying degrees of analysis, can lead to a choice between clear alternatives based upon sensible business criteria. Emerging risks, by definition, usually do not have any supporting data. So how do businesspeople investigate these emerging risks?

This is just the question that a self-selected and ad-hoc group of risk managers decided to explore with a virtual project organized through the International Network of Actuarial Risk Managers (INARM). The participants were from the United States, Australia and Germany. The group meetings were held via the INARM blog, and over 10,000 words of the discussions are still posted there.

The group worked on the project over four months. We agreed to use a six-step process:

1. Envision a specific emerging risk scenario.
2. Develop potential impacts of the scenario on an insurance company.
3. Discuss how to produce a stress test that can identify the potential severity of the impact.
4. Describe ways that an insurer might develop plans to minimize the impact of the risk.
5. Develop a plan to perform a dry run test (if applicable).
6. Develop leading indicators that might show that the risk is more or less likely and define action triggers as well as triggers for removing the risk from surveillance.

At the end of the four months, the group had several insights from the project:

- Dedicated resources are essential—people attempting to identify emerging risks need to have a significant portion of their time allocated to this; it will not be effective if simply added on to their existing workload.
- The process is more difficult than anticipated, especially when the emerging risk is not something that is an extrapolation of current insurance business trends.
- More questions were raised than were answered.
- Most group members never became comfortable with the scenario chosen.
- The experience with this project will make future emerging risk projects easier and more productive.
- The blog was not the best media for this project; more live discussions would have been helpful.
- More structured leadership was needed than the all-volunteer group could provide; with more resources allocated within a firm, a formal process can be undertaken.

The remainder of this article is a brief summary of the group's results from the six steps.

STEP 1. ENVISIONING A SPECIFIC EMERGING RISK SCENARIO

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The scenario selected was specifically chosen because it was different from other emerging risks discussed in other forums. It was taken from *Terror and Consent* by Philip Bobbitt, where the evolution to a "market state" (from a "nation state") was a central idea of the book. In a "market state" more and more responsibilities of governments are left to the market to provide, to the extent that private sector options are available for such services. Less government involvement is replaced by more involvement by non-government organizations (NGOs). Market states are legitimated by promoting the opportunities of their people; the United States, United Kingdom and European Union

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are seen as examples of states that appear to be evolving to market states. For a more detailed discussion, the interested reader is referred to the blog at *http://riskviews.wordpress.com/emerging-risk-project/* and to Bobbitt's book. One member of the group called the scenario "emerging risks from government's withdrawal from historic core functions"—a succinct summary.

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One of the ironies of the project was that over the four months that we worked on it, the scenario came to look more and more unlikely as the world moved toward more government intervention rather than less. The group members spent almost half of the project examining and seeking to understand the scenario. This is not unusual, as it is important for those involved to have a solid understanding of the scenario. In practice, independent experts may be consulted in matters pertaining to the scenario, in particular its contextual setting.

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The "market state" scenario was eventually deemed to have implications on globalization, pensions and healthcare, and regulatory constraints on corporate behavior. To bring the scenario down to more manageable proportions, the group agreed to limit the scenario to the situation where one country quickly moves closer to a market state, rather than attempting to work through the consequences of the entire world shifting in that direction.

STEP 2. ENVISIONING POTENTIAL IMPACT ON INSURERS

The group interactively developed the following list of potential implications:

- More business opportunities for insurance companies.
- Higher technical challenges due to Social Security type features of insurance coverages and a more diversified ethnic mix in the portfolio.
- Not necessarily less regulation, but more principle-based and strong solvency regulations due to the increasing importance of the private sector for the social welfare. Potentially more Social Security regulations will be instituted for particularly sensitive private sectors (for example, this is true in France today for certain carriers in the second layer).
- More active regulators and more non-formal supervision by NGOs, e.g., consumer organizations.
- Strong expectations on the part of the insurers, the political function, the public (mobilized via NGOs) and the legislature that companies act in a socially responsible way while remaining exposed to capital market pressure to produce adequate returns. This could mean that changes in the legal forms of the companies are necessary.
- Increased responsibility and necessity for the private sector to introduce cost efficiency while operating in an environment shared by state social security (example: curbing health insurance expenditure).
- Improved risk management for catastrophe risk.
- Challenge to drive the capital market environment such that it can accommodate bigger and bigger investments for retirement and other covers.
- Challenge to deal with longevity risk from an aging population.
- Increased cross-border competition and M&A activity.
- Increased technical competencies required to succeed in the business.
- Increased claims on insurance policies that were sold before the shift to market state.

Insurers will have to determine which lines of business ("risks") they will pursue, which will depend, in turn, on their own strengths, including expertise levels, economic capital requirements, availability of capital to support business plans, infrastructure requirements to support the lines, distribution implications, etc.

A final summary of this step would be to develop a risk matrix along the dimensions: internal (product, operational functions, investments, human resources, capital resources, strategy, etc.) and external (competitive environment, regulatory, macroeconomic drivers, systemic market risks,

"To go from possible plans to actual implementation choices, management must decide on the appropriate risk response(s) along internal and external dimensions."

etc.). This would allow us to create diverse risk scenarios and assess them along the relevant dimensions.

STEP 3. DISCUSS HOW TO PRODUCE A STRESS TEST THAT CAN IDENTIFY THE POTENTIAL SEVERITY OF THE IMPACT.

The company could first do sensitivity testing to see how sensitive the volume and amounts of claim payments are to changes in individual assumptions. Then, deterministic scenarios could be run increasing/decreasing those assumptions to which claim volume and amounts are most sensitive, to see at what values of those assumptions the pricing no longer covers claims plus expenses as well as just the claims.

The company might also do stress testing to see what volume of policies is needed to achieve assumptions +/- X standard deviations with Y% confidence.

The company might also want to identify other scenarios which could interfere with meeting objectives for this business.

After these analyses and testing have been done, the company would want to identify leading indicators that might mean negative outcomes are becoming more likely, and then monitoring systems for those indicators.

Negative outcomes are not only in additional quantum of claims; there is also the potential loss of market share as competitors react more appropriately to the changing conditions.

STEP 4. DESCRIBE WAYS THAT AN INSURER MIGHT DEVELOP PLANS TO MINIMIZE THE ADVERSE IMPACT OF THE RISK.

To go from possible plans to actual implementation choices, management must decide on the appropriate risk response(s) and may be guided by an analysis of potential risk responses along the internal and external dimensions described above or adjusted as appropriate.

The response can be internal or external. Internal responses include actions such as: adjustment of product strategy; adjustment of underwriting strategy (for example in disability); identification of improved investment possibilities; strengthening of know-how in product, underwriting, investment, etc. areas by bringing in new staff; additional capital resources for higher and riskier business volume; and increased peer review. As examples of external responses we have: the use of consultants to increase know-how in certain areas including pricing of new coverages; reinsurance for difficult to assess, rare or new, "unknown" and "difficult to quantify risk"; alternative risk transfer solutions such as catastrophe bonds; market-wide pooling of otherwise uninsurable risks; joint ventures to leverage common resources; joint marketing effort; and regulatory effort to bring down systemic market risks.

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STEP 5. DEVELOP A PLAN TO PERFORM A DRY RUN TEST (IF APPLICABLE)

The group decided that this scenario did not lend itself to a dry run, in part because the impact of this type of shift of government policy would be felt increasingly over an extended period of time. A dry run test is more oriented to an incident that hits suddenly in a compressed time frame.

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STEP 6. DEVELOP LEADING INDICATORS THAT MIGHT SHOW THAT THE RISK IS MORE OR LESS LIKELY AND DEFINE ACTION TRIGGERS AS WELL AS TRIGGERS FOR REMOVING THE RISK FROM SURVEILLANCE.

Changes in the following indicators were considered important:

1. Market share for companies with different forms of governance and management.
2. Level of discussions at industry events, articles in newspapers and pressure from NGOs.

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3. Unemployment and underemployment rates.
4. An index of medical costs for various coverages.
5. Numbers and amounts of claims submitted relative to expected.
6. Relative competitive price index and price differentials.
7. Numbers and amounts of claims compared with government statistics

CONCLUSION

In the end, do we really want to study risks like this that seem so implausible? Most likely, if scenarios are really implausible within a certain time horizon, then we shouldn't bother. Management responds to risks that are plausible but with low probability. In this case, the idea of a change in the way the political system, the social system and the economic system interact may be judged to be either more or less plausible as the current crisis evolves.

Part of this change will be the loss of influence by the Chicago free-market school, whose ideas were pushed too far by various rent-seekers, naïve but influential ideologues who misunderstood the theory, and agents (in the economic sense) who pushed the "theory" for their own gain, e.g., senior management in most investment banks, ordinary banks and other companies.

We don't even need new regulation for this to happen—regulators using their current powers but with more determination, and less regulatory capture, will be sufficient. So perhaps this scenario is not really implausible; it just hasn't happened yet.

In the end, the group decided that even in this case where events that occurred during the project period led us to think that the world was going in the opposite direction, an exercise in imagining the impact of less regulation and government involvement in the economy was useful practice for imagining the ramifications of more regulation and government involvement, in part because the exercise encouraged imagination in a way that is not often required in day-to-day business. ✦

As this project was ending, all of us agreed that we wanted to try this again using some of the "lessons learned." We're starting by focusing on what seemed to be hardest for us—understanding the future scenario. Several members of the Forecasting and Futurism Section are now working with us, as well as the author of the periodic survey on emerging risks. We've selected the emerging risk that we think we will focus on and are now doing research to collect as much information as possible in order to select the best technique for studying a possible future event. If this sounds interesting to you and you'd like to join us, please contact Bev Barney.

Analyzing Credit Concentrations

By Diane Reynolds

This article focuses on one key idea from a paper submitted to the ERM Symposium: risk attribution analysis.

CONCENTRATION RISK IN GENERAL AND CREDIT CONCENTRATIONS IN PARTICULAR, CAN CREATE CONSIDERABLE SYSTEMIC RISK. For this reason, particular emphasis is currently being placed on assessing, monitoring and managing credit concentration risks. From the business perspective, models that fail to consider existing portfolio concentrations corrupt signals used to make business decisions.

To illustrate, consider a case where two investments are possible. Both investments have exactly the same profit profile: product type, default probability, maturity horizon and loss given default. However, one investment lies in the sector in which the firm is highly concentrated, while the other is in an emerging business area for the firm. The second investment clearly adds more diversification, creating an overall more optimal portfolio.

The usefulness of portfolio models lies in their ability to incorporate many facets of credit risk into a single measure. Typically, such models acknowledge and capitalize various types of risk and the interactions between key risk types. For example, market-driven derivative exposures might combine with macroeconomic impacts on probabilities of default and recovery values over the varying life-cycles of each transaction.

The result is a single benchmark metric useful in controlling risks, managing limits and creating consistency with the overall risk appetite of the firm.

However, a single number is not sufficient for risk management and mitigation. Manipulating the risk profile to best serve the needs and preferences of an organization is a multi-dimensional task, making it important to understand the sources and interactions of risk in the portfolio at a more granular level. This can be done through the process of capital attribution.

Estimated losses at the portfolio level can be attributed to different risk types (or sources) by recalculating the risk measures using different combinations of assumptions to isolate particular risks. Usually, the most influential risks are: default risk, migration risk, name risk and sector risk. It is possible to isolate each of these risks in turn by varying the model assumptions.

To illustrate the information gleaned from such analysis, and the details of its implementation, we make extensive use of a case study based on an international portfolio of 500 publicly traded and rated exposures. The overall exposure of the portfolio is approximately $44.5 billion USD, with individual exposures ranging from just over $1 million to almost $3.5 billion. The average exposure is approximately $88 million, but the median exposure is only $10 million.

Exposure breaks down into six major ratings grades (Fitch Ratings) and 10 major industries (Dow Jones) across 10 countries. By design, clear concentrations are apparent in the financial and energy sectors, in single-A-rated firms and in the United Kingdom, United States and Canada.

In the base case of the case study, all credit risk factors are modeled using a mark-to-market approach that includes both default and migration risks. Specifically, a multi-factor model is used in which drivers of systematic credit risk are used to represent all default correlations. These credit drivers are associated to names based on their country and industry. Idiosyncratic risks are modeled using Monte Carlo simulations. The overall loss (99.9 percent) is estimated to be $2.58 billion USD.

To assess the impact of these factors on total capital is not entirely straightforward. The immediate tendency would be to modify the settings for each factor, one by one. In fact, this is insufficient because of the interaction between components. So, we consider eight cases, including the base case just discussed. The other cases involve turning on and off the key assumptions in various combinations. The cases are divided into three

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Table 1: Risks Measured in Each Case

	Migration Risk	Name Concentrations	Sector Concentrations
Core Models			
Base Case	Yes	Yes	Yes
Simple Model	No	No	No
First-Order Effects			
Default-No Default (DND)	No	Yes	Yes
Full Diversification (FD)	Yes	No	Yes
Single-Factor (SF)	Yes	Yes	No
Second-Order Effects			
DND / FD	No	No	Yes
DND / SF	No	Yes	No
FD / SF	Yes	No	No

Table 2: First-Order Effects

Model	Loss (99.9%)	Interpretation	Attribution (Base - Model)
Base Case	2,581,738,825		
Default / No Default (DND)	1,944,680,630	Migration Risk	637,058,195
Full Diversification	2,125,727,123	Name Concentration	456,011,702
Single Factor	3,533,178,245	Sector Diversification	951,439,420
		Total First-Order Effects	141,630,477

categories: core models, first-order effects and second-order effects, as summarized in Table 1.

To attribute a portion of this risk to migration risk, we "turn off" migration risk and recalculate under the assumption of a two-state model: default and no-default. The resulting loss (99.9 percent) level is $1.94 billion USD. Thus, we can attribute the difference, i.e., $637 million USD, to migration risk.

Recall that the base case is a multi-factor model. By changing to a single-factor model, we see a loss (99.9 percent) level of $3.53 billion USD. Thus, the multi-factor environment (expressed partially through sector diversification within the portfolio) is providing $951 million USD of diversification benefit.

If the increase in loss (99.9 percent) seems unintuitive initially, it is easily explained by examining the correlation assumptions. Overall, higher correlations imply higher losses. Because the multiple factors are correlated, but not perfectly correlated, having only a single credit driver for all counterparties increases the average pair wise asset correlations significantly, from 18.7 percent in the multi-factor case to more than 31 percent in the single-factor case. Higher asset correlations lead to higher default correlations as well (2.1 percent vs. 0.9 percent).

