RISK MANAGEMENT SECTION

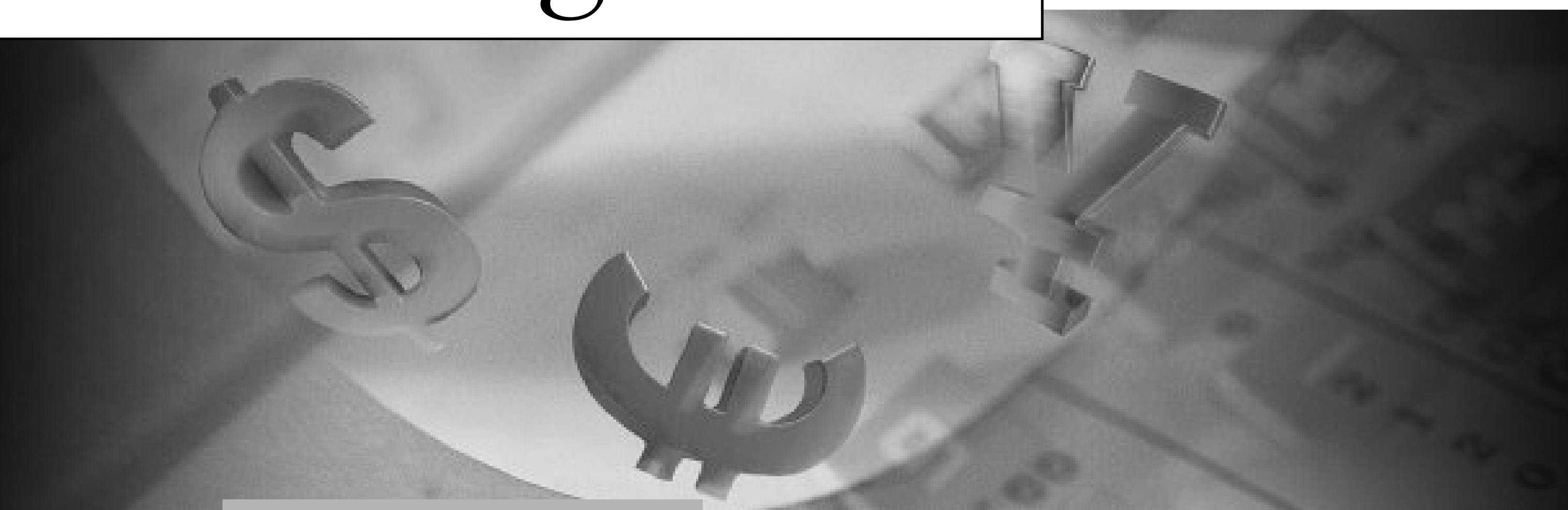
"A JOINT SECTION OF SOCIETY OF ACTUARIES, CASUALTY ACTUARIAL SOCIETY AND CANADIAN INSTITUTE OF ACTUARIES"

Canadian Institute of Actuaries / Institut canadien des actuaires

Risk Management

September 2007, Issue No. 11

Published in Schaumburg, Ill. by the Society of Actuaries



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Actuaries
Risk is Opportunity.[sm]

What's in a Name (Reprise)?

by Douglas W. Brooks

A year ago, the Joint Risk Management Section of the Society of Actuaries and the Casualty Actuarial Society (as it then was) looked at the possibility of a new nickname for the section, finding the foregoing somewhat clumsy, and not given to a catchy acronym. Dave Ingram's Chairperson's Corner article in the July 2006 issue, "What's in a (Nick) Name," discusses this. The name chosen at the time was Enterprise Risk Management Actuarial Professionals (ERMAP). For various reasons, the name was not proceeded with, in part because there were discussions about the new risk management designation, and concern over potential confusion between the designation and the name of the section. Since then, the section has added the Canadian Institute of Actuaries as a sponsoring organization, making the official name even more of a mouthful. As well, the new designation Chartered Enterprise Risk Analyst (CERA) has been developed and announced, and the name is distinct enough that the use of ERMAP as a moniker for the section is not a problem. Therefore, we are pleased to announce that the section will now be known as ERMAP (for all but the most official purposes).

Does a name make a difference? Juliet's point, in Romeo and Juliet, is that a name should not matter: "What's in a name? That which we call a rose By any other name would smell as sweet." The play goes on to demonstrate that, unfortunately in that case, names and labels do matter, at least to many people. Names are an important part of communication, and communication is a critical success factor of any initiative involving groups of people. The name of the section is not likely to make a significant difference in the ability to communicate our goals, but nevertheless can help to give a group an identity. It also serves as a reminder of the broader importance of communication, and tools for improving communication and as a result the effectiveness of organizations.

Doug W. Brooks, FSA, CERA, FCIA, MAAA, is senior vice president and chief financial officer at Equitable Life Insurance Company of Canada. He can be reached at *dbrooks@equitable.ca.*

A more significant attempt to develop a tool for communication in risk management is the recent paper just published by the CAS-CIA-SOA Risk Management Section Research Team on risk management terminology. The study looks at risk terminology across industries, and was developed by a research team from the University of Wisconsin-Madison. The motivation for the research was the desire to improve communications among risk professionals both within and across organizations. The study can be found at *http://www.soa.org/research/risk-management/risk-mngt-terms.aspx.*

Why is common terminology important?

It improves our ability to communicate about risk management without having to clarify meaning at each stage, or, more usually, assume that meaning is clear without validating and find out at a future stage that in fact different parties understood things quite differently. The results can range from the inefficient (gaps or duplication of work) to the dangerous (two parties each assume the other is taking care of a particular threat when in fact neither is doing so).

Common terminology is one of the building blocks of a strong ERM framework. Other components include a common currency (i.e. measurement basis), a strong culture and aligned incentives. A common terminology enables communication among risk managers within an organization. Different professions and even different areas within the same profession often develop their own language for dealing with their specific issues. Often, significant insights can be gained by learning from the experiences of others in dealing with situations that have underlying characteristics that are similar to those that we are grappling with. Language differences, however, can make it difficult to get at the common underlying issues—things may sound like two entirely different problems when in fact they are very similar!

Common terminology also assists significantly in taking a true enterprise-wide view of an organization by aggregating similar risks. If terminology is different, it is much harder to identify when a risk should be aggregated with another. A common basis of risk classification, applied consistently across an organization, on the other hand, facilitates both aggregation and understanding.