To isolate the name risk, we change from Monte Carlo models for idiosyncratic risk to the assumption of full diversification. As a result, loss (99.9 percent) drops to $2.13 billion USD. Clearly, the portfolio is not large enough to completely diversify away the idiosyncratic risk. Attributing the $456 million USD difference to name concentration risk in the portfolio provides significant insight: no matter what diversification strategy we assume, we are unlikely to reduce capital requirements, as measured by loss (99.9 percent), beyond the $2.13 billion USD level.

For each of the three sources of risk, we have measured its isolated impact on the portfolio-level risk measure, loss (99.9 percent). Such first-order attributions allow ranking of the risks in order of importance: sector diversification, migration risk and name diversification. These are referred to as first-order effects because, in each case, only one assumption was changed. Table 2 shows a summary of the results of the first-order attributions.

"It is not only important to assess the impact of each risk but also to look at the interactions between them in creating a complete picture of concentrations."

Can the first-order effects be used to explain changes in the capital support for the portfolio? Consider an experiment where all three changes identified above are made simultaneously. The result is a default-only model assuming full diversification and based on a single factor. (It is worth noting that this model is well-aligned with the assumptions underpinning the formulae for Basel II calculation.)

Under this very basic model, the loss (99.9 percent) result when all three assumptions are changed simultaneously is $1.95 billion USD. The total change is thus $626 million USD. So, in fact, the total first-order effect of $141 million USD comprises less than 23 percent of the total change.

The reason for the discrepancy is that the model is neither straightforward nor linear. It includes interdependencies, correlations and interactions between these sources of credit risk. Clearly, with higher-order effects contributing $485 million USD or almost 88 percent of the total change, interactions are critical. These calculations are summarized in Table 3.

Table 3: Higher-Order Effects

Model	Loss (99.9%)
Base Case	2,581,738,825
Single Factor, No Name Concentration, DND	1,954,955,399
Difference	626,783,426
Total First-Order Effects	141,630,477
Total to be Explained by Higher-Order Effects	485,152,949

Further assessment of second-order effects provides additional information, and renders an accounting of almost all differences observed between the base case and the most basic model. From the results in Table 4, we see that the second-order effects account for almost all of the initial discrepancy. The largest of the second-order effects arises from the interaction between the multi-factor models and migration risk. This might arise if migration risk has a regional or sector-specific component, indicating the need for further investigation before attempting to hedge either type of risk.

Table 4: Second-Order Effects

Model	Loss 99.9%	Deviation	Total First-Order Effects	Second-Order Effect
Base Case	2,581,738,825			
DND / FD	1,340,623,229	1,241,115,596	1,093,069,897	148,045,699
DND / SF	2,404,043,868	177,694,957	-314,381,225	492,076,182
FD / SF	3,241,306,962	-659,568,137	-495,427,718	-164,140,419
Total Second-Order Effects				475,921,462

In contrast, the largest combined effect is from the removal of name concentration risk and migration risk. This second result is expected, since the single-factor model is based on an overall higher level of correlation. When we remove the idiosyncratic risk from the portfolio and no longer allow migration between credit states, the capital requirements decrease substantially. However, the decrease is only slightly more than the sum of the decreases from applying each of these assumptions individually. This implies that there is little relationship between name concentrations and migration risk, indicating independent hedging strategies are likely to be as effective as a coordinated effort.

In actual portfolios we've assessed, the breakdown between first- and second- order effects has varied substantially. We have seen, as illustrated in this case study, that it is not only important to assess the impact of migration risk, name risk and sector risk, but also to look at the interactions between these types of risk in creating a complete picture of concentrations.

Concentration risk is likely to remain an issue that requires a significant amount of time and effort to manage. However, regulators and other stakeholders are demanding more accurate and precise answers which can only be obtained by using comprehensive models to support more detailed, multi-dimensional analyses. ✦

A Review of the Performance of Near Term Hurricane Models

By Karen Clark

INTRODUCTION

Catastrophe models are valuable tools for estimating what *could* happen. But how good are they at predicting what *will* happen? More specifically, can catastrophe models be used to predict actual catastrophe experience over a brief one-, two- or five-year period?

Such "short-term" or "near-term" hurricane models were introduced to the insurance industry in 2006 and were designed to estimate insured hurricane losses for the five-year period ending in 2010. Use of these near-term models by insurance and reinsurance companies was a radical departure from the way in which catastrophe average annual losses (AALs) and probable maximum losses (PMLs) are typically derived from the catastrophe models. Use of the near-term models also caused market disruptions in coastal areas because of the significant increases in hurricane losses the near-term models predicted.

With the close of the 2008 hurricane season, we are three years into the five-year prediction period. While no definitive conclusions can be reached at this stage, we are beyond the midway point and can review the performance to date of the near-term hurricane models.

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THE BLACK BOX

With recent advances in computing power and the ability to quickly analyze large volumes of data, computer models have become ubiquitous in many industries, particularly financial services. While computer models are valuable decision-making tools, they can lead to bad business decisions when not used correctly. Model users frequently forget that all models are based on simplifying assumptions, and therefore *all models are wrong*. Models attempt to replicate reality, but they are not reality.

It's easy to forget this fact when models produce detailed reports showing numbers with two decimal place precision. Many of the models used in the financial services industries are complex computer programs developed by Ph.D.-level scientists, engineers and statisticians. Because most non-technical people, in many cases the decision-makers, don't understand what's inside the "black box," they don't question what comes out. But precision does not equal accuracy.

Many models are inaccurate simply because they are constrained by a lack of data and scientific knowledge. This is certainly the case with the catastrophe models used extensively by the insurance industry. No matter how many Ph.D.s work on a catastrophe model, the fundamental uncertainties around the frequencies and intensities of large magnitude events cannot be removed.

This doesn't mean the models are not valuable—the catastrophe models do provide a consistent framework for making risk management decisions. They are valuable tools for generating estimates of what could happen. They can also provide credible estimates of the probabilities of different size losses occurring.

THE NEAR-TERM MODELS

The 2004 and 2005 hurricane seasons were particularly active and resulted in over $80 billion of insured hurricane losses. In 2006, the three major catastrophe modelers—AIR Worldwide (AIR), EQECAT and Risk Management Solutions (RMS)—introduced new hurricane models. These new models are based on short-term assessments of the frequencies of hurricanes. Instead of basing hurricane frequency assumptions on long-term experience, the new "near-term" models predict hurricane frequency over a much shorter time horizon. This time horizon has been generally established as a five-year period.

AIR's near-term model was designed to capture possible elevated hurricane activity and losses over the period 2006–2010. According to the company's white paper, "Understanding Climatological Influences on Hurricane Activity: The AIR Near-term Catalog," AIR's approach to estimating five-year hurricane rates was based on statistical analysis relating sea surface temperature (SST) anoma-

"While computer models are valuable decision-making tools, they can lead to bad business decisions when not used correctly."

lies to regional risk from hurricanes. AIR's approach was developed in conjunction with Accurate Environmental Forecasting and Climatek. It was peer reviewed by Dr. Kerry Emanuel of MIT and Dr. Jim Elsner of Florida State University.

Using a five-year forecast of SST conditions, AIR's 2006 near-term hurricane model projected significant increases in hurricane losses. While increases varied geographically, the overall annualized increase in hurricane losses in the AIR near-term model was 40 percent. In 2007, AIR changed its methodology to eliminate the SST forecast element, and changed the name from a "Near-Term Catalog" to a "Warm SST Conditioned Catalog," reflecting the fact that the revised view of risk is conditioned on a typical "warm ocean" season rather than five-year projections of SST. Consequently, increases in risk relative to the long-term model for 2007 and 2008 fell to 16 percent countrywide. This latest research has been published in the peer-reviewed *Journal of Applied Meteorology and Climatology.*

After introducing its near-term model, EQECAT updated it for the 2007 and 2008 hurricane seasons. EQECAT also predicted increases in hurricane activity and losses relative to its long-term averages. Its annual increases have been relatively consistent and range between 35 and 37 percent for countrywide average annual losses.

RMS has been a strong proponent of near-term hurricane models and, in 2006, became the first modeling company to submit its near-term model to the Florida Commission on Hurricane Loss Projection Methodology. The commission reviews catastrophe models on an annual basis to determine their acceptability for personal residential rate filings in the state of Florida. In a presentation at the Florida Commission on Hurricane Loss Projection Methodology Workshop in July 2006, RMS indicated it determined the appropriate risk horizon for catastrophe models is a five-year period. In the workshop presentation, they explained their methodology, which uses a range of statistical analyses and an elicitation of leading experts in the field. The elicitation was organized to obtain a consensus of hurricane activity for the period 2006–2010. RMS ultimately withdrew their near-term model from Commission review, and currently the Florida Commission has not accepted a near-term model submission from any modeling company.

Based on the results of the elicitation process, RMS announced that increases in hurricane landfall frequencies assumed in its model would increase annualized insurance losses by 40 percent on average for the Gulf Coast, Florida and the Southeast, and by 25–30 percent in the Mid-Atlantic and Northeast regions relative to those in its long-term model. Furthermore, its five-year model assumed a higher frequency of major hurricanes making landfall, which led to increases in modeled annualized losses closer to 50 percent in the Gulf, Florida and the Southeast, and 40 percent countrywide.

RMS recommended this model be used for all standard applications of the model by insurers, reinsurers, rating agencies and regulators. In October 2006, RMS held a second and expanded annual elicitation of expert opinions, and announced that the five-year predictions would remain

unchanged for the upcoming hurricane seasons. In December 2007, RMS again confirmed the elevated activity rates and increased overall losses of 40 percent for 2008 and beyond.

HOW THE MODELS PERFORMED

All three catastrophe modelers predicted above-average hurricane activity and losses for the period 2006–2010. In order to evaluate the performance to date of the models, we applied the overall countrywide loss increase predicted by each model to the number of hurricanes, the number of U.S. landfalling hurricanes and the long-term average annual hurricane losses for each year. Note that because the modelers did not publicize the predicted number of hurricanes and landfalling

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hurricanes, the near-term predictions in Tables 1 and 2 are derived numbers. While the modelers could argue that their predicted landfall frequencies are not as high as shown in the table below because they predicted some of the increased loss would come from hurricane intensity increases, the numbers below should be reasonable approximations.

Table 1: Number of Atlantic Hurricanes

			Near-Term Predictions		
	Long-Term Average	Actual	AIR	EQECAT	RMS
2006	5.9	5	8.4	8.0	8.4
2007	5.9	6	6.8	8.0	8.4
2008	5.9	8	6.8	8.1	8.4
Total	17.7	19	22.0	24.1	25.2

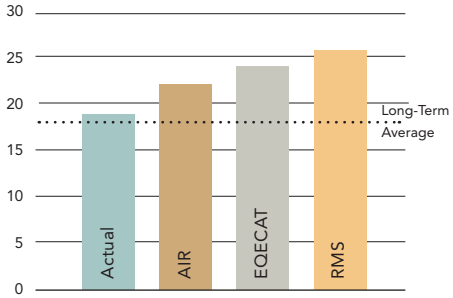


Table 2: Number of U.S. Landfalling Hurricanes

			Near-Term Predictions		
	Long-Term Average	Actual	AIR	EQECAT	RMS
2006	1.7	0	2.4	2.3	2.4
2007	1.7	1	2.0	2.3	2.4
2008	1.7	3	2.0	2.3	2.4
Total	5.1	4	6.4	6.9	7.2

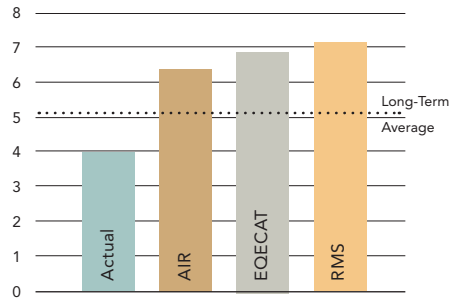
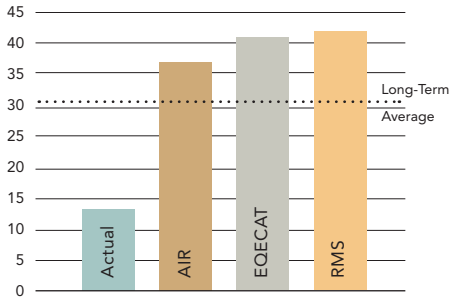


Table 3: U.S. Insured Losses from Hurricanes ($ Billions)

			Near-Term Predictions		
	Long-Term Average	Actual	AIR	EQECAT	RMS
2006	10	0	14.0	13.6	14
2007	10	0	11.6	13.5	14
2008	10	13.3	11.6	13.7	14
Total	30	13.3	37.2	40.8	42



> "There are complicated feedback mechanisms within the atmosphere that cannot be quantified precisely even by the most sophisticated and powerful climate models."

The actual number of hurricanes for each year along with the long-term average number of hurricanes and landfalling hurricanes are from NOAA data. The tables below show how the predictions performed each year and for the cumulative three-year period, 2006–2008.

The long-term average annual hurricane losses shown in Table 3 represent estimates of countrywide insured losses for onshore properties from the long-term hurricane models. Analyses of publicly available information resulted in about $10 billion for AIR and RMS modeled average annual hurricane losses. The near-term predictions were calculated by applying the overall countrywide loss increase for each model to $10 billion. The actual U.S. insured losses are from Property Claim Services (PCS) data.

Three years into the five-year prediction period, all of the near-term models significantly overpredicted the number of hurricanes that would form in the Atlantic, the number of landfalling hurricanes and the insured hurricane losses. While the number of hurricanes is running a bit above average for the cumulative period, 2006–2008, landfalling hurricanes are running about 22 percent below average, and insured losses are more than 50 percent below average.

IMPLICATIONS FOR MODEL USERS

While it is too early to make definitive conclusions about the accuracy of the near-term hurricane models, for the cumulative period, 2006–2008, insured losses are significantly *below* average, suggesting that there is too much uncertainty around year-to-year hurricane activity to make short-term predictions. Hurricane activity is influenced by many climatological factors, many of which are known but some unknown by scientists. There are complicated feedback mechanisms within the atmosphere that cannot be quantified precisely even by the most sophisticated and powerful climate models.

Insurers, reinsurers and regulators need to evaluate the efficacy of the near-term hurricane models in light of this uncertainty. Even the standard, long-term catastrophe models are characterized by a high degree of uncertainty. Short-term assumptions on frequency and severity only magnify this uncertainty and the volatility in the loss estimates.

Of course, if we knew there was a long-term trend in either hurricane landfall frequency and/or severity, and the trends could be credibly quantified, that information should be captured in premium calculations and other risk decisions taken by insurance companies. But hurricane activity can change markedly year to year, as the past several seasons illustrate. Two or three active seasons in a row, even those as extreme as 2004 and 2005, do not necessarily indicate a continuous trend, particularly for hurricane landfalls and insured losses.

CONCLUSIONS

Three years into the application of near-term hurricane models, the model predictions have not performed well. While all three major catastrophe modeling companies predicted significantly elevated hurricane activity and losses for the period 2006–2010, two of the past three years have been below average. Catastrophe models are capable of simulating thousands of potential scenarios of what *could* happen to an insurance company—but have yet to demonstrate significant skill in estimating what *will* happen in any given year or short time period. While catastrophe models, used appropriately, can provide credible estimates of a company's potential loss experience, the models are not able to predict where, when or how big actual events will be. While a definitive conclusion on the near-term hurricane models cannot yet be made, early indications are that a five-year period may be too short for hurricane loss estimation. ✦

Case Study: Economic Capital Analysis at Guardian (The Early Years)

By Barbara Snyder and Ben Mitchell

The management of The Guardian Life Insurance Company of America (Guardian) decided during 2006 to perform an economic capital (EC) analysis, with results to be delivered in the spring of 2007. A second generation EC analysis (EC 2.0) was conducted from fall 2007 through spring 2008. This article describes EC 2.0.

GUARDIAN IS A MUTUAL LIFE INSURANCE COMPANY, with several subsidiaries, operating in numerous lines of business, including individual life insurance, individual disability insurance, retirement products and services (individual and institutional) and group medical and non-medical business.

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In 2008, total premiums for all lines of business, while not in one company, were approximately $7.2 billion. Reserves totaled $32.7 billion; liabilities were about $35.4 billion; and total assets were $39.1 billion.

GENERAL APPROACH: SHORT- OR LONG-TERM?

Guardian first had to decide on the approach for the EC analysis. Two basic approaches were considered.

1. Short-Term

The short-term approach generally looks at a one-year time horizon. An economic basis is used for assets and liabilities so that the long-term impact of the one-year events can be captured. EC is the amount of capital required so that the probability of insolvency is less than the target level, such as 0.5 percent.

Many European insurance companies and their U.S. subsidiaries have used this approach.

2. Long-Term

The long-term approach uses a multi-year time horizon. Thirty years might be a typical horizon. The statutory accounting basis is generally used. Projections are performed using a large number of stochastic scenarios for the primary risk factors. The conditional tail expectation at the x% level, CTEx, is calculated as the average of the worst (100-x)% of the results. This defines the required EC.

The result of each 30-year projection is not quantified by the present value of profits for all 30 years (PV30). Rather, the greatest present value of loss (GPVL) is calculated as the worst of the 30 values calculated by taking the present value of the earnings for the first year only, then the first two years, then the first three years… continuing up the PV30 present value for all of the projection years. If there is no loss (the GPVL is greater than zero) the GPVL is set equal to zero.

For purposes of CTEx calculations the value of "x" might be anywhere from 60 percent to 99 percent.

A few European companies, and some U.S. companies, have used this approach. One of the major rating agencies (Fitch) has developed its own EC model system using this long-term approach.

GUARDIAN'S CHOICE

Guardian chose to use the long-term approach for the following reasons:

- The long-term approach using CTEx is consistent with several other calculations being performed and/or discussed for U.S. insurers, such as C3-Phase II and VAC-ARVM for variable annuities as well as principle-based reserves and capital for individual life insurance.
- Since Guardian is a mutual company, the primary focus is upon statutory values. Guardian's focus is also more on long-term capital needs than on short-term fluctuations.
- The short-term approach must calculate liabilities on an economic basis to reflect the impact of the one-year events. Guardian had not already established a basis for the calculation of liabilities on an economic basis.
- Guardian believed that long-term EC approach using statutory values would be better understood and accepted by the senior management of the corporation and the lines of business, and in the future, the analysis can be incorporated into the way the business is managed.

"The distribution of results for individual risk factors had to be combined into a composite distribution reflecting all of the risks."

Guardian's Process

After initial consideration of the project, we concluded that external resources would be required, both for conceptual assistance and for computing capacity. Consultants from Milliman were selected to provide the required assistance in performing the EC analysis.

The analysis was divided into four primary components, as follows:

1. Business Risk
2. Operational Risk
3. Strategic Risk
4. Capital Analysis

BUSINESS RISK

Guardian operates in four primary lines of business (LOBs).

1. Life—primarily par whole life plus term and universal life.
2. Individual Disability Income.
3. Group—medical and non-medical businesses, comprising dental, life, short-term and long-term disability.
4. Retirement Products and Services—fixed annuities, variable annuities and group pension annuities.

The following chart shows the primary risk factors modeled for each line of business. An "S" indicates that stochastic scenarios were used. A "D" indicates that variations in lapse rates were dependent on changes in other risk factors.

Risks Modeled by Line of Business

	Life	IDI	Group	Retirement
Mortality	S			S
Morbidity		S	S	
Lapse	S		D	D
Interest	S	S	S	S
Credit	S	S	S	S
Market				S

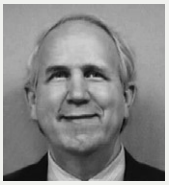
MG-ALFA™ and MG-Hedge™ were used to make 30-year projections, except for Group, where a proprietary stochastic model was developed.

Risks were assumed to be independent, with the following exceptions. Dependent lapse rates were used for some LOBs. Interest rate and market risk scenarios were generated together reflecting correlation between the two risk factors.

After-tax portfolio earned interest rates were used for the discount rates.

Baseline best estimate assumptions were established for each risk factor in each LOB. After-tax profits were projected for 30 years using the baseline assumptions. The present value of these profits was calculated (PV30).

Sets of 1,000 stochastic scenarios were generated around the baseline assumptions for the risk factors marked with an "S" in the chart above. After-tax profits and PV30 were calculated using the stochastic scenarios for each risk factor and LOB, varying one risk factor at a time. A "delta" value was calculated for each scenario as the difference between the scenario PV30 and the baseline PV30.



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The distribution of results for individual risk factors had to be combined into a composite distribution of results reflecting all of the risks. A large number (250,000 was selected) of observations from the composite distribution was created by choosing 250,000 uniformly independent random integers between 1 and 1,000 for each of the stochastic risk factors. For each of the 250,000 observations, the sum of the deltas for the selected scenario number for each risk factor was calculated. This aggregate delta was an estimate of the delta from the baseline PV30 for a projection reflecting the randomly selected scenarios, based on the assumption that the risks are independent.

For example:

Assume that observation number 10,000 was assigned the following random numbers for the stochastic risk factors:

Mortality	142
Morbidity	038
Lapse	871

CONTINUED ON **PAGE 28**

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Interest/Market	413
Credit	910

Then the aggregate delta for observation 10,000 would be calculated as follows:

Life delta for projection using mortality scenario	142 +
Life delta for projection using lapse scenario	871 +
Life delta for projection using interest scenario	413 +
Life delta for projection using credit scenario	910 +
IDI delta for projection using morbidity scenario	038 +
IDI delta for projection using interest scenario	413 +
IDI delta for projection using credit scenario	910 +
Etc.	

Sorting the aggregate deltas allowed for the identification of the composite observations in the adverse tail of the composite distribution. Guardian chose to use CTE99 as the basis for calculating EC, so the worst 2,500 observations were needed. Because the aggregate deltas assume that the risks are independent, and this is not entirely true, the worst 5,000 composite observations were selected for further analysis. This measure made it reasonably certain that all of the worst 2,500 results were included in the sample.

For each of the worst 5,000 observations, a projection was made for each LOB using the combination of scenarios indicated by the randomly selected scenario numbers for that observation. The annual profits for all LOBs were summed to give a 30-year aggregate profit stream for the observation and PV 30 was calculated. The PV30s for all 5,000 observations were sorted and the worst 2,500 defined the worst 1 percent tail of the composite distribution to use in the calculation of CTE99. The GPVL was calculated for each of the worst 2,500 observations, and the average of these 2,500 GPVL values equaled the CTE99 value of the EC for the combination of Guardian and its subsidiaries.

And what is the result?

The "corporate" EC for business risk was less than 0.1 percent of beginning surplus.

There are several reasons that the corporate EC for business risk is very low.

- *The dividends paid on the par whole life business can be adjusted to reflect changes in experience*. The EC projections calculated adjusted dividends to reflect changes in portfolio earned interest rates. The dividends could have been adjusted to reflect adverse experience in mortality and credit, but Guardian elected not to make these adjustments in the model, resulting in extra conservatism. The cushion resulting from the adjustability of the par dividends allows a well-run mutual company to absorb wide fluctuations in experience without the extreme adverse impacts that might be found in other companies.
- *The Group business is repriced annually to reflect emerging experience.* The EC projections assume that repricing is done annually and that pricing changes impact the persistency of the business.
- *There is a significant diversification benefit when the profit streams of the four LOBs are combined to get the aggregate profit stream.* Everything does not go bad at the same time, so bad experience in one risk factor requently can be offset by good experience in other areas of the business.

OPERATIONAL AND STRATEGIC RISKS

In addition to the business risks, an analysis also was performed for both operational risk and strategic risk.

Leaders within each line of business, along with the operational risk officer, identified the primary operational risk scenarios for their business. For each scenario, two estimates of frequency and severity were made. One estimate represented a low cost with a high frequency, and the other estimate represented a high cost with a low frequency.

A copula model was used to develop the aggregate distribution for the combination of all of these risk scenarios, allowing for judgments to be included for the correlation of the scenarios. The EC for operational risk was calculated to be less than 3 percent of surplus.

Strategic risk analysis was based on a brainstorming session moderated by Milliman consultants. The senior corporate management team developed an extensive array of possible strategic events. The Milliman consultants then used their strategic risk model to develop a grid showing the interrelationships of the strategic events and to identify the most significant clusters of risks. The EC for strategic risk was calculated to be less than 5 percent of surplus.

> "In addition to analysis of corporate EC, Guardian performed EC analysis for each line of business as if it were a stand-alone entity."

When the losses for operational and strategic risk were combined with the annual profits for each of the tail observations of business risk, the resulting aggregate EC for business, operational and strategic risks combined was less than 3 percent of surplus.

CAPITAL ANALYSIS

Guardian performed an extensive analysis of the distribution of future performance of the existing surplus. Much of the surplus is invested in common stocks, protected by a sophisticated dynamic hedge program. The purpose of this analysis was to demonstrate that a large portion of the beginning surplus of $3.7 billion would be available to support the aggregate risks, even in the tail of the distribution.

OTHER ANALYSIS USING EC PROJECTIONS

Guardian expanded the basic EC analysis in a variety of ways.

- *By LOB*—In addition to the analysis of corporate EC for business risk, Guardian performed the EC analysis for each LOB as if it were a stand-alone entity. Only the risk factors for the target LOB were used to define the composite distribution for that LOB. Profits from other LOBs were not available to offset losses in the target LOB. The sum of the EC results for the four LOBs was less than 2 percent of surplus, compared to the corporate EC for business risk that was less than 0.1 percent of surplus.
- *New business*—EC analysis is generally performed on the closed block of business in force on the effective date of the analysis. Guardian also performed the analysis by including five years of new business along with the in-force business. As expected, losses in writing new business generated larger GPVLs. The sum of the EC results, including new business, for the four LOBs was less than 7 percent of surplus.
- *Reduction in PV30*—EC at the CTE99 level measures the amount of capital required to cover the average losses in the adverse 1 percent tail of the distribution. This produced some very interesting information, and management was happy that EC was not a large amount (less than 0.1 percent of surplus). However, amounts very close to zero are difficult to use in evaluating the impact of actual events or potential management actions. Another point of view would be to consider the total baseline PV30 for all LOBs to be a component of the value of the enterprise. Then the reduction in PV30 in the 1 percent tail would show how much value is lost in these extreme adverse environments. The average of the PV30s, including new business, over the 1 percent tail of the distribution was about 75 percent of the baseline PV30. The business is still generating significant value, even in the 1 percent tail of the distribution, but this 25 percent reduction provides a significant base so that the impact of actual or proposed actions can be evaluated.
- *Stress tests*—During 2008, senior management and the board asked questions about the impact on Guardian regarding various possible future scenarios. Two of the questions related to the impact of a long recessionary environment along with a Japanese-like bear market scenario. The EC analysis was used to answer these questions by identifying observations from the composite distribution that combined sets of scenarios for the individual risk factors that were consistent with the target environments. The results for these observations were combined and analyzed to provide meaningful answers to the questions.

PLANS FOR THE FUTURE

As we look at future expansion of the EC analysis, there are several modeling enhancements, as well as tactical goals, to be considered.

First, we expect to perform expanded analysis for the entire distribution of results, rather than focusing primarily on the 1 percent tail of the distribution. Second, we want to enhance the Group stochastic model to refine the handling of timing and effectiveness of repricing actions. Third, we want to improve the sensitivity of the dependent variables for each line of business.

Tactically, we will eventually bring the modeling capabilities in-house, and we are currently in the process of building out our grid computing capability. More importantly, we want to expand the uses of the EC modeling, including performance measurement of the businesses.

We at Guardian have just scratched the surface in developing our EC modeling and analysis. The next important step is to decide how to incorporate the results of the analysis into the decision-making process in the organization. ✦

Structural Credit Risk Modeling: Merton and Beyond

By Yu Wang

The past two years have seen global financial markets experiencing an unprecedented crisis. Although the causes of this crisis are complex, it is a unanimous consensus that credit risk has played a key role. We will not attempt to examine economic impacts of the credit crunch here; rather, this article provides an overview of the commonly used structural credit risk modeling approach that is less familiar to the actuarial community.

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INTRODUCTION

Although credit risk has historically not been a primary area of focus for the actuarial profession, actuaries have nevertheless made important contributions in the development of modern credit risk modeling techniques. In fact, a number of well-known credit risk models are direct applications of frequency-severity or hazard rate models commonly found in actuarial/insurance literature. As credit risk became an increasing concern in recent years, various advanced methods have been employed extensively to measure credit risk exposures. It is necessary for actuaries to become familiar with these popular methods and their strengths and shortcomings, in order to stay competitive in this dynamic and rapidly evolving area.

Nowadays, structural and reduced form models represent the two primary classes of credit risk modeling approaches. The structural approach aims to provide an explicit relationship between default risk and capital structure, while the reduced form approach models credit defaults as exogenous events driven by a stochastic process (such as a Poisson jump process). In this sense, most actuarial models used for credit risk measurement lie within the reduced form class.

Structural models, pioneered by Black, Scholes and Merton, ingeniously employ modern option pricing theory in corporate debt valuation. Merton model was the first structural model and has served as the cornerstone for all other structural models. To illustrate key concepts behind structural approach, we will review Merton model in detail, and briefly introduce some important extensions to this model. Major advantages and disadvantages of both structural and reduced form models will also be summarized, followed by a quick discussion involving the latest financial crisis.