Communication with business managers and finding ways to make business leaders aware of risk management tools, methods and measures is also critical. Common language, including common terminology for risks and a common risk classification, is one of the tools that can assist in communicating with business managers.

The actuarial profession has been criticized for being less than fully effective in communication. This is an area that we must continue to work at proactively and in fact an area in which we can make a significant contribution to the development of effective risk management practices. ✦

> **"...communication... is an area that we must continue to work at proactively. ..."**

Update from the International Committee of ERMAP & INARM

by David Ingram

The International Committee is off to a roaring start both because of outstanding support from ERMAP member volunteers and due to very warm international responses. The activities have focused in three areas: Newsletter translations, network building and joint projects.

Thanks to the Canadian Institute of Actuaries (CIA), the newsletter translation effort started with one non-English edition, the French edition. This was produced for the French speaking members of the CIA and it has also been circulated to actuaries in France. In addition, Ken Seng Tan, the editor of the newsletter has been working with China Institute of Actuarial Science, Central University of Finance and Economics to produce an edition in Mandarin Chinese. That edition should be available in September and consists of selected articles from the past year that are thought to be of high interest to non-North American actuaries working in risk management. A third project is a Spanish translation of summaries of the articles from the newsletters. That translation is being undertaken by the Mexican College of Actuaries. We are in discussion with actuaries in other parts of the world about possible translations of the international edition or the summaries into other languages.

David Ingram, FSA, CERA, MAAA, is director of enterprise riskmanagement with Standard & Poor's in New York, N.Y. He can be reached at *david_ingram@standardandpoors.com.*

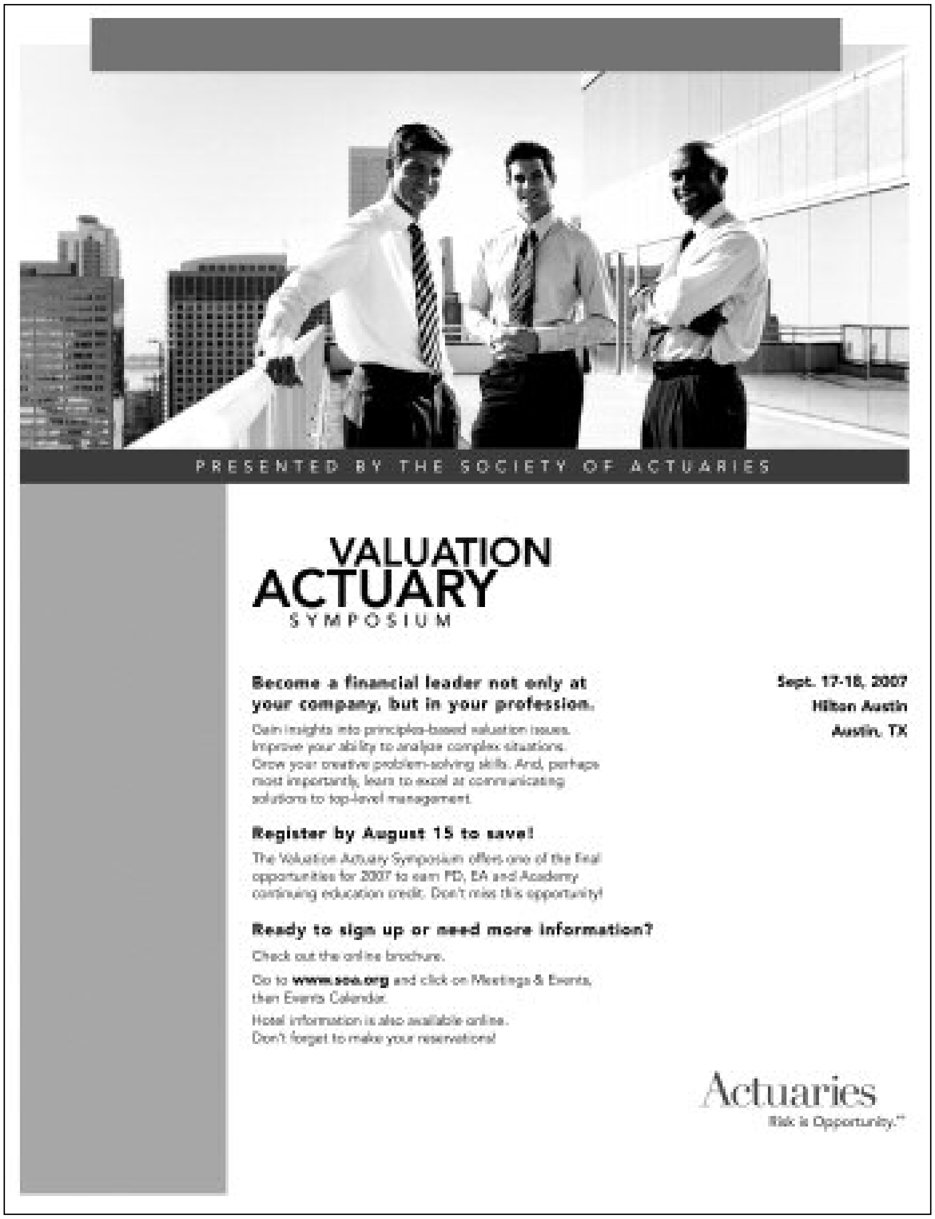
Our efforts to form affiliations with other actuaries around the world has had such enthusiastic response that we decided to give the effort a name. The International Network of Actuarial Risk Managers (INARM) now has affiliates from seven countries (Australia, China, Germany, Hong Kong, Korea, Mexico, United Kingdom) plus Canada and United States via ERMAP and we are in active discussion with a dozen more. Representatives for some of these groups join our monthly working group calls and others interact through an ERMAP volunteer who acts at the ambassador.

We are positioning this network similarly to the standing of a section within the SOA—that is, as a bottom-up membership driven group of volunteer practitioners and other interested parties. We hope to augment the IAA Enterprise and Financial Risk Committee (EFIRC) and are working toward forming a statement of understanding regarding the relationship. We expect to be able to support the IAA activities in risk management, and in addition, to pursue member initiated projects. We hope that this will work just as SOA sections work with the SOA and the AAA, recruiting volunteers for some projects and taking complete responsibility for others.