THE MERTON MODEL

The real beauty of Merton model lies in the intuition of treating a company's equity as a call option on its assets, thus allowing for applications of Black-Scholes option pricing methods. To start reviewing this influential model, we consider the following scenario.

Suppose at time t a given company has asset A_t financed by equity E_t and zero-coupon debt D_t of face amount K maturing at time $T > t$, with a capital structure given by the balance sheet relationship:

$$A_t = E_t + D_t. \tag{1}$$

In practice a debt maturity T is chosen such that all debts are mapped into a zero-coupon bond. In the case $A_T > K$ the company's debtholders can be paid the full amount K, and shareholders' equity still has value $A_T - K$. On the other hand, the company defaults on its debt at T if $A_T < K$, in which case debtholders have the first claim on residual asset A_T and shareholders are left with nothing. Therefore, equity value at time T can be written as:

$$E_T = \max(A_T - K, 0). \tag{2}$$

This is exactly the payoff of a European call option written on underlying asset A_t with strike price K maturing at T. It follows that the well-known Black-Scholes option pricing formulas can be applied if corresponding modeling assumptions are made. Let us assume the asset value follows a geometric Brownian motion (GBM) process, with risk-neutral dynamics given by the stochastic differential equation:

$$\frac{dA_t}{A_t} = rdt + \sigma_A dW_t \tag{3}$$

where W_t is a standard Brownian motion under risk-neutral measure, r denotes the continuously compounded risk-free interest rate, and σ_A is the asset's return volatility. Note that A_t grows at risk-free rate under the risk-neutral measure and thus has drift r in (3), implicitly assuming the continuous tradability of corporate assets. Now applying the Black-Scholes formula for European call option

would give:

$$E_t = A_t\Phi(d_+) - Ke^{-r(T-t)}\Phi(d_-) \tag{4}$$

where $\Phi(\cdot)$ denotes the $N(0,1)$ cumulative distribution function, with the quantities d_+ and d_- given by:

$$d_+ = \frac{\ln(\frac{A_t}{K}) + (r + \frac{1}{2}\sigma_A^2)(T-t)}{\sigma_A\sqrt{T-t}}, \tag{5}$$

$$d_- = \frac{\ln(\frac{A_t}{K}) + (r - \frac{1}{2}\sigma_A^2)(T-t)}{\sigma_A\sqrt{T-t}}. \tag{6}$$

Under this framework, a credit default at time T is triggered by the event that shareholders' call option matures out-of-money, with a risk-neutral probability:

$$P(A_T < K) = \Phi(-d_-), \tag{7}$$

which is sometimes converted into a real-world probability by extracting the underlying market price of risk.

Although debtholders are exposed to default risk, they can hedge their position completely by purchasing a European put option written on the same underlying asset A_t with strike price K. Such a put option will be worth $K - A_T$ if $A_T < K$, and worth nothing if $A_T > K$. Combining these two positions (debt and put option) would guarantee a payoff of K for debtholders at time T, thus forming a risk-free position:

$$D_t + P_t = Ke^{-r(T-t)} \tag{8}$$

where P_t denotes the put option price at time t, which can be determined by applying the Black-Scholes formula for European put option:

$$P_t = Ke^{-r(T-t)}\Phi(-d_-) - A_t\Phi(-d_+). \tag{9}$$

The corporate debt is a risky bond, and thus should be valued at a credit spread (risk premium). Let s denote the continuously compounded credit spread, then bond price D_t can be written as:

$$D_t = Ke^{-(r+s)(T-t)}. \tag{10}$$

Putting (8), (9) and (10) together gives a closed-form formula for s:

$$s = -\frac{1}{T-t}\ln[\Phi(d_-) - \frac{A_t}{K}e^{r(T-t)}\Phi(-d_+)] \tag{11}$$

which allows us to solve for credit spread when asset level and return volatility (A_t and σ_A) are available for given t, T, K, and r. One common way of extracting A_t and σ_A involves assuming another geometric Brownian motion model for equity price E_t and applying Ito's Lemma to show that instantaneous volatilities satisfy:

$$A_t\sigma_A\frac{\partial E_t}{\partial A_t} = E_t\sigma_E. \tag{12}$$

Black-Scholes call option delta can then be substituted into (12) to obtain:

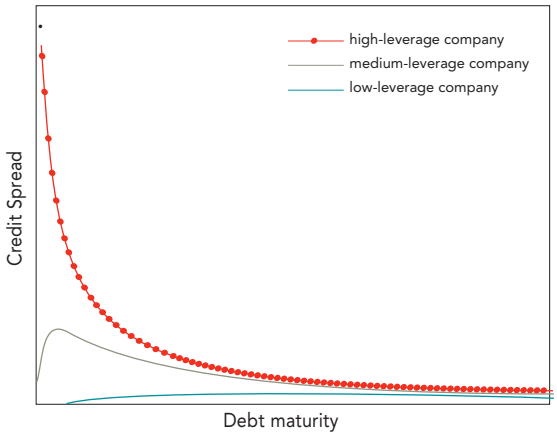
$$A_t\sigma_A\Phi(d_+) = E_t\sigma_E \tag{13}$$

where equity price E_t and its return volatility σ_E are observed from equity market. Finally, (4) and (13) can be solved simultaneously for A_t and σ_A, which are used in (11) to determine credit spread s.

TERM STRUCTURE OF CREDIT SPREADS UNDER MERTON MODEL

Credit spread compensates for exposure to credit risk, and such risk is linked to structural variables (assets, liabilities, etc.) under Merton model. A good risk indicator in Merton's framework is leverage ratio (such as the debt-to-asset ratio), and in (11) the spread is indeed an increasing function of leverage. To better understand implications of this model, we examine term structure of credit spreads determined by (11) and plotted against different debt maturities:

Term Structure of Credit Spreads under the Merton Model



As shown above, the implied credit spread term structure from Merton model appears realistic, with the following

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key observations and facts:

- A low-leverage company has a flatter credit spread term structure with initial spreads close to zero since it has sufficient assets to cover short-term liabilities. Spread slowly increases with debt maturity (reflecting future uncertainties), before it starts to decrease at the long end.
- A medium-leverage company has a humped-shape credit spread term structure. The very short-term spreads are low as the company currently has just enough assets to cover debts. Spread then rises quickly since asset value fluctuations could easily result in insufficient assets, before it gradually drops for longer maturities.
- A high-leverage company has a downward-sloping credit spread term structure which starts very high and decreases for longer maturities as more time is allowed for the company's assets to grow higher and cover liabilities.
- Empirical studies have shown that Merton model tends to underestimate credit spreads, particularly short-term spreads for high-quality debts (recall the very low initial spreads for the low-leverage company mentioned above). This drawback has been tackled by several extended models developed more recently, which are to be discussed next.

EXTENSIONS AND IMPROVEMENTS TO MERTON MODEL

Ever since the works of Black, Scholes and Merton started the literature of structural credit risk modeling, many researchers have proposed extensions to Merton model, which has been criticized for basing on a number of simplifying assumptions. The extended structural models represent important improvements for Merton's original framework as they are more realistic and able to better align with market data (e.g., CDS spreads). Some of these areas of improvements are introduced below:

- In Merton's framework, a company could only default at its debt maturity date. The model can be modified to allow for early defaults by specifying a threshold level such that a default event occurs when asset value A_t falls below this critical level. The methods for pricing barrier options can be applied in this setting. Such threshold level sometimes results from shareholders' optimal default strategy to maximize equity value. Extensions to Merton model along this direction were pioneered by Black and Cox, and this group of models is often referred to as First Passage Time models.
- The constant interest rate assumption is not reliable, and a stochastic interest rate model can be incorporated into Merton model or its extended versions. In this case, correlation between asset and interest rate processes can also be introduced if needed.
- Mapping all debts into a single zero-coupon bond is not always feasible. It has been shown that multiple debts with different characteristics can also be modeled using a structural approach. The *Geske Compound Option model* developed by Robert Geske was the first structural model of this category.
- Several more sophisticated structural models involving stochastic volatility, jump diffusion and even regime-switching methods have also been proposed. These applications can help explain market observations with higher accuracy, but they often involve a high level of analytical complexity.

ADVANTAGES AND DISADVANTAGES OF CREDIT RISK MODELS

Structural approach, led by Merton model, has the highly appealing feature of connecting credit risk to underlying structural variables. It provides both an intuitive economic interpretation and an endogenous explanation of credit defaults, and allows for applications of option pricing methods. As a result, structural models not only facilitate security valuation, but also address the choice of financial structure.

The main disadvantage of structural models lies in the difficulty of implementation. For example, the continuous tradability assumption for corporate assets is unrealistic, and calibrating stochastic asset processes using publicly available information is sometimes more difficult than anticipated. Furthermore, although improved structural models have addressed several limitations of earlier models, they tend to be analytically complex and computationally intensive.

"To make the best possible use of models and avoid repeating costly mistakes, a sound ERM framework is needed where model outputs alone cannot dominate the decision-making process."

Reduced form models do not consider endogenous cause of defaults; rather, they rely on exogenous specifications for credit default and debt recovery. This feature is both a strength and a weakness—while these models suffer from the lack of economic insights about default occurrence, they offer more degrees of freedom in functional form selection. Such flexibility contributes to analytical tractability and ease of implementation and calibration (compared to structural models). However, reduced form models' dependence on historical data may result in good in-sample fitting properties but limited out-of-sample predictive power.

In general, structural models are particularly useful in areas such as counterparty credit risk analysis, portfolio/security analysis and capital structure monitoring, while the difficulty in calibration limits their presence in front-office environments. Reduced form models, on the other hand, are widely used on credit security trading floors where traders require fast computation tools to help them react to market movements quickly.

REFLECTION ON THE CURRENT FINANCIAL CRISIS: ROLE OF RISK MODELS

The current financial crisis originated in 2007 from the U.S. subprime mortgages and related credit products markets, and quickly imposed severe adverse consequences on financial markets worldwide, leading to a global recession. Today, lack of regulations and failures of well-known risk models are being blamed, especially credit risk models considering the origin of the crisis. To conclude this article we will briefly discuss the role of risk models.

Let us acknowledge the obvious: there has been a rapid growth of financial risk modeling in recent years thanks to technological developments and an increasing supply of human capital. The acceptable performance of various risk models during stable market periods often leads risk managers to overlook these models' inherent limitations, resulting in overreliance on popular modeling approaches and related analyses. This is particularly dangerous during a crisis, when major flaws of risk models are highlighted and cause significant losses. Furthermore, the popularity of certain models may lead many market participants to execute similar strategies, which in turn quickly dries up liquidity and destabilizes prices, thus amplifying the crisis.

At the end of the day, risk models are constructed based on simplifying assumptions and inputs; therefore, they are only as good as these assumptions and inputs, and even risk measures generated by highly regarded models should be treated with caution. In order to make the best possible use of models and avoid repeating costly mistakes, a sound enterprise risk management framework is needed where model outputs alone cannot dominate the decision-making process. As the saying goes: "All models are wrong, but some are useful." ✦

Note: The opinions expressed in this article are those of the author and do not reflect the views of Manulife Financial.

Basis Risk in Annuity Guarantees: Pricing and Enterprise Risk Implications

By Simpa Baiye

BACKGROUND Sales of variable annuities have increased in recent years, due in part to the proliferation of aguarantee riders offered by insurers. Living benefit riders are now seen as a means to protect retirement income while preserving the goal of wealth accumulation well into the retirement years. Variable annuity sub-account offerings now include a lineup of commodity funds, actively managed funds and exchange-traded funds, as well as passively managed funds.

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Sales have also been enhanced by the variety of actively managed funds offered by reputable asset managers. These funds aim to provide superior returns—relative to a broad-based index—in return for higher management fees. Superior returns are typically achieved through leverage, or by overweighting or underweighting components of the index on a tactical basis. Active fund managers thus introduce tracking error relative to the benchmark index, in order to produce incremental returns.

Annuity insurers generally provide guarantees on the performance of variable annuity sub-accounts. These guarantees are typically priced under the implicit assumption that returns on the funds in which these sub-accounts are invested—including *actively managed* funds—can be completely explained by a basket of *passively* managed funds. This attribution does not reflect the risks and rewards associated with active management. Consequences of this approach can include mispricing of equity guarantees and hedge breakage, both of which can have a significant impact on the capital position of the underwriting company.

Insurers are now recognizing the impact of actively managed funds on the performance of their hedge programs and are mitigating this through product design. It is anticipated that passively managed funds will feature more prominently in variable annuities than they have in the recent past. Nevertheless, actively managed funds still occupy an important position in the average in-force variable annuity fund profile. The risk management of actively managed funds is thus still an important consideration.

We review a key method currently employed in risk-managing actively managed funds, highlight its benefits and shortcomings and propose a technique that preserves the benefits of the current method and incorporates the risks and rewards of active fund management.

THE STATUS QUO

Annuity carriers offer a wide variety of funds in variable annuities. The selection and approval of funds to be offered in a variable annuity involve conducting the appropriate due diligence on fund managers, assessing how the marginal decision meets the needs of a spectrum of risk appetites and tolerances and ensuring that fund operating expenses are reasonable.

From an insurer risk-management perspective, an important step in this process involves decomposing the returns of each fund to the returns from a combination of benchmark indices that completely explain the fund's systematic and idiosyncratic performance history. This decomposition is typically done through a linear regression that requires that the benchmark indices completely explain the systematic performance of the prospective fund. Benchmark indices are typically a set of passive indices of broad-based market performance. These include (but are not limited to) the S&P 500, the Russell 2000, the NASDAQ 100, the EAFE and the Lehman Aggregate Bond indices.

The functional form of this linear regression is given by

$$R = \alpha + \Sigma\beta_i r_i + e_i \quad ,$$

Such that $\Sigma\beta_i = 100\%$ and $\beta_i \geq 0$

Where

- R represents the returns of the actively managed fund under consideration
- α is the bias or incremental return achieved through active management
- β_i represents the factor or weight associated with benchmark index i
- r_i represents the return periodic return on benchmark index
- e_i is the error term

"Incremental returns (also known as 'alpha') are generally non-zero for actively managed funds."

Incremental returns (also known as "alpha") are generally non-zero for actively managed funds. This stems from the fact that these funds aim to beat the returns on broad-based passive benchmark indices through superior stock, sector and country selection. Active fund managers thus introduce tracking error relative to their benchmarks with the hope of earning marginally superior returns.