We have started two projects already. The first is a compilation of information about the status of regulatory and actuarial roles regarding ERM throughout the world. This project is being undertaken for the IAA EFIRC and is being lead by Ian Laughlin of Australia. The second is the development of a Beginners guide to ERM, in the form of an FAQ. This project is being conducted via a web based tool and is lead by Geraldine Kaye of the U.K. We are hoping to get participation from as many different countries as possible in both of these projects, whether network affiliates or not.

This is a truly amazing level of activity. However, there is more that could be done. We could use more volunteers to act as ambassadors and volunteers to support projects and future activities. We expect that future projects will be developed from member and IAA requests, so if you have any suggestions for future projects, we would be happy to have those ideas as well. Please note that our intention with the network is to promote risk management developments as our first priority. There is not a requirement that volunteers have an international job or work for an international company. Volunteers who are interested in risk management and who would be willing to cooperate with practitioners and learners in other parts of the world are what we are looking for. At this point in time, everyone seems to agree that Risk Management is a borderless discipline. There is not a unique U.S. or Canadian or European or Chinese or Japanese version of Risk Management. Through INARM, we hope to continue to develop the unique actuarial contribution to risk management. The borderless condition of risk management allows us to work together to use all of our collective skills, knowledge and experiences to build up the actuarial contribution. To volunteer, contact *david_ingram@standardandpoors.com* or *jwebber@soa.org*.

Finally, we realize that not everyone is able to volunteer. We would like to invite anyone who would like to follow our efforts on a real time basis to join an e-mail group that will get at least monthly updates on INARM activities. This can be done by connecting to the SOA Web site page *http://www.soa.org/news-and-publications/listservs/list-public-listservs.aspx*. There you can sign up for the e-mail group. ✦



Operational Risk Management and Business Continuity Planning

by Camilo Salazar

Hurricane Katrina came ashore on Aug. 29, 2005, wreaking havoc on the Gulf States of Louisiana, Alabama, and Mississippi. The huge storm and its destructive power shone a spotlight on the critical relationship between operational risk management and business continuity planning.

Hurricane Katrina was a devastating natural disaster. Its effects—physical, emotional, and political—are still being felt almost two years later. The business disruption experienced by many companies in the area was compounded by the personal hardships of their employees.

Although no two disasters are precisely alike, all present a similar core of critical issues. These include the challenges that a business is likely to encounter during the crisis, what a business continuity plan can and cannot do, and how individuals typically respond, both personally and professionally.

The ultimate business interruption

Hurricane Katrina exposed not only the frailty of the people, but also the confusion and lack of leadership at many levels in government. It forced many companies to change how they do business and reconsider how they work internally.

Hurricane Katrina was three correlated events, one after another, occurring within a 72-hour window:

1. On Sunday, Aug. 28, at 10:00 a.m., anticipating the storm, a total and mandatory evacuation order of the entire city of New Orleans was issued.

2. On Monday morning, Aug. 29, Hurricane Katrina made landfall as a Category III hurricane with sustained winds of 125 mph and storm surges up to 25 feet high.

3. On Monday evening, three Lake Pontchartrain levees in New Orleans began to give way, and 80 percent of the city was under water at peak flooding, which in some places was 20 to 25 feet deep by Tuesday morning.

The combination of these three events wrapped into one changed everything. During the first few days, there was no information coming from anyone at the local, state or federal government as to when or how things would begin to return to normal. There was simply no similar precedent, and no clear plan where to start recovery operations.

As the disaster unfolded for many companies based in the New Orleans area, their management teams began to grasp that returning to normal operations from the home office could not happen soon and would not be easy. The challenge presented itself starkly: how to operate the enterprise without a home office for an extended period of time with significantly reduced staff, all of whom were themselves displaced and experiencing severe personal hardship? A business continuity plan designed around the concept of a short-term evacuation would not sustain the company for more than a few weeks. Companies that had planned only for such short-term events needed to change their approach and plan for a much longer "return to normalcy."

Camilo Salazar, ASA, MAAA, is a senior consultant with Milliman, Inc. He can be reached at *camilo.salazar@milliman.com.*

For individual employees, the situation looked bleak. There might not be a home to return to. How can you live or work out of a cramped motel for weeks or months—with the kids and maybe extra relatives or even pets sharing the space—when you never intended to stay there for more than a few days? What about work and getting a paycheck? Where will the kids go to school? These questions were increasingly difficult to answer as it became clear that the displacement would go on indefinitely.

How companies respond to a business interruption

Any catastrophic event affects different people in different ways. The same can be said about businesses and companies, depending on the type of business, how it operates, its size, where it is located, and other factors.

From the perspective of an insurance company, the lessons from Hurricane Katrina provide a reference point for planning, preparation and recovery. These lessons can be divided into internally and externally focused management decisions:

- **Internal**: Make sure you can continue to operate and serve your clients. Internal management is directed at employees and the processes needed to keep the business whole. Internal activities relate to being able to process new and existing business in terms of handling new applications, premiums, claims, paying commissions, investments, accounting, and actuarial matters.

- **External:** Make sure the business keeps coming in. External management extends to vendors, suppliers and other organizations that are crucial to a business's ability to generate revenue. External activities are driven by the need to make sure the company can continue to receive new business and is able to serve its existing clients.

A consistent and delicate balance of both is needed to ensure the client continues to be served. Focusing mostly internally might result in employees capable and ready—but unable to perform because of the lack of business coming in. Likewise, focusing mostly externally will leave critical weaknesses internally that eventually will disrupt the business coming in as client service deteriorates and new business goes elsewhere.

Hurricanes and the Gulf region

In the Gulf region, when people think of disasters, they think of hurricanes. As such, the planning at home typically includes three stages:

- Evacuate for two or three days to a motel, to a relative's or friend's home, or to some other location out of the hurricane's path.
- Return home; clean up the yard and repair the house as needed.
- Go back to work; the kids go back to school.

At work, the approach is typically more sophisticated. In one particular instance, the business continuity plan was based on a three-day regressive countdown approach:

- Three days before a potential impact: Begin to make basic preparations to evacuate (making tape backups, shipping data to off-site location, preparing basic office facilities off-site).
- Two days before potential impact: Start preparing essential personnel to leave the city.

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> “Any catastrophic event affects different people in different ways. The same can be said about businesses and companies. ...”

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- One day before potential impact: Begin to evacuate.

A successful business continuity plan

A disaster can be externally driven, such as a hurricane, an earthquake, or a terrorist act; or it can be internally driven, such as a fire, a system failure, or a disgruntled employee that does something to damage the organization.

Any basic business continuity plan must address four essential elements:

- **Operating infrastructure:** A remote facility to operate the business. Such a facility will likely have scaled-down capabilities (using reduced staff); it requires well-documented processes, policies and procedures, including accounting processes that can document extraordinary expenditures during the disaster.
- **Information technology infrastructure:** Redundant networks with multiple points of access. Data should be regularly and safely backed up and stored remotely.
- **Human resources:** Regular employee training to establish awareness on how to respond, at least in the first few hours of a disaster. These first few hours are critical.
- **Executive participation:** Business continuity cannot be merely an operational matter; it is a strategic concern that should be discussed at the executive level. Senior decision-makers need to know where their revenue-generating capability is most vulnerable and should plan to address these vulnerabilities.

The plan can also be organized along functional lines, such as operations and administration, actuarial, accounting and investments, marketing, sales, and distribution. Regardless of how the plan is organized, there are internally driven and externally driven issues that need to be considered. This brings us to some considerations with regard to risk management and business continuity planning:

- Do not think it cannot happen to you or your organization. A company can certainly take steps to minimize internal sources of a potential disaster, but it cannot control external events.
- Do not dismiss planning under the pretext that no amount of planning is perfect. Although every disaster is different and each situation is quite fluid, a complete lack of planning, even for basic and obvious steps, could lead to the collapse of the company.

Key ingredients of a successful business continuity plan

The essential components of any business continuity plan, regardless of the industry or the circumstances, must address three things that could destroy or seriously damage a company. These are:

1. **Loss of intellectual capital.** Intellectual capital is the collective know-how that defines the company. This capital resides in the data, in the systems, in the documented processes, and in the minds of employees.
2. **Loss of human capital.** Human capital consists of employees as well as all those who do business with the company—those essential to maintaining the organization's ability to generate revenue. This includes external relationships with producers, providers, regulators, and rating agencies.
3. **Leadership and communication.** Leadership and communication make a business continuity plan work during and in the aftermath of a disaster. Communication with those affected both internally and

externally is crucial to the resiliency of the business.

Internally, most employees are likely to be distraught during a major crisis, experiencing loss and lack of direction. They fear not only for their potential personal losses, but also for their jobs.

Senior management has some sense of control as it stays connected and makes decisions that affect the organization; but for most employees, as was the case during Hurricane Katrina, there is a sense of isolation because they have been displaced from their homes and jobs.

Employees need to hear from senior management in order to get a sense of direction and belonging—and the sooner they hear from business leaders, the better. Employees are ready and willing to do whatever the company asks of them that can validate their sense of value to the company and give them a sense of belonging to a greater effort, of being part of a process and a team.

Externally, producers and providers also need to hear from senior management to understand what is really happening and whether or not it makes sense to continue doing business with the company. If senior management does not talk to them promptly, the competitors will.

A business continuity plan needs to address some basic elements aimed at recovering and protecting the intellectual and human capital of the company, and examine how to manage the leadership and the communication process during a crisis.

With regard to data and other vital information, these basic elements include things such as redundancy in systems and accessibility to them from various points, as well as the alternative of outsourcing certain functions, such as systems administration or valuation processes, especially for a small or medium-sized company. Business processes need to be documented and maintained in more than one medium and accessible from more than one location.

With regard to human capital, the best way to ensure business continuity is to maintain connections among people. When Hurricane Katrina hit, many companies lost their e-mail systems for several days. Suddenly, they could not reach or communicate with their employees. Likewise, employees could not communicate with their employers to find out what was happening.

One way to preserve these connections in the event of a disaster is to print wallet-sized cards for all employees with the following information, to be used following a business interruption:

- A company Web site, which can be activated during an event and which will provide information and updates to employees.
- A telephone conferencing call process, with a different password by function area. A conference call can be held every day at a specific time following a disaster declaration. Employees can dial in and obtain and exchange information, and thus feel connected with their peers.

Hurricane Katrina was unique in that the employees also suffered personal hardship on a large scale, so companies had to deal with not only how to facilitate a working environment in alternative office space, but also how to help employees and their families with housing needs.

Finally, there is the question of leadership. Senior management needs to lead and provide examples. Managers should make decisions based on the best facts available, and change

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“ With regard to human capital, the best way to ensure business continuity is to maintain connections among people. ”

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them if the facts change. Senior management needs to be seen and heard.

As for producers, providers and anyone the company does business with externally, senior management needs to communicate with them, in person if possible, address their concerns, communicate the desire to continue doing business together, and extract a commitment to continue the relationship. External constituents include regulators and rating agencies, who may need some objective explanation of how management is addressing the crisis.

In terms of communications, it is best to control the message whenever possible by providing timely, frequent updates. This extends not only to customers but also to media. In certain instances, effective communication may require the company to dispel the image the media has created of the disaster in general (by rational extrapolation, people think a company is likely affected, regardless of how the media has portrayed the wider event). An objective, simple, and clear message needs to be consistently delivered when addressing outside contacts.

Communication strategies must also be mindful of the potential for limited access to usual means of communication. Other means of communication available need to be used: newspaper and radio ads, e-mails, conference calls, business contacts, and even connections with board members.

Coming home

Nothing lasts forever. Eventually the crisis begins to settle down, and the nature of the crisis changes. In the case of Hurricane Katrina, after three months of operating in remote locations, the challenge for many companies was how to start migrating back to the home office when New Orleans began to reopen. But which functions should they migrate back and in what order should they do it?

This challenge was not so simple to address. After three months, many employees had "settled" in alternative locations and were not able or willing to move back or commute to the city. Many of their children had been enrolled in new local schools, and New Orleans schools were not going to reopen anytime soon. For many employees, their homes in New Orleans were destroyed or severely damaged, so they had no place to live, even if they did want to go back to work in the city.