Alpha is generally ignored in the pricing, valuation and risk management of guarantees for various reasons. One is the widely held view that alpha converges to zero in the "long run." In the light of hedge program losses in the past year that were driven by differences between expected and actual fund performance, it is certainly more prudent to evaluate the impact of active fund management in the pricing of guarantees.

Furthermore, alpha could still be significant for funds that do not closely track a broad-based index in the long run.

Mapping funds to passive benchmark indices is a key step in pricing and hedging rider guarantees of fund performance in a variable annuity. To the extent that alpha is left unincorporated, pricing of equity guarantees is then done under the assumption that the underlying funds are all passively managed. Guarantees are thus likely to be mispriced. Any hedge positions set up to hedge market returns, convexity or volatility can be affected by this mischaracterization. The implications of not properly reflecting alpha in pricing warrant a review of potential remedies. One such remedy, and associated implications on pricing and economic capital, is reviewed next.

REFLECTING ACTIVE MANAGEMENT IN P RICING: THE REGIME ALPHA APPROACH

This approach involves determining expected alpha for each of two regimes: when historical fund returns are positive, and when historical fund returns are negative. Historical performance data for benchmarks and the fund under consideration are subdivided two categories: all returns for periods in which the active fund enjoys positive returns, and all returns for periods in which the active fund experiences negative returns. Linear regressions are performed on entire sample as well as the two categories. The alpha estimates derived from the subsample regressions are designated as regime alphas. These regime alphas are added (when appropriate) to risk-free rates employed in projecting risk-neutral return scenarios associated with the constituent benchmark indices. Factor weights for the benchmarks are derived from the regressions performed on the entire sample return data.

In addition to the enabling assumptions governing any linear regression method, the regime alpha approach—as described—assumes the following:

1) *Regime alphas represent incremental performance in both the real world and the risk-neutral world.* To the extent that alpha represents incremental returns achieved through management behavior in the real world, it can be argued that this incremental real-world return remains unchanged in a risk-neutral context. This assumption is crucial for risk-neutral pricing.

2) *Tracking error associated with active management has no material impact on benchmark index volatility assumptions employed in risk-neutral pricing.* This assumption is reasonable if the predictive power of the regression is sufficiently high. Highly predictive regressions demonstrate that volatility is driven by systematic influences that are well captured in the benchmark-index constituents.

3) *Benchmark factor weights, i.e., Betas obtained from the entire sample data do not vary by alpha regime.* To the extent that the data strongly suggests otherwise, adjustments will have to be made to pricing results. These adjustments are not considered here.

The primary rationale for the regime alpha approach lies in the fact that liabilities on guarantee riders are triggered by sustained, negative market performance. Biases in fund management that amplify negative benchmark-index performance should thus be analyzed and evaluated for materiality.

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Table 1: Regime Alpha Regression Results

	Entire Sample	Positive-Return Regime	Negative-Return
Months of data	77	47	30
A	0.15%	0.8%	-0.7%
ß S&P	73%	75%	56%
ß NASDAQ	21%	11%	24%
R-Squared	89%	82%	75%

Table 2: Assumptions for Illustrative Pricing Example

Product Features	
Underlying Fund	American Growth and Income Fund "R" Series
Death Benefit	Account Value
Total Expenses	2.15%
Market Assumptions	
Risk-free Rate	3% (all years)
Implied Volatility	S&P – 25% NASDAQ – 35%
Benchmark Indices and Weights	S&P 500 – 78% NASDAQ 100 – 22%
Regime Alphas	Positive regime – 10% annualized Negative regime – (8%) annualized
Benchmark Index Correlation	70%
Market Return Model	Geometric Brownian Motion
Option Pricing Model	Black-Scholes
Key Actuarial Assumptions	
Income Utilization Rate	100% of Lifetime Income Immediately
Lapse Rates	1, 2, 3, 4, 5, 6, 15, 10, 10, … 10
Mortality	100% of Annuity 2000 Table

Table 3: Pricing Results

Age	Baseline Case (bps)	With Regime Alpha (bps)	% Difference
60	150	170	13%
80	35	43	22%

APPLYING THE REGIME ALPHA APPROACH: AN ILLUSTRATIVE EXAMPLE

Monthly returns—over a seven-year period ending in December 2008—for the American Funds Growth and Income "R" series were obtained from a public Web site. This actively managed fund has a large cap value style, a bias for growth and may invest in bonds from time to time. Returns were thereafter grossed up for fund operating expenses. The fund's profile suggests that the S&P 500 and NASDAQ 100 are potential candidates for benchmark constituents. Comparable returns from these two indices were obtained from the same Web site. The results of the regression for all sample data and the two regimes—positive fund returns and negative fund returns—are shown in Table 1.

The analysis deserves a few comments. For the entire sample, alpha is generally positive. This apparently suggests that active management for the funds is a net benefit—before expenses—in the long run. However, a closer look at the regime alphas indicates that active management beat its constituent benchmarks in periods of positive returns but underperformed its constituents in periods of negative returns. This observation is consistent with anecdotal evidence of fund manager behavior in general. Factor weights also differed significantly between regimes, as evidenced by the increased weight of the NASDAQ 100 in the negative regime. This shift may explain the higher volatility of fund performance in periods of negative returns. Nonetheless, the overall predictive power of each regression remained within tolerable limits.

In order to apply the regime alphas in pricing, we illustrate using a hypothetical guaranteed minimum withdrawal benefit (GMWB) with an income guarantee of 5 percent for life for a 60-year-old and an 80-year-old. Pricing assumptions for this example are listed in Table 2.

From the results in Table 3, we can deduce that pricing for active-fund management could raise rider charges by 10 percent or more for a common growth and income fund. In addition, it should be noted that the severity of active management risks is a direct function of the expected

"Active management beat its constituent benchmarks in periods of positive returns but underperformed its constituents in periods of negative returns."

lifetime of the rider. This confirms that though alpha is less of an issue over the long run, it still remains an important consideration for pricing and capital management.

ECONOMIC CAPITAL IMPLICATIONS OF REGIME ALPHA APPROACH

U.S. regulatory capital guidelines for variable annuities recognize the impact of active fund management on risk-capital consumption. They effectively require that the methodology for mapping underlying funds to benchmarks meet certain calibration requirements, and that provision be made for hedge ineffectiveness due to alpha. However, the guidelines do not prescribe a specific method for quantifying active-management-driven basis risk. Employing the regime alpha approach can help in quantifying both regulatory and economic capital implications of active fund management. We illustrate its application with the hypothetical GMWB issued to the 60-year-old that was previously described. For purposes of this illustration, we assume that the internal economic capital methodology is the one-year value at risk (VAR) of net assets. We assume that a 50 percent market drop and a 15-percentage-point increase in implied volatility are equivalent to the 98th percentile of annual potential outcomes. The results are summarized in Table 4.

Table 4: Economic Capital Implications of Active Management

Item	One-year Value at Risk (% of Issue Premium)
Hedge Assets	22%
Liability (with Regime Alpha)	23%
Net Assets	(1%)

Hedge assets in Table 4 reflect a proxy liability value that ignores the impact of active management, while the liability value shown reflects the regime alpha method. Results show that the economic capital associated with active management could be in the order of $10 million for every $1 billion of newly issued business. At face value, the additional annual charge of 20bps—or $2 million per $1 billion of new business, derived earlier for the same GMWB—provides a meaningful return on the additional capital required for basis risk.

IMPLICATIONS OF ALPHA ON ENTERPRISE RISK MANAGEMENT

The preceding examples, however instructive, assume that only one fund is offered. In reality, a wide variety of funds—each with varying degrees of active management risk— are offered on a typical variably annuity. This does present the opportunity to diversify and reduce the impact of active management on risk-capital consumption, within the variable annuity product line. For example, the active management risk of the growth and income fund could perhaps be somewhat offset by the active management risk of a bond fund offered in the same portfolio. *Ceteris paribus*, the greater the diversity of active management styles, the lower the aggregate impact of active management on annuity-rider risk and rewards. Lowering the negative impact of active management increases the ability for an insurance carrier to compete in today's market for guarantees.

Achieving "capital-efficient" fund diversity within the annuity product line may be even more challenging from a sales and distribution perspective. Insurance carriers have complex relationships with both fund managers and annuity sales representatives. Funds that have the potential to bring about favorable active management diversity may have limited capacity to absorb annuity cash flow. Others may not have the brand name that can help generate sales. It is thus crucial to temper the benefits of fund diversification with the realities of distribution and other competing organizational constraints. The ability to reflect active management risks in pricing and risk capital will help in achieving much-needed balance.

Reflecting the impact of alpha on guarantee liability "greeks" could also be a viable approach. Employing the regime alpha approach could provide greeks that are reflective of active management biases, in the same manner that dynamic policyholder behavior also

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impacts liability greeks. This approach could have a modest impact on the existing model risks and should be considered carefully.

To the extent that active management amplifies the downside market risks associated with variable annuity guarantees, finding meaningful risk offsets in other life company product lines remains a challenge. Diversifying the existing fund lineup within the annuity line is still the next best alternative to imposing a marginal price for active management.

SUMMARY AND CONCLUSIONS

Actively managed funds feature prominently in most variable annuities today. It is expected that these funds will outperform their respective benchmarks over the long run, providing wins for both the customer and underwriting company. However, market performance—both in the long and short run—drives the lifetime (time till benefits commence) of rider guarantees. It is therefore important to evaluate the materiality of factors that amplify market performance. Active management "alpha" is a significant factor. We have shown that the regime alpha approach provides insight into the impact of alpha, through the segregation and regression of fund performance. For the actively managed fund that underlies the illustrations and examples, alpha has a significant impact on the price and associated capital requirements of a GMWB rider overlay.

The enterprise risk implications of alpha can be managed through fund diversification and hedging. Each management tool comes with its advantages and drawbacks. These approaches need to be considered carefully, in light of various competing organizational objectives.

The regime alpha method is not free of the risk that reality could diverge from what is modeled. Expected alphas may differ from actual alphas and require an additional level of performance attribution. Nevertheless, the regime alpha method represents a step forward in incorporating the realities of active fund management in the pricing, hedging and capital management of variable annuity guarantees. ✦

Climate Negotiations Pass Milestone on Insurance

By Dr. Koko Warner

GOOD CHANCES for insurance solutions to be part of the UN-Climate Conference in Copenhagen 2009

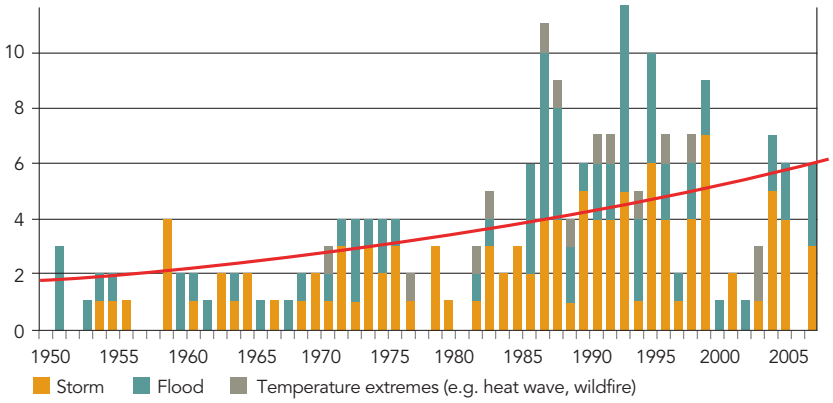
Insurance has been included into the interim negotiating text for the climate summit 2009 in Copenhagen at the climate negotiations this week in Bonn. This is a critical juncture to build insurance mechanisms into the architecture of the agreement that will emerge in Copenhagen this year.

EXTREME WEATHER EVENTS ON THE RISE IMPACTING DEVELOPING COUNTRIES THE MOST

Weather-related risks play an important role for the insurance sector. Climate change changes the probability of weather-related extreme events, often increasing the frequency and/or intensity of such events. According to the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007), human-induced climate change trends will continue to have a major influence on weather-related risks. Increasing hazard frequency and intensity cycles, probably associated in part with an underlying climate change trend, increase the potential for losses. The insurance sector will need to quantify this emerging trend where applicable and include the findings into its risk calculations, pricing and underwriting (Charpentier 2008).

Economic losses from weather-related natural hazards are rising, averaging roughly US$100 billion per annum in the last decade (MunichRe 2007). The losses in value and productive capacity are the highest in developing countries. The need for risk management tools such as insurance is growing in these areas at a time of mounting climate-related and other risks. By providing financial security against droughts, floods, tropical cyclones and other forms of weather variability and extremes, insurance instruments present an opportunity for adapting to climate change (Hoeppe and Gurenko 2006).

Figure 1: Great Weather Disasters 1950–2007



Thus a dual challenge, and opportunity, faces the insurance sector and society. First, most of the factors related to increasing losses are not climate-related, but societal in origin, thus increasing the need for effective and integrated risk management and risk reduction (Ward et al. 2008, Maynard 2008). Risk reduction efforts, if effective, can help maintain insurability as the proportion of risk attributable to climate change rises through time (Bals et al. 2006). Second, there is a need and a market niche to develop insurance solutions for areas facing increasingly frequent and intense weather-related hazards (Dlugolecki et al. 2009, Mills 2007).

CLIMATE NEGOTIATIONS PASS MILESTONE ON INSURANCE

An important milestone was passed at the April Climate Talks in Bonn, Germany. The secretariat to the climate negotiations, the UNFCCC, issued a "focus paper" as a foundation upon which negotiators will build the elements of the negotiating text heading into Copenhagen. That paper laid out the crucial points for establishing insurance in the Copenhagen treaty:

Dr. Koko Warner,
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- First, a risk management framework that includes insurance. Risk reduction and insurance are areas of broad Party consensus.
- Second, the paper calls for a specialized financial mechanism and dedicated multilateral funds for adaptation. This includes any financial support that may be needed to support elements of a new mechanism for insurance. Institutional arrangements to enable financing for adaptation would include a political framework and dedicated committee.

Thus insurance will not merely appear as a keyword in the Copenhagen agreement, but will see concrete funding and operational considerations put into it. Christoph Bals, vice chairman of MCII and executive director of the NGO Germanwatch expects that "the climate negotiations will, by the end of 2009, create an adaptation framework with risk management—of which insurance solutions targeting the most vulnerable in developing countries will be part."