Still, over the following months, local businesses started to return and the city began to function with some sense of normalcy. For the companies and businesses in the area, both small and large, Hurricane Katrina was an event that changed them in significant ways. Hopefully, the lessons discussed here can be applied to any business anywhere and can help strengthen a company's operational risk management practices for the future.✦

A Report on the CAS COTOR Risk Premium Project

by J. David Cummins, Richard A. Derrig and Richard D. Phillips

The Risk Premium Project (RPP) represented the most extensive, thorough and up-to-date analysis of the theory and empirics of risk assessment for property-casualty insurance through 2000. The Project began as a response by industry and academic researchers to a request for proposals issued by the Committee on the Theory of Risk (COTOR) of the Casualty Actuarial Society (CAS) due April 1, 1999.[1] At the time, the discounting of loss reserves was an important topic of debate among casualty actuaries, and COTOR was interested in providing the members of the CAS with a review of the seemingly disparate academic and actuarial literature with the express hope of revealing appropriate discount rates for liabilities. The members of RPP proposed to address the topic using a three phased approach:

Phase I: Provide a compilation of the most relevant academic and actuarial literature on risk assessment for the prior 20 years, approximately 1980-2000.

Phase II: Discuss the equilibrium pricing for insurance risk in light of the Phase I literature.

Phase III: Propose empirical projects to quantify some of the Phase II theoretical conclusions.

COTOR accepted the RPP proposal on Aug. 13, 1999 and the researchers presented their final report on Phases I and II to COTOR on June 30, 2000.[2]

Phase I produced an annotated bibliography of 138 items consisting of 14 referenced books and 124 articles and papers from 37 financial and actuarial publications, including the *Proceedings of the Casualty Actuarial Society, Journal of Finance, Journal of Portfolio Management*, the *ASTIN Bulletin*, and National Bureau of Economic Research working papers. The bibliography is searchable by author, title and keyword online at *www.casact.org/cotor/index.cfm?fa=rpp*. The articles and papers are separated into themes that cover general finance, asset pricing, insurance risk, surplus allocation, the history of applications in finance and insurance and some miscellaneous topics.

The abstract of Phase II report is as follows: *This report summarizes the authors' review of the actuarial and finance literature on the subject of risk adjustments for discounting liabilities in property-liability insurance. The authors find that the actuarial and financial views of risk priced in the market are converging: systematic or non-diversifiable risk still plays a central role in equilibrium pricing, but non-systematic costs arising from market frictions such as taxes and financial risk management also contribute to market valuations. Recent advances in risk assessment and capital allocation techniques are noted. Several empirical follow-up projects are identified.*

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[1] There were four members of the RPP. The academic researchers included J. David Cummins and Richard D. Phillips. The industry researchers were Robert P. Butsic from Fireman's Fund and Richard A. Derrig who, at the time of the project, was with the Automobile Insurers Bureau of Massachusetts. Both industry members have recently retired while the academic members remain with their universities.

[2] The report is available on the CAS Web site at *www.casact.org/cotor/index.cfm?fa=rpp*. Alternatively you can search the CAS Web site using the key words Risk Premium Project.

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J. David Cummins, Ph.D., is the Joseph E. Boettner Professor of Risk Management, Insurance, and Financial Institutions at Temple University's Fox School of Business. He can be reached at *cummins@temple.edu*.

Richard A. Derrig, Ph.D., is now president of OPAL Consulting LLC and a Visiting Scholar at the Wharton School. He can be reached at *rderrig@aib.org*.

Richard D. Phillips, Ph.D. is the Bruce A. Palmer Professor of Risk Management and Insurance and Department Chair at Georgia State University. He can be reached at *rphillips@gsu.edu*.

The specific conclusions the researchers reached included:

(1) Although actuaries have long argued that non-systematic (non-market) risk plays a role in insurance pricing, financial economists have recently developed various theories that provide sound justification for this conclusion.

(2) Systematic risk plays a role in valuing liabilities either because the loss cash flows are contemporaneously correlated with market-wide returns or because unexpected changes in the interest rate used to discount long-term liabilities is correlated across all future cash flows in the economy. This latter effect is expected to be a more important factor for longer duration insurance liabilities.[3]

(3) Returns to financial assets cannot be adequately explained by the Capital Asset Pricing Model (CAPM) beta. Additional factors have been identified which significantly enhance the explanatory power of the models in general. Unfortunately, no such research focuses on insurance company returns.

(4) Equity capital can be allocated in a theoretically consistent way. Unfortunately no such research focusing on actual insurance companies exists.

(5) The issue of insurance default should be recognized in pricing.[4]

The Phase II report concluded with four specific suggestions for a follow-up Phase III empirical research that were focused on two broad areas of inquiry. The proposed areas of inquiry included studies to investigate the relevance of the multi-factor asset pricing models for the property-casualty insurance industry and to empirically investigate the role of capital allocation in insurance pricing given the recent theoretical advances in the literature. The projects were recommended based upon the observations in the Report that recently developed methods such as the Fame-French 3-factor extension of CAPM and the Myers-Read allocation of capital formulas allowed for new empirical estimates of cost and allocation of capital, both lacking for the property-casualty industry as a whole.

Ultimately, two of the four proposed projects were selected to be funded: one on cost of equity capital for insurers by-line of insurance and one on allocation of capital for insurers.[5] The result of the cost of capital study is a peer-reviewed paper that appeared in the *Journal of Risk and Insurance* (Cummins and Phillips, 2005). The paper was recently awarded the CAS prize for the best paper of interest to the CAS members in the 2005 volume of the Journal of Risk and Insurance. A session on the paper will be scheduled for the joint CAS/ASTIN meetings in June 2007 in Orlando, Fla. The second Phase III study has resulted in a working paper (Cummins, Lin, and Phillips, 2006). Both papers are available on the same CAS/RPP Web site as the Phase I and II report. The principal results of those two studies are discussed next.

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[3] As an example of the latter effect, the Phase II report cites research that shows supposedly "riskless" Treasury bonds have positive betas: 0.14 for intermediate maturity bonds and 0.42 for long-term maturities bonds (see Cornell, 1999).

[4] Insurer default is generally recognized as a pay-as-you-go system through guaranty funds.

[5] The two studies were jointly funded by the Casualty Actuarial Society and the Insurance Research Council.