INSURANCE PROPOSALS AT THE CLIMATE NEGOTIATIONS

At the 2008 climate talks in Poznan and again in April in Bonn, negotiators stressed the need for risk management, including insurance as an element of risk management, in the architecture of the Copenhagen Agreed Outcome (UNFCCC 2008a, 2008b). Numerous proposals have been put forward during the climate negotiations that mention insurance.[1] Two detailed insurance-related proposals were tabled by the Association of Small Island States (AOSIS) and the Munich Climate Insurance Initiative (MCII). The two proposals explore how risk management including insurance mechanisms could fit into a longer-term adaptation financing framework (i.e., post-2012) (AOSIS 2008, MCII 2008). Both proposals emphasize that risk prevention and risk reduction are the points of departure for managing climate-related disasters. When effective risk reduction is in place, insurance can be a complementary measure to facilitate adaptation.

Dr. Koko Warner, who leads a department at the United Nations University, noted: "All parties agree that the best starting point to address climate change is reducing risk. They look to the insurance sector for its expertise, and are looking for ways to engage the sector more actively—from risk modeling and pricing to the provision of insurance services."

The AOSIS proposal asked the climate negotiators to create a multi-window mechanism with three components to address loss and damage from climate change impacts: insurance, compensation for loss and damage from progressive cumulative adverse impacts such as sea level rise and risk management. While the AOSIS proposal does not detail where that technical advice might come from, the insurance sector would likely be involved in such activities if it were part of the Copenhagen Agreed Outcome.

The MCII provides more detail on the insurance elements in a larger UNFCCC framework of risk management. Low-level risks are often effectively addressed by risk reduction and prevention measures. The estimated cost of the prevention pillar is $3 billion per year. Risks at the medium and high level can be addressed by insurance measures that complement and incentivize risk reduction and prevention. MCII´s proposal envisions two parts in the insurance pillar: a Climate Insurance Facility and a Climate Insurance Pool (CIP).

The Climate Insurance Facility would catalyze nascent risk sharing and risk transfer systems including microinsurance at the medium level of risk. For middle level risks, a Climate Insurance Assistance Facility could create the necessary framework for insurance—especially microinsurance but also social safety nets and similar tools—to help the vulnerable adapt to climate change. Such a facility could provide support for data collection, necessary infrastructure and activities that lower transaction costs and stabilize the system. It is also possible that such a facility could pool medium level risks and reinsure small

FOOTNOTES:

[1] Most recently proposals have come from countries like Switzerland, Mexico, some countries of the European Union and further ideas from Bangladesh (for the LDCs), China, India, Argentina, the Philippines, Malaysia, Saudi Arabia and other countries, and from observers like Munich Climate Insurance Initiative (MCII), the Climate Adaptation Network (CAN), and others.

"Climate negotiations will create an adaptation framework with risk management—of which insurance solutions targeting the most vulnerable in developing countries will be part."

insurance schemes. Generally the risk part of the premium should not be subsidized; however, it should be possible for premiums to be paid "in-kind": The vulnerable that receive insurance coverage could contribute to premium payments by contributing work time to reduce risk locally. The estimated cost for a Climate Insurance Assistance Facility is $2 billion per year.

For very large risks such as 100-year or greater weather hazards that go beyond national coping mechanisms in vulnerable countries, MCII proposes a CIP to absorb a pre-defined proportion of disaster losses, at no cost to the beneficiary developing countries. The CIP will be reinsured against extreme loss years in the global reinsurance market. The estimated cost for the CIP including reinsurance is estimated to be around $5 billion per year. The loss ratio to be indemnified has to be negotiated by the international community; ultimately it should be linked to an estimated attribution of global warming to the losses covered. The requisite funding for a CIP covering the top 30 percent of losses arising from the most extreme climate events (return period of 1 in 100 years) in eligible developing countries can be assessed as: indemnification of the top 30 percent of the total direct economic losses (both public and private) would range between USD$2.7 billion and USD$3.6 billion, with the maximum insured losses to be capped between 10 and 50 billion depending upon the availability of premium income for the pool. The gross annual costs of the suggested insurance scheme including capital and administration costs of reinsurance would range between USD$3.2 billion and USD$5.1 billion for the range of the above.

Climate negotiators considering the creation of a CIP might ask: Why invest adaptation funds in a CIP when we could, instead, allocate these same funds to national adaptation programs that include an insurance module? One answer: Disbursing a portion of climate adaptation funds to the CIP pools the risks of extraordinary losses, costing far less money or requiring far less reinsurance than if each country created its own fund or made individual insurance arrangements.[2]

KEY QUESTIONS FOR THE INSURANCE INDUSTRY

Climate negotiators express great interest engaging the private sector and other relevant stakeholders and communities in the context of risk insurance. Several questions arise about what the industry would need to participate in any mechanism created by the UNFCCC Copenhagen agreement in December 2009.

First, what would be most necessary to engage in the design and provision of climate risk insurance, the private sector? In a statement to the climate negotiators on April 6, 2009, Professor Peter Hoeppe of Munich Re emphasized that "The insurance sector would need assurance that premiums for the various insurance programs would be "risk adequate"—meaning that the premiums are sufficient to cover expected losses." Correct, risk adequate pricing is a key for sustainable insurance business. In many of the target developing countries the database for pricing is currently insufficient. For countries without suitable meteorological as well as historical loss data, it is imperative to build up systems that could fill data gaps in the medium term. During a transition phase before all necessary data is in place, modeling approaches and comparisons with other similar countries where data is available could help to make risks in such countries insurable. Further, while the appropriate data basis is being established, the potential for inaccurate loss estimates could be covered by an insurance pool solution such as that

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FOOTNOTE:

[2] The CIP will utilize market-based pricing of its cover and will transfer risk to private risk carriers. This helps avoid distorting private capital markets or catastrophe risk reinsurance markets.

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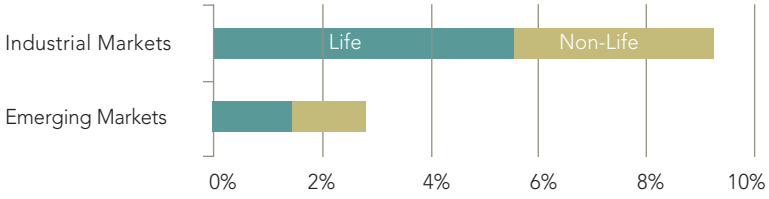
suggested by MCII. As currently the losses from weather-related disasters in developing countries are about 7 percent of global losses, cover of this kind should not pose an insurmountable obstacle for the capital requirements of insurance. Climate risk insurance programs, such as that proposed by MCII, could be established in a time range of three to five years—assuming prompt action would be taken to establish a sufficient basis of data.

Second, given the current underdevelopment of insurance markets in many developing countries, what kind of enabling conditions would need to be established to ensure the success of insurance programs to enhance the ability to adapt to climate change? Current insurance penetration in terms of premiums in percentage of GDP amounts to roughly 4 percent in industrial markets, whereas in emerging markets it amounts to less than 2 percent (see Figure 2).

Figure 2: Insurance Penetration 2007 (Non-life premiums in % of GNP)



Source: Swiss Re, sigma No 2/2009

Losses from and natural disasters are typically absorbed by individuals, corporations and insurers. In case of low insurance penetration (e.g., in emerging markets) insurers only absorb a fraction of the losses.

Thus, especially in early phases, the MCII proposal to the Climate Talks is based on a internationally supported mechanism that would facilitate public private partnerships with clearly defined roles and a few hallmarks of the climate negotiations process: The international community will, in some form, pay for the costs of many activities that are needed to help those vulnerable countries most affected by climate change. This would include the premiums and associated costs of a climate risk insurance program. The risk that long-tailed events are miscalculated can be avoided by calculating premiums on an annual basis. This allows insurance providers to adjust the risk assessment to new scientific findings or additional loss experience annually. Insurance capacity will not be affected significantly as additional money needed to provide insurance coverage for extreme weather-related hazards (associated in part with climate change) will come out of the climate agreement expected in December 2009.

Developing countries could receive international support to promote sustainable, affordable and incentive-compatible insurance programs that serve the poor without crowding out private sector involvement. The public sectors in participating countries would be tasked to set enabling conditions and engage in measurable risk reduction activities necessary for adaptation to climate change. The private sector would have enhanced opportunities to provide risk transfer and risk management services.

ON THE ROAD TO COPENHAGEN

During the current Bonn Climate Talks, the delegations called strongly for insurance measures and began hammering out negotiating text reflecting their priorities regarding insurance. Prof. Peter Hoeppe, chair of MCII and head of Geo Risks Research of Munich Re stated: "The decision at the climate talks in Bonn has made it very likely that insurance solutions for developing countries will be part of the climate agreement that hopefully will be decided upon at the end of this year. MCII will help support this process in the next round of Climate Talks in June by delivering a technical paper, together with ISDR, that explores the evidence on how insurance mechanisms can help reduce disaster risk and support adaptation—by organizing an adaptation, risk management and insurance symposium—and by elaborating a more detailed proposal for the Bonn negotiations in June answering questions of delegations posed in the current UN climate negotiations."

Dr. Koko Warner is a founding member and executive director of the Munich Climate Insurance Initiative (MCII). Warner also leads the Climate Adaptation Section at the United Nations University Institute for Environment and Human Security (UNU-EHS). She researches adaptation and climate risk insurance, and financial mechanisms to assist the poor. Warner is an associate at the ETH Zürich, Department for Environmental Science and Economics, and an assistant professor at the University of Richmond's Emergency Service Management graduate program. She can be reached at warner@ehs.unu.edu.

"The best starting point to address climate change is reducing risk... they look to the insurance sector for its expertise—from risk modelling and pricing to the provision of insurance services."

ABOUT THE MUNICH CLIMATE INSURANCE INITIATIVE (MCII):

The Munich Climate Insurance Initiative (MCII) was launched in 2005 in response to the growing realization that insurance-related solutions can play a role in adaptation to climate change, as advocated in the Framework Convention and the Kyoto Protocol. This initiative brings together insurers, experts on climate change and adaptation, NGOs and policy researchers intent on finding solutions to the risks posed by climate change. MCII provides a forum and gathering point for insurance-related expertise on climate change impact issues.

MCII was founded by representatives of the European Climate Forum, Germanwatch, IIASA, Munich Re, the Munich Re Foundation, the Potsdam Institute for Climate Impact Research (PIK), the United Nations University Institute for Environment and Human Security (UNU-EHS), the World Bank and independent experts. The group is open to new members, e.g., representatives of other insurance or reinsurance companies, climate change and adaptation experts, NGOs and policy researchers seeking solutions to the risks posed by climate change.

Information about the Munich Climate Insurance Initiative (MCII): *www.climate-insurance.org* ✦

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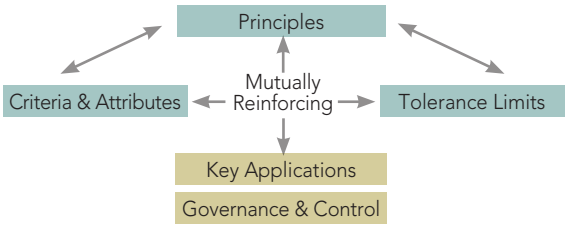
Risk Appetite Statements: What's on Your Menu?

By Michael Stramaglia

"A CLEARLY ARTICULATED RISK APPETITE STATEMENT IS A CRITICAL PREREQUISITE FOR IMPLEMENTING AN EFFECTIVE ENTERPRISE RISK MANAGEMENT PROCESS. This represents a relatively new (albeit rapidly evolving) area of practice as evidenced by the large number of organizations that have yet to develop a formal risk appetite statement, and by the lack of any clearly established best practice standard among those that have.

Figure 1 outlines a proposed framework for structuring a formal risk appetite statement.

Figure 1: Risk Appetite Statements: A Proposed Framework



It is proposed that each of the five key components of this model should form a primary section of the formal risk appetite statement. This article attempts to outline this framework and present some key suggestions and considerations regarding the form and content of these key elements in the context of a comprehensive enterprise risk management discipline.

KEY RISK APPETITE PRINCIPLES

The risk appetite statement should include a set of core principles that reflect the organization's enterprise risk management objectives and risk taking philosophy. This section therefore provides the foundational context for the remaining sections of the risk appetite statement. An organization's risk appetite defines the type and amount of risk it is willing to take on in pursuit of its vision, mission and objectives. This suggests the following examples of principles that might be covered in this section of the formal risk appetite statement:

- *Strategic Alignment*
  Any organization generally needs to take on and successfully manage risk in order to achieve its strategic goals. The risk appetite statement should highlight this linkage and identify those risks it deems to be core (intimately linked to customer value proposition, business strategy and return prospects), non-core (not aligned with core strategy and, hence, little or no risk appetite reserved) or collateral (incurred as a necessary by-product of assuming core risks and, hence, not directly pursued and ideally mitigated to the extent that the level residual risk is balanced to the cost of control).
- *Stakeholder Interests*
  The risk appetite statement needs to appropriately balance the various needs, expectations, risk/reward preferences, investment horizons, etc. of a wide range of internal and external stakeholders. In particular, for publicly listed insurance companies, the risk appetite should support the pursuit of shareholder value while ensuring that the company's ability to pay claims and fulfill long-term policyholder commitments is not compromised. The risk appetite should also support the maintenance of target credit and financial strength ratings, and ongoing favorable access to capital markets.
- *Alignment with Corporate Values and Culture*
  An organization's risk appetite should appropriately reflect its core values. The formal risk appetite statement provides an ideal platform for senior leadership to articulate its corporate values and attitudes to risk, and to set a clear "tone from the top" with regard to risks to reputation and brand value.
- *Risk Management Capacity and Capability*
  The risk appetite should be explicitly calibrated to the financial risk taking capacity (current as well as reasonably obtainable) as well as the organization's specific risk management capabilities. It should actively seek out risk taking opportunities where these capabilities can be effectively leveraged and, conversely, avoid those areas where it does not have the requisite risk management skills or available financial capacity.
  The CRO should be prepared to assume the role of Chief "Reality" Officer in order to ensure that the risk appetite statement appropriately reflects this important principle.
- *Total Portfolio Perspective*
  Adopting an enterprise risk management framework requires that risks and opportunities are not just considered based on their intrinsic merits, but also based on their marginal contribution to the organization's aggregate risk position. In particular, the risk appetite should explicitly provide for the recognition and management of diversification and concentration effects across the enterprise risk portfolio.

• *Returns Commensurate with Risks*
An organization must establish a risk appetite that is commensurate with its target return expectations. The risk appetite statement should facilitate the effective iteration and ultimate reconciliation between these two fundamental elements. This is particularly true of insurance entities where, by definition, risk management is very much at the core of their customer value proposition. This generally requires that the risk appetite framework should incorporate some form of risk budgeting process whereby risk capacity and capital can be allocated, on a total portfolio basis, across opportunities that collectively optimize the organization's overall risk adjusted returns.

While a number of the above examples may have applicability to a wide range of institutions, the specific scope and definition of these and any other applicable principles must be suitably calibrated to the actual risk philosophy and circumstances of each organizational application.