Cost of Capital

The study estimates CAPM and Fama-French cost of capital estimates for a sample of 117 companies writing property-casualty insurance over the sample period 1997-2000. Cost of capital estimates are estimated for each year of the sample period based on 60 monthly observations. The Fama-French model augments the CAPM market systematic risk factor with two additional factors, for firm size and financial distress, respectively. The size factor is based on the firm's market capitalization (number of shares multiplied by share price) and the financial distress factor is represented by the ratio of the book value of equity to the market value of equity.[6] In addition, the cost of capital is estimated specifically for the property-casualty, automobile, and workers' compensation insurance lines of business using both the full information industry and sum beta methodologies. These methods are fully explained in Cummins and Phillips (2005).[7] The cost of capital estimates are presented in several tables in the article. The results of the study demonstrate the statistical inadequacy of the single factor CAPM in estimating the cost of capital for property-casualty insurers. I.e., the study demonstrates the importance of including the Fama-French adjustments for size and financial distress when estimating the cost of capital for property-casualty insurers.[8] In particular, the CAPM tends to significantly under-estimate the cost of capital for firms in this industry.

Although there is considerable empirical evidence supporting the use of the financial distress factor in asset pricing, researchers have yet to agree on the rationale for the presence of this effect. The financial distress effect is also often called the value effect because the ratio of book-to-market equity is often used to identify so-called "value" stocks. Theoretically, the literature on the value effect seems to have split into two camps: (1) The "rationalist" camp, which argues that the value factor is a rational pricing factor consistent with Merton's intertemporal capital asset pricing model (ICAPM) or Ross' arbitrage pricing theory (APT). (2) The "behavioralist" camp, which argues that the value factor may be a behavioral effect reflecting irrational investor behavior (e.g., Lakonishok, Schleifer and Vishny, JF 1994).

Principal Findings

(1) Sum betas are larger than raw betas
As expected, sum beta estimates are consistently larger than ordinary beta coefficients. For the sample as a whole, the raw beta averaged 0.677 versus the sum beta 0.836, or a 23 percent larger equity beta. The reason for the increase in averages is the dominance of smaller insurers with relatively infrequent trading (which sum beta corrects) in the 117 company sample (see Table 2 of Cummins and Phillips (2005)).

(2) The Fama-French market systematic risk beta is about 1.0 for P&C Insurers
The overall market beta for P&C insurers, with (1.04) or without (0.98) the sum beta correction, is about the market average of

> **Ultimately, two of the four proposed projects were selected to be funded: one on cost of equity capital for insurers by line of insurance and one on allocation of capital for insurers.**

[6] The Fama-French cost of capital is obtained by adding the risk-free rate, usually the 30-day Treasury bill rate, to the market systematic risk beta multiplied by the market risk premium for systematic risk plus the size beta multiplied by the market risk premium for size plus the financial distress beta multiplied by the market risk premium for financial distress.

[7] The current status of the asset pricing literature is reviewed in Fama and French (2004).

[8] Additional specifications of multifactor models specific to insurer returns are discussed in the Recent Developments section here.

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1.0. This result indicates that the low raw beta average (0.67) arises primarily from the single simple factor regression omitted variables problem identified 10 years earlier by financial researchers,[9] size and financial distress (see Table 3 of the Cummins and Phillips (2005)).

(3) The FIIB market systematic risk beta for auto insurance averages 0.92 based on unweighted regressions but averages 0.64 when the regressions are weighted by market values.
Based on equally weighted regressions, the market systematic risk betas are about the same for automobile insurance (0.92) and workers' compensation (0.86). However, based on market value weighted regressions, the market systematic risk beta for auto insurance (0.64) is significantly different from the beta for workers' compensation (0.882) (see Table 8 of the Cummins and Phillips (2005)). Because the market value weighted regressions give greater weight to larger insurers, the results provide clear evidence that systematic risk betas vary by firm size.

(4) The FIIB Fama-French market systematic risk beta with the sum beta correction for auto insurance is about 1.0 based on market value weighted regressions.
Applying all methodologies to estimate the underlying market equity beta yields a market weighted average of 1.031 and a panel estimate of 0.965, neither significantly different from 1.0, for automobile insurance. The contrast with conclusion (3) indicates a strong case for using the sum beta adjustment (see Table 9 of the Cummins and Phillips (2005)).

(5) The size factor in the FIIB Fama-French estimation is significantly different from zero at about 1.6.
The FIIB Fama-French three-factor estimates in Table 9 show size betas for auto insurance of 1.686. Applying a size beta of 1.6 to the long-term excess market premium for size of 2.35 percent yields an average size adjustment of about 3.8 percent. Ibbotson (2006, p. 31) graphically displays the difference in the realized return distributions between large company stocks and small company stocks in general. Small stocks have larger mean returns and a larger variance of returns. Of course, the notion that a (non-systematic) small stock premium exists has been known since at least the 1980s. The Cummins-Phillips extends that result specifically to the insurance industry as a whole and to property casualty insurers in particular.

(6) The financial distress betas for property-casualty insurance are substantially greater than for firms on average from other industries.
Based on market value weighted regressions, Table 7 of the Cummins and Phillips (2005), shows financial distress betas of 0.917 for personal lines and 0.992 for commercial lines. Based on the financial distress risk premium for 2000 (3.85 percent), the financial distress factor adds more than 3 percent to the cost of capital. Based on es-

[9] The fact that significant explanatory variables omitted in a structural regression can cause distorted results is well known in statistics (see, for example, Maddala (1992), pp. 161-64).

[10] The risk premium puzzle is simply that realized market risk premiums excess of a risk free rate for some recent time periods would relate to risk aversion coefficients in standard models that exceed all prior (reasonable) estimates. Of course, those simple risk aversion/risk premium models could be misspecified just as the simple CAPM is misspecified with significant omitted variables.

timates for other industries, financial distress or, conversely, proxies of the quality of insurer risk management affects returns for insurers much more significantly than for most other firms in the economy.

Risk Premium Puzzle

The theoretical developments above paralleled a flurry of papers that attempted to make progress on the empirical estimation of the systematic or market factor risk premium used in all the extended models. Known as the "risk premium puzzle" since the mid-1980s,[10] many researchers promoted market risk premium estimates based on varieties of data series, both U.S. and international, methods of interpreting the data, and even surveys of "experts" such as finance professors. Derrig and Orr (2004) surveyed a representative sample of such efforts and found a wide disparity of prospective market risk premiums in the studies ranging from - 0.9 percent to 8.5 percent. A fair amount of the numerical disparity was based on a lack of a common definition for "the market risk premium." Rather, the risk premiums in the studies varied by the use of real or nominal interest rates, arithmetic or geometric averaging, short, intermediate and long horizons, short or long run averages, and conditional or unconditional estimates. Put on a common definitional basis of short horizon, long run, arithmetic, and unconditional risk premium, the appropriate basis for valuation of quarterly flows in insurance pricing, the range of risk premium estimates narrowed considerably to 5.0 to 9.0 - percent. The risk premium puzzle is now incorporated into Part 8, Investments and Financial Analysis of the CAS Fellowship Examinations.

Allocation of Capital

The paper by Cummins, Lin, and Phillips (2006) provides an empirical test of the theories developed by Froot and Stein (1998), Froot (2005), and Zanjani (2002). The overall prediction of these papers is that prices of illiquid, imperfectly hedgeable intermediated risk products should depend upon firm capital structure: the covariability of the risks with the firm's other projects, their marginal effects on the firm's insolvency risk, and negative asymmetries of return distributions. In particular, prices should be higher for lines of insurance with higher covariability with the insurer's overall insurance portfolio and for lines that have a greater marginal effect on insurer insolvency risk. Cummins, Lin, and Phillips (2006) provide empirical tests of these theoretical predictions using data from the U.S. property-casualty insurance industry. The strategy in the paper is to estimate the price of insurance for a sample of property-casualty insurers and then to regress insurance price on variables representing firm solvency risk, capital allocations by line, and other firm characteristics.

The empirical tests in Cummins-Lin-Phillips are based on two pooled, cross-sectioned, time-series samples of U.S. property-casualty insurers over the sample period 1997-2004. The first sample consists of the maximum number of insurers with usable data that report to the National Association of Insurance Commissioners (NAIC). The second sample consists of the subset of insurance firms that have traded equity capital.

To measure the price of insurance, Cummins-Lin-Phillips utilize the economic premium ratio (EPR) suggested by Winter (1994). The EPR, the ratio of the premium revenues net of expenses and policyholder dividends for a given insurer and line of insurance to the estimated present value of losses for the line, provides a measure of the insurer's return for underwriting a line of insurance. Theory predicts that the EPR will be related cross-sectionally to insurer capital structure, the covariability among lines of in-

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> "Cummins, Lin, and Phillips (2006) provide empirical tests of ... theoretical predictions using data from the U.S. property-casualty insurance industry."

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surance and between insurance lines and assets, and the amount of capital allocated to each line of business.

To estimate by line capital allocations, Cummins, Lin and Phillips (2006) utilize the methodology developed by Myers and Read (2001). Myers and Read allocate capital marginally by taking the derivative of the firm's insolvency put option with respect to changes in loss liabilities for each project or line of business. The methodology provides a unique allocation of 100 percent of the firm's capital. Although the Myers and Read model is not dependent upon specific distributional assumptions for the returns on the firm's assets and liabilities, distributional assumptions are required to implement the methodology empirically. Cummins, Lin, and Phillips (2006) assume that assets and liabilities are jointly lognormally distributed so that capital allocation is based on the Black-Scholes exchange option model (Margrabe 1978).

Although the Myers-Read model clearly has normative implications for insurance management and regulation, Cummins-Lin-Phillips hypothesize that it also has positive implications for insurance markets. That is, an implicit underlying hypothesis in the paper is that cross-sectional differences in insurance prices can be partially explained by Myers-Read capital allocations. In order for this hypothesis to be correct, it is not necessary that insurance companies actually allocate capital according to the Myers-Read model. It is only necessary that, through the operation of insurance markets, risks are priced in such a way that prices reflect the marginal burden that specific risks place on the insolvency risk of insurers. This requires only that markets are sufficiently rational so that insurers are able to assess the riskiness of policies that are being priced and that their price quotes reflect these insolvency risk assessments.

The Cummins-Lin-Phillips tests support the theoretical predictions. The price of insurance as measured by the EPR is inversely related to insurer insolvency risk, consistent with prior research (Phillips, et al. 1998). Moreover, prices are directly related to the amount of capital allocated to lines of insurance by the Myers-Read model and thus are also directly related to the covariability of losses across lines of insurance. Thus, the results support the predictions of Froot and Stein (1998) and the capital allocation literature (Myers and Read 2001, Zanjani 2002). The tests provide somewhat weaker evidence that prices reflect negative asymmetries of return distributions (Froot 2005).

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Due to space considerations, an expanded version and all remaining references are available at *www.derrig.com*. ✦

Highlights from the 5th Annual ERM Symposium

by Valentina A. Isakina and Max J. Rudolph

With sessions ranging from Decision Making under Extreme Events and Emerging Risks to Dashboards to Environmental Impacts, the 5th annual Enterprise Risk Management Symposium covered a wide range of topics with something for everyone interested in risk management. Over 500 attendees mingled with their counterparts from the financial services, energy, government, and manufacturing industries. The event is co-sponsored by the Joint Risk Management Section (Casualty Actuarial Society, Canadian Institute of Actuaries, and Society of Actuaries) and Professional Risk Managers' International Association (PRMIA) in collaboration with Georgia State University. The attendees came to Chicago from across the world to network and learn more about Enterprise Risk Management (ERM) and how to implement it in their venue.

The first day featured three workshops, covering very distinct topics:

- Operational Risk Management
- ERM Essentials for Decision Makers, and
- Banks and Insurers: Separate Paths But a Common Destination

These daylong seminars allowed participants to dive deeper into specific issues than a single session allows. The Operational Risk workshop was a particular success, having completely sold out with standing room only.

The overarching goal of the symposium is to show how ERM principles, tools, and techniques compare across industries, allowing risk managers to talk to and teach each other. In this way, best practices can be shared and disseminated faster.

Terrence Odean set the tone for the meeting as he discussed behavioral finance and its link to risk management. Only by knowing our own biases can we truly understand current and emerging risks. Dr. Odean showed how investors generally act in the financial markets at inopportune times, making it hard to optimize their results.

Three other general sessions provided consistency to the meeting:

- Leading off on the first day was a session discussing the convergence of ERM practices internationally.
- The View from the Top shared views about how ERM is being implemented in board rooms.
- The Role of ERM in Regulation got the second day off to an energetic start as representatives from rating agencies and others familiar with the regulatory process spoke about how ERM should be a by-product of work already being done, not something specifically created to check a regulator's proverbial box.
- The meeting concluded with a general session discussing ERM perspectives from practitioners as they discussed past, present and future states of ERM.

In addition, 35 concurrent sessions were organized around six different tracks, including a risk management research track organized by Georgia State University. All the sessions were taped to mp3 format and are available, along with the presentation slides, on *www.ermsymposium.org*.

For the second year, the symposium featured a call for scientific papers, along with a call for presentations. Both had strong response rates, and the symposium committees were challenged to choose those who would present. All of the submitted papers can also be found at *www.ermsymposium.org*.

The next symposium will be held in Chicago April 14-16, 2008. By building off past symposiums, keeping what worked, and bringing fresh ideas into the mix, it will surely be a highlight of the year for ERM continuing education events.✦

Valentina A. Isakina, ASA, MAAA, is a senior consultant with McKinsey & Company, Inc. in Atlanta, Ga. She can be reached at *Valentina_Isakina@mckinsey.com*.

Max J. Rudolph, FSA, CERA, MAAA, is the founder of Rudolph Financial Consulting, LLC, Omaha, Neb. He can be reached at *max.rudolph@rudolphfinancialconsulting.com*.

Second Annual Scientific Track Continues to Push the Envelope at the ERM Symposium

by Steven C. Siegel

The 2006 ERM Symposium established its first-ever annual call for ERM-related research papers to present the very latest in ERM thinking and move forward principles-based research. The overwhelming response and success of this first effort, originally the brainchild of Max Rudolph, set into motion high expectations for succeeding years. In light of these lofty expectations, I am pleased to report that the 2007 ERM Symposium Scientific Paper did not disappoint.

With over 40 abstracts submitted for review, the level of response significantly exceeded the previous year's and again proves that ERM is something that companies ignore at their own peril. The papers review committee, chaired by Rudolph, included returning members Mark Abbott, Sam Cox, Emily Gilde, Krzysztof Jajuga, Nawal Roy, Fred Tavan, and Al Weller as well as newcomers Maria Coronado, Steve Craighead, Dan Oprescu, Matthieu Royer, and Richard Targett. Choosing from among the 40 abstracts for nine presentation slots was no small task and given the quality and number of abstracts, the committee regretted that there were only nine slots available.

The final task of the committee was to select the prize winning papers. This year, in addition to the Actuarial Foundation ERM Research Excellence Award for Best Overall Paper, two more prizes were awarded: the PRMIA Institute New Frontiers in Risk Management Award and the Risk Management Section Best Paper Award for Practical Risk Management Applications.

Steven C. Siegel, ASA, MAAA, is a staff research actuary with the Society of Actuaries in Schaumburg, Ill. He can be reached at ssiegel@soa.org.

The award winners along with the paper abstracts are shown below. Awards were presented at the ERM Symposium General Luncheon session held on March 30th.

2007 Actuarial Foundation ERM Research Excellence Award for Best Overall Paper:
Mark Beasley, Don Pagach, and Richard Warr of North Carolina State University for "Information Conveyed in Hiring Announcements of Senior Executives Overseeing Enterprise-Wide Risk Management Processes."

Mark Beasley and Don Pagach accept second annual Actuarial Foundation award from David Cummings.

ABSTRACT (see page 21 of this newsletter for an abridged version of the article)

Enterprise risk management (ERM) is the process of analyzing the portfolio of risks facing the enterprise to ensure that the combined effect of such risks is within an acceptable tolerance. While ERM adoption is on the rise, little academic research exists about the costs and benefits of ERM. Proponents of ERM claim that ERM is designed to enhance shareholder value; however, portfolio theory suggests that costly ERM implementation would be unwelcome by *shareholders who can use less costly diversification to eliminate idiosyncratic risk. This study examines equity market reactions to announcements of appointments of senior executive officers overseeing the enterprise's risk management processes. Based on a sample of 120 announcements from 1992-2003, we find that the univariate average two-day market response is not significant, suggesting that a broad definitive statement about the benefit or cost of implementing ERM is not possible. However, our multivariate analysis reveals that market responses to such appointments are significantly positively associated with a firm's size and prior earnings volatility, and negatively associated with the amount of cash on hand relative to liabilities and leverage on the balance sheet. These results are confined to non-financial firms, possibly due to the regulatory requirements for enterprise risk management that already exist for financial firms. We conclude that the costs and benefits of ERM are firm-specific.*

2007 PRMIA Institute Award for New Frontiers in Risk Management: Klaus Böcker and Claudia Klüppelberg of the Munich University of Technology for "Multivariate Models for Operational Risk."

ABSTRACT (see page 26 of this newsletter for an abridged version of the article)

In Böcker and Klüppelberg (2005) we presented a simple approximation of Op-Var of a single operational risk cell. The present paper derives approximations of similar quality and simplicity for the multivariate problem. Our approach is based on modelling of the dependence structure of different cells via the new concept of a Lévy copula.

2007 Risk Management Section Award for Best Paper Award for Practical Risk Management Applications: Neil Bodoff of Willis for "Capital Allocation by Percentile Layer."

Neil Bodoff accepts Risk Management Section award from Kevin Dickson.

Klaus Böcker accepts PRMIA Institute award from David Koenig.

ABSTRACT (see page 32 of this newsletter for an abridged version of the article)

Motivation. *Capital allocation can have substantial ramifications upon measuring risk adjusted profitability as well as setting risk loads for pricing. Current allocation methods that emphasize the tail allocate too much capital to extreme*

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events; "capital consumption" methods, which incorporate relative likelihood, tend to allocate insufficient capital to highly unlikely yet extremely severe losses.

Method. *In this paper I develop a new formulation of the meaning of holding capital equal to the Value at Risk. The new formulation views the total capital of the firm as the sum of many percentile layers of capital. Thus capital allocation varies continuously by layer and the capital allocated to any particular loss scenario is the sum of allocated capital across many percentile layers.*

Results. *Capital Allocation by Percentile Layer produces capital allocations that differ significantly from other common methods such as VaR, TVaR, and coTVaR.*

Conclusions. *Capital Allocation by Percentile Layer has important advantages over existing