RISK TOLERANCE LIMITS

Risk tolerance limits are quantitative financial benchmarks that set out the amount of risk an organization is prepared to take on in specified key risk categories. They therefore provide a key mechanism for cascading the principles outlined above into more explicit management guidance. It is clearly not possible to develop explicit risk tolerance limits for all the risk categories that an organization faces (for example, many operational risks do not readily lend themselves to being expressed in the form of standard risk tolerance limits). However, the risk appetite statement should set out clear risk tolerance limits for at least the organization's core financial risks (i.e., credit, market, insurance).

Management will need to consider a number of key questions in designing this portion of the risk appetite statement, including:

• *What risk metric(s) will be used to define the risk tolerance limits?*
A common "currency" is required for quantifying risk tolerance limits across the spectrum of specified key risks and for measuring the actual exposure levels against these prescribed limits. Potential risk metrics can span a number of key dimensions, as illustrated by the following:

Figure 2: Risk Tolerance Metrics: Two Dimensions (examples)

	Flow-based Value Measure*	Point in time Value Measure*
Accounting	GAAP Earnings-at-Risk	Regulatory Capital-at-Risk
Economic	Change in Market Consistent Embedded Value-at-Risk	Economic Capital-at-Risk

** Expressed relative to some form of base-line level (e.g. plan, expected, current state, etc.)*

Each quadrant merits consideration for inclusion in any insurance company's risk appetite framework, and there are various pros and cons to each. For example, an organization may decide to establish risk tolerance limits for both earnings-at-risk (ease of communication, clear alignment with key stakeholders, etc.) and some form of economic capital-at-risk (most closely reflects long-term intrinsic value, is risk-based, etc.) in order to appropriately span these key dimensions and balance short- and long-term business perspectives. Related questions include whether the risk appetite statement will reflect tolerance limits based on prescribed deterministic stress tests (and how the associated stress scenario(s) for each risk category should be defined) or summary statistics derived from some distribution of risk outcomes (including choice of percentile or conditional tail expectation (CTE) level(s)).

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- *Should risk tolerance limits be structured as "maximums" or "targets"?*

  Risk tolerance limits have traditionally been positioned as maximum risk level control points. Emerging best practice frameworks incorporate a structure based on risk tolerance target levels or ranges, bounded by both maximum and minimum control points. This approach obviously supports a more strategic enterprise risk management approach by incorporating more explicit management perspectives and biases on opportunities for introducing both short and long positions relative to the articulated target risk appetite.

- *At what organizational level(s) will risk tolerance limits be defined?*

  In addition to setting out risk tolerance limits at the aggregate level, the risk appetite statement may set out limits at more granular organizational levels. The "top down" process for allocating enterprise risk taking capacity across the more discrete organizational units, including the treatment of diversification effects, should also receive appropriate coverage in the formal risk appetite statement.

- *Will the risk tolerance limits be based on "gross" or "net" risk exposures?*

  Principles for reflecting the impact of potential management actions, diversification/concentration impacts and other key mitigation strategies should be explicitly codified in the risk appetite statement, and supporting methodologies should be developed for appropriately incorporating these considerations into the prescribed risk tolerance limit methodology. Rather than approaching these considerations on an "either/or" basis, important risk mitigation insights and transparency can be achieved by evaluating risk exposures on both gross and net bases.

RISK APPETITE CRITERIA AND ATTRIBUTES

While risk tolerance limits provide valuable technology for translating risk appetite principles to management practice, more supporting guidance is generally required in order to develop sufficiently robust and comprehensive risk appetite statements. These could take the form of qualitative and/or quantitative criteria. Examples of quantitative criteria include key financial ratios (such as debt service coverage, financial strength ratings, liquidity ratios, risk adjusted return metrics, etc.) or various key notional limits that have been calibrated to, and therefore enable the effective implementation of, the explicit risk tolerance limits outlined above (interest rate duration mismatch limits, underwriting retention limits etc.).

The risk appetite statement should also set out key qualitative criteria when required to provide further context and definition to the risk appetite principles. For certain key principles (such as corporate values alignment in the examples outlined above), these may represent the only qualifying guidance; however, even risk principles that have been translated to financial and quantitative criteria can often benefit by some form of supporting qualitative definition. These qualitative criteria will, by definition, tend to be somewhat subjective. Consequently, the risk appetite statement should attempt to provide sufficient definition and detail so as to enable reasonably verifiable, replicable and more objective assessments of risk appetite assessment and alignment. This can often be achieved by developing inventories of sample transaction attributes that might give evidence to low or high levels of alignment with the applicable risk appetite principle and incorporating these inventories into some form of "scoring model."

The articulation of the aforementioned risk appetite principles, risk tolerance limits and these supporting criteria helps to ensure that a suitably holistic management approach can be taken in implementing the risk appetite. Indeed, when appropriately aligned and integrated, the combined impact of explicitly articulating these three elements as part of the risk appetite statement should be significantly greater than the sum of the parts.

"A well crafted risk appetite statement can be an invaluable tool for helping organizations navigate through the myriad of issues and opportunities characterized by today's challenging business environment."

KEY APPLICATIONS

The risk appetite statement should set out the terms of reference for how this document and its embedded guidance should be positioned within the organization's overall risk management framework and associated management decision-making processes. Given the foundational role that risk appetite plays in this regard, the statement should highlight explicit linkages to the organization's key risk identification, assessment, response development, monitoring and reporting processes. Similarly, recognizing the important linkages that need to exist between an organization's risk appetite and its strategic management and planning processes, the statement should explicitly identify, codify and facilitate these key areas of interdependency. Other key management processes that might warrant recognition for explicit alignment as part of the risk appetite statement include product development and pricing, capital budgeting, and mergers and acquisitions processes.

The risk appetite statement should also be fully integrated into the organization's performance management and compensation systems. The obvious goal is to ensure that management is appropriately compensated for successfully achieving risk adjusted returns in business areas that are well aligned with the organization's articulated risk appetite, and not inadvertently incented to pursue risk taking in those areas that are not.

It is generally sufficient that the risk appetite statement identify the key management applications where these explicit linkages are required and then set out some high level principles for how these should generally operate in practice. More detailed application guidance can be relegated to supporting polices, operating guidelines, procedure manuals, etc., as appropriate based on the organization's particular risk governance framework.

GOVERNANCE AND CONTROL

This section of the risk appetite statement should set out the requisite protocols to ensure that it functions within an overall control environment commensurate with its importance as a foundational risk management tool. It would therefore set out applicable approval protocols (ideally at the board level) for the statement's embedded limits and operating requirements. The statement should be subject to explicit change management controls and include minimum requirements for frequency of reviews and refreshes.

This section should also set out the specific accountabilities for ongoing monitoring and reporting of organizational compliance relative to the identified requirements, as well as the requisite escalation procedures should operational breaches arise in connection with any of the embedded limits and requirements.

CONCLUSION

A well crafted risk appetite statement can be an invaluable tool for helping organizations navigate through the myriad of issues and opportunities characterized by today's challenging business environment. It is hoped that the continued evolution of this practice area will lead to a clearer consensus, and, ultimately, more operational convergence, of the salient themes that warrant explicit coverage for crafting formal risk appetite statements intended to satisfy "best practice" application standards. With this in mind, industry practitioners should continue an active dialog on this practice area and, as part of this process, consider the key elements outlined above as potential candidates for inclusion in their organizations' own risk appetite statements.

The process of articulating formal risk appetite statements provides an ideal forum for active discussion and debate of the organization's most fundamental risk management beliefs and practices. In order to derive maximum value from this activity, this process should incorporate the broad-based participation and perspectives of all the organization's key stakeholders. It should also reflect the understanding that this is a practice area where value is generated as much through the journey as the ultimate destination, and where success often depends upon the organization's willingness and ability to challenge conventional beliefs and explore less traveled terrain. ✦

Communicating Risk: Presentation Matters

By David Cummings

MOST OF THE READERS OF THIS ARTICLE WILL REMEMBER JAN. 28, 1986, even if they don't remember the specific date itself. This was the day that the space shuttle Challenger exploded shortly after liftoff from the Kennedy Space Center in Florida, killing all seven astronauts on board. As a result of this disaster, the American manned space flight program was grounded, and NASA's entire mission was put in jeopardy.

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The cause of this disaster was quickly determined to be the failure of two rubber O-rings in the joint of the solid rocket boosters of the shuttle. The O-rings failed because of the freezing temperatures that existed prior to and at the time of the launch. At these cold temperatures, the rubber O-rings lost their resiliency and failed under the stresses of rocket ignition, allowing hot gases and flames to escape from the side of the rocket. These flames ignited the large fuel tank, which exploded and destroyed the shuttle.

One of the most surprising things about the Challenger disaster is that it was completely avoidable. The engineers who designed and maintained the solid rocket boosters knew that the O-rings would very likely fail at freezing temperatures. They had significant physical and statistical evidence that supported these concerns. They even presented this evidence to NASA officials and had extensive discussions with them the day before the launch. But the NASA officials were unconvinced by the presentation, so the launch proceeded.

The Challenger disaster provides an interesting case study of several facets of risk management. In many ways, the risk management systems functioned as intended. Engineers were aware of the risks posed by freezing temperatures and successfully identified the likely result. Senior management of the organization was made aware of the risk in a timely manner. Yet this did not prevent the Challenger from being launched. In the post mortem analysis of this event, there was much criticism of NASA's decision-making culture. These criticisms tend to place the entire blame for the disaster on the NASA officials who failed to stop the launch. However, in addition to the failure of the final decision, there was also a significant failure in how the risk of O-ring failure was communicated to the decision makers. The lessons of this communication failure are very relevant to risk management professionals in every organization.

THE FAILURE OF PRESENTATION

In his book *Visual Explanations*, Edward Tufte provides a thorough analysis of the 13 pages of information that were given to NASA officials by the engineers.[i] His analysis shows that the information provided and the way it was presented may have left significant doubts in the mind of NASA officials about whether freezing temperatures would result in an O-ring failure.

While the presentation clearly stated that low temperatures would lead to O-ring failure, the data presented did not support these assertions. The documents included several tables describing O-ring damage events that had occurred during previous launches and tests. Surprisingly, very few of these tables actually related temperature to these events. The relationship between temperature and O-ring damage was the key to the entire argument, but the engineers did not present this relationship in their documents. There was plenty of data provided, but little of it directly supported the argument. As Tufte said in his analysis, the engineers "had the correct theory and they were thinking causally, but they were not *displaying* causally." [ii]

One of the key weaknesses in the presentation was that the engineers focused their analysis only on the two launches where the O-ring damage was most severe. The evidence based on these two "blow by" events alone was very inconclusive. The most severe event occurred when the launch temperature was 53 degrees—the coldest launch to date. The engineers tried to extrapolate from that one data point that the O-rings would fail at freezing temperatures.

FOOTNOTES:

[i] Tufte, Edward. 1997. Visual Explanations: Images and Quantities, Evidence and Narrative. Cheshire, Conn.: Graphics Press, pp. 39–53.
[ii] Tufte, pp. 44.

"While the processes that identify and evaluate risks are critical to a successful risk management program, the process of communicating these risks is equally important."

However, there was another launch with a "blow by" event that had occurred at a launch temperature of 75 degrees. Faced only with these two data points to consider, the evidence seemed contradictory. Instead of supporting the point the engineers were rightfully trying to make, the data the engineers provided suggested that O-ring failure might not have been related to temperature at all.

Tragically, by focusing only on the most severe cases, the engineers discarded information that could have greatly strengthened their case. As Tufte recreated the data tables, he recognized that every launch that had occurred below 65 degrees had experienced some O-ring damage, and the damage became more severe as the temperature decreased. This information could have helped the NASA officials to recognize the cause-effect relationship that O-ring failure was directly related to colder temperature, and that catastrophic O-ring failure was likely to occur at freezing temperatures. Had this information been provided, NASA officials may have made the decision to halt the launch of the Challenger.

LESSONS FOR RISK MANAGEMENT PROFESSIONALS

Ineffective communication about data and statistical evidence may have played a substantial role in failing to prevent the launch of the Challenger. As risk management professionals—particularly *quantitative* risk management professionals—there are important lessons that we can learn from this incident that can improve our competency in risk communication.

This story clearly demonstrates that presentation matters. While the processes that identify and evaluate risks are critical to a successful risk management program, the process of communicating these risks is equally important. This is particularly true in communicating quantitative information. It is essential for risk management professionals to clearly communicate the conclusions of their analyses and to provide support for the decisions they recommend. The following questions motivated by the Challenger example can help us to design more effective risk communications.

1. *Does the presentation provide sufficient information about cause and effect?*
   Inherent in the evaluation of a risk is an assessment of the potential effect from not treating or mitigating the risk. Similarly, an assessment of how the risk treatment will reduce the risk is necessary for decision makers to make an appropriate decision. Information must be presented in a way that enables the decision maker to make the comparison between the cause and the effect.

   However, in some risk management presentations, the cause-effect relationship can be buried in layers of aggregation that make it difficult to discern. For example, in evaluating catastrophe risk, analyses of total potential losses during a year across multiple hazards and multiple events provide an important assessment of the effect of catastrophe risk on the enterprise. However, by summing across all of these occurrences, it may no longer be clear whether the exposure may be driven by one hazard more than another, or by concentrations in one location more than others. Risk management professionals can enhance these presentations by developing ways to describe the cause-effect relationships that underlie the risk exposure.

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FOOTNOTE:

[ii] Tufte, pp. 44.

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2. *Does the presentation provide an appropriate basis of comparison for decision making?*
   Effective quantitative presentations enable the user to make meaningful comparisons to inform their judgment. As Tufte says, "Numbers become evidence by being in relation to."[iii] In designing a presentation, it is essential to consider what information should be provided in order to make these comparisons. Oftentimes this will guide us in choosing an appropriate scale for comparison—such as the axes of a graph—to help facilitate the comparison.

   In risk management applications, we often present data in a form that uses probabilities as a basis of comparison. While probabilities are a natural and often essential element of these presentations, we ought to think carefully about whether other bases of comparison might be more relevant to the decision process. For example, in certain reinsurance decisions, reinsurance attachment points may provide a better basis of comparison than probability thresholds would.

   Carefully evaluating whether probabilities are the most relevant basis is important for at least two reasons. First, it is not natural or intuitive for most people to make comparisons based on probabilities. Secondly, the probabilities resulting from most stochastic analyses are truly only estimates themselves. Particularly in evaluating extreme event risk, the error in estimating the probabilities can exceed the probability estimate itself. So when probabilities do provide an appropriate basis of comparison, it is important for us to communicate clearly and consistently what they mean.

3. *Does the presentation include the right amount of supporting information?*
   Quantitative risk analyses can easily produce volumes of data that can overwhelm the potential user. Therefore it is essential for us to carefully evaluate which information is truly needed to support the decision process. At the same time, we must be careful not to exclude information that can provide meaningful insight to support the conclusions of the analysis. Just as the engineers did by focusing only on the most severe O-ring failures, it is possible for us to focus too much on the most extreme risk events. Such extreme events may have significant uncertainty about their magnitude. Less severe events may provide significant information to guide a risk management decision and reduce the uncertainty about the effects of these decisions.

RISK COMMUNICATION AS A KEY COMPETENCY

The failure of communication that occurred between NASA officials and the engineers is a powerful example that demonstrates the crucial role of effective presentation of quantitative information in risk management. Risk management professionals must develop their ability to communicate risk effectively and support their assessments with meaningful quantitative findings. Risk management professionals who consider risk communication to be a key competency will strengthen this critical link in the risk management process. This in turn will enhance their ability to establish and maintain robust risk management within their organizations. ✦

Can Bad Culture Kill a Firm?

By Stephen W. Hiemstra

CAN BAD CULTURE KILL A FIRM?

Clearly. Weak cultures leave firms exposed to risks that had previously been assessed and mitigated. In my previous article, I illustrated this problem by showing how market and organizational changes have undermined risk management decisions. In this article, I analyze how cultural influences can impede learning and weaken risk management.

DECISION COSTS INFLUENCE CULTURE

Nobel laureate economist Herbert Simon defined rationality as making a choice among all possible alternatives. Economists more generally hypothesize that the firm strives to maximize its net present value assuming perfect knowledge of all future cash flows. Because all decisions are rational and predictable given knowledge about technology and market prices, this theory implies that a firm has no culture.

In practice, we observe that decisions are costly, resources are limited, and decisions are frequently made based on rules of thumb and habit. For these reasons, in part, Simon extended the theory of the firm to limit rational behavior—his theory of bounded rationality (Simon 1997, 88).

What is culture? Culture arises because highly rational decisions are costly. Managers ration their time by applying rules of thumb based on previous decisions. These rules of thumb plus manager training and experience determine a firm's decision culture. Interestingly, the more costly rational decisions are, the stronger the cultural effect.

The existence of culture implies that history is interesting. The time sequence of decisions and their consequences predisposes the organization toward some growth paths and away from others. The personal histories of leaders are important in understanding attitudes about alternatives and the speed at which decisions are made.

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Cultural Types. The existence of culture suggests why organizations develop classifiable personalities. Chart 1 outlines several widely observed types. Criteria describing these types include preferred decision style, key values, primary mode for training, nature of control process, and default transaction-opportunity cost trade-off.

A culture articulates key values in terms of where decisions ideally take place. A modern culture delegates authorities to line managers because good decisions require the objective information they produce. A postmodern culture shares decision authority to assure that decisions are equitable. A traditional culture centralizes many decisions to adhere to senior management preferences. Training and control processes reinforce these cultural preferences.

A dying organization is an organization in crisis. A dying organization may start with any affinity but evolves toward traditional culture. This is because crises consist of a rapid series of nonstandard problems that exceed delegations and require senior management input. Cutbacks likewise strengthen the position of senior managers.

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NOTE:
Dr. Hiemstra is an economist and financial engineer living in Centreville, Virginia. In 2007 and 2008, he served on the program committee for the Enterprise Risk Management Symposium. For more details about the ERM Symposium, see: *www.ERMSymposium.org.* Dr. Hiemstra contributed to research of the Enterprise Risk Management Institute International (see references). Part one of this series, *Can Bad Culture Kill a Firm*?, appeared in the December 2008 edition of *Risk Management Newsletter.*

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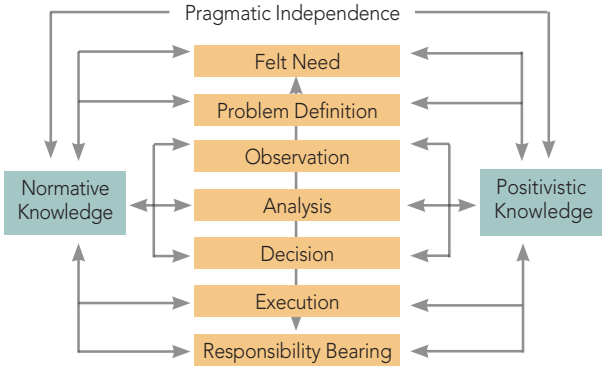
Chart 1: Corporate Cultural Types

Culture	Decisions	Key Value	Primary Training	Control Processes	Transaction/Opportunity
Modern	Line Managers	Objectivity	Formal	Formal	M/L
Postmodern	Consensus	Equity	Formal and OTJ	Informal	H/M
Traditional	Senior Managers	Loyalty	OTJ	Discretion	L/H
Dying	Any of the above under pressure				

Transaction cost = overhead cost of doing business, Opportunity cost = costs of foregone opportunities, OTJ = On the job, L = Low, M = Medium, H = High

Chart 2: Steps in Problem Solving and The Knowledge Used



Sources: 1 Glenn L. Johnson, 1986. Research Methodology for Economists, MacMillan Publishing Company, New York. P. 15. 2. John Dewey. 1997. *How We Think*. Dover Publications, Inc. Mineola, NY.P.12.

The mix of transaction costs and opportunity costs also reflects cultural affinities. Transaction costs rise with the number of people participating in decisions, while opportunity costs rise as decision alternatives are excluded. The traditional culture has the lowest transaction costs because it considers the fewest options—only senior manager preferences are consulted. The postmodern culture consults the most people, but it is not particularly reflective—only options actively advocated are considered. Transaction costs in the modern culture fall between these two extremes, but the modern culture prefers a review of all options.

Williamson (1981, 1564) sees both organizational costs constrained by market prices. The implication is that cultures evolve to reflect competitive conditions in the markets that firms serve. The dominant culture type may evolve with both market pressures and leadership changes, which may over time lead to overlapping cultural attributes. An office evolving from a modern to a postmodern type, for example, may begin to exhibit more group decision making, place less emphasis on academic credentials in assignments and promotions and rely less on peer review of work products.

BEHAVIORAL WEAKNESSES IMPEDE LEARNING

Cultural types describe key attributes at a point in time. Changing circumstances, however, force organizations to learn and adapt. Learning behavior is therefore a key measure of risk management performance.

"Even though models epitomize rational decision making, models are cultural artifacts fixed in time and place."

How does bad culture evolve? We observe behavior problems when incentive structures disrupt normal learning processes, create logical traps or exacerbate normal organizational inertia.

Rational Learning. A prominent rational decision process is the scientific method that combines learning and decision making into a process for solving nonstandard problems. Steps include: a felt need, problem definition, observation, analysis, decision, execution and responsibility bearing (Chart 2). Because this process is costly, the firm rations the number of decisions that employ this process.

Behavioral Decision Making. Rule-based decisions match current environmental states to prior decisions. This matching process can be formal, as in the promulgation of a law, or informal, as in the case of managerial application of experience. This decision process satisfies the conditions of behavioral learning.[2]

The most prominent behavioral learning process in psychology—stimulus-response theory—operates in a similar fashion. Actions (like matching to a rule with a positive result) involving a positive stimulus (+) attract further action, while actions (like matching a rule with a negative outcome) involving a negative stimulus (-) provoke avoidance (Cross and Guyer 1980, 9). We learn by repeating actions following positive stimuli and avoiding actions following negative stimuli.

Learning Surprises. A learning surprise occurs when long strings of positive stimuli are followed by negative stimuli (+++++++-), or if long strings of negative stimuli are followed by positive stimuli (------+). Cross and Guyer (1980, 4) refer to this problem as a social trap—a situation defined as having *multiple but conflicting rewards.* Such patterns disrupt behavioral learning and suggest why habits may be a poor guide in making important decisions. Smoking, gambling behavior, drug addiction and marital cheating have an incentive structure with long strings of positive stimuli followed by negative stimuli (short-term pleasure leads to long-term pain). Higher education, research and investment decisions have the opposite pattern: a long string of negative stimuli (cash outlays, lost income and hard work) followed by positive stimuli (increased status, power and income).

Organizational Inertia. Inertia is the physical property expressed in Sir Isaac Newton's first law of motion: a body at rest tends to stay at rest, and a body in motion tends to stay in motion.[3] Inertia leads organizations to resist change and discount low-probability events.

An organizational culture mirrors its environment because decisions and rules evolve over time to deal with environmental challenges. Rewards of money, power and status within an organization accrue to leaders that facilitate this evolution. When prior decisions and rules need to change, a conflict arises because those changes may threaten the social position of those leaders.

Consider the case of a firm in a growing business. Suppose the firm starts out as a specialized firm in a competitive market. As it grows and acquires competitors, it takes market prices as given. As market share grows, however, it eventually becomes the market and can set price. Further growth requires that it diversify into new markets. At each stage in the firm's growth, the rules for success and risks change (Porter 1980, 191-295). If the organizational culture adapts with a lag and a threat grows quickly enough, firm solvency could be threatened before adaptation is complete.

Example of a Learning Trap. Cultural factors dominate behavior even in a financial modeling shop because a model summarizes firm practices and market processes captured in the data history. Even though models epitomize rational decision making, models are cultural artifacts fixed in time and place.

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FOOTNOTES:

[2] The logic implied here is metaphorical. The syllogism is: the world is like X. Therefore, the last time X happened, we did Y and things worked out fine. The key to model use is making sure that a close match exists between the previous world condition and X. This is the basic logic behind most economic modeling. *http://en.wikipedia.org/wiki/Newton's_laws_of_motion.*

[3] *http://en.wikipedia.org/wiki/Newton's_laws_of_motion.*

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Rational choice theory presumes that the firm computes expected loss (probably of loss event times the expected loss given the event) before deciding how to respond. If managers outside the modeling team assume historical (unconditioned) relative frequencies of loss that are tiny, further analysis will always appear extravagant until a consensus develops that more recent forecasts show higher probabilities. A natural gap can accordingly arise between conditioned and unconditional views of the probability of loss. The higher the cost of acquiring new information and the more organization inertia marshaled behind the old view, the larger the gap that may arise.

RISK MANAGEMENT PERFORMANCE

Good enterprise risk management (ERM) balances rational choices while attending to cultural challenges. Attributes of good ERM include:

- The whole firm is considered (holistic characteristic).
- Share profits and losses equitably across stakeholders (equitable ethics characteristic).
- Peers are encouraged to provide positive leadership (intensive management characteristic).
- Risk taking is separated from risk management (objective assessment characteristic).
- Risk management is a key corporate value, second only to profit maximization (postmodern characteristic).

If ERM is incorporated into decisions at all levels of the organization, the effect of focusing on ERM is to narrow the gap between new and historical risk perceptions. What is your firm's appetite? The assumption here is that a firm accustomed to assessing risks against an internal risk target adapts more readily to a changing risk environment than a firm whose default response is to focus on other things. ✦

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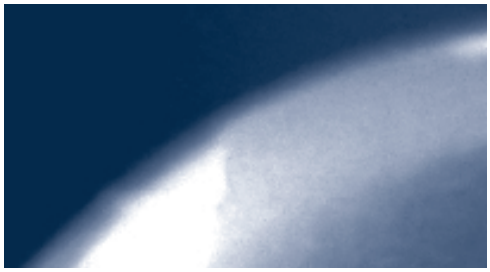
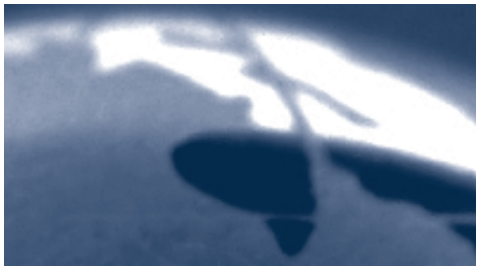
[5] Williamson, Oliver. 1981. The Modern Corporation: Origin, Evolution, Attributes. Journal of Economic Literature. December, pp. 1537-68.

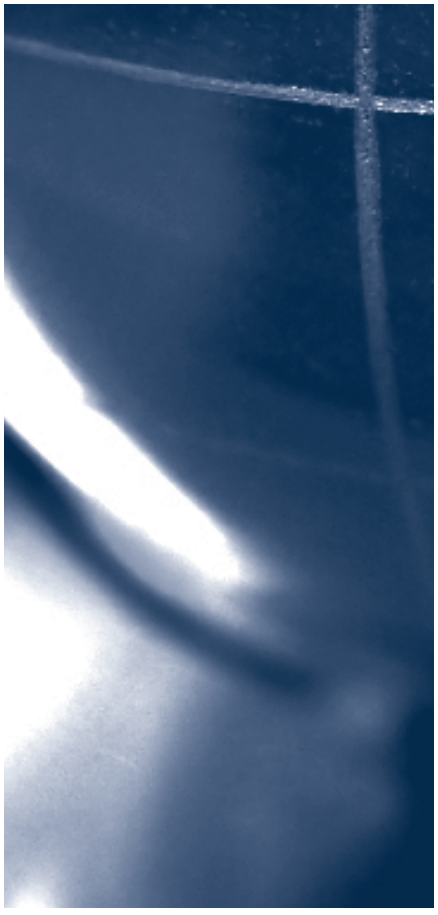




CAS Professional Education Calendar

These upcoming CAS Continuing Education Opportunities will keep you up to date on the latest trends in actuarial science.

Actuaries
Risk is Opportunity.℠



Dates to Remember

CAReE Reinsurance Boot Camp on Pricing Techniques
August 10-11, 2009
New York, NY

Predictive Modeling Limited Attendance Seminar
August 12-13, 2009
Chicago, IL

Testing Loss Reserve Assumptions Limited Attendance Seminar
August 24, 2009
Chicago, IL

Reserve Variability Limited Attendance Seminar
August 25-27, 2009
Chicago, IL

Casualty Loss Reserve Seminar (CLRS)
September 14-15, 2009
Chicago, IL

London CAReE Seminar: Pricing and Issues in Todayís Market
September 15, 2009
London, England

Introduction to Enterprise Risk Management
October 2-19, 2009
Online Couse

In Focus: The Underwriting Cycle Seminar
October 5-6, 2009
Alexandria, VA

Enterprise Risk Management and Modeling (ERM2) Limited Attendance Seminar
October 19-20, 2009
Chicago, IL

CAS Annual Meeting
November 15-18, 2009
Boston, MA

See Reverse Side for Details on Limited Attendance Seminars

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JOINT RISK MANAGEMENT SECTION

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Risk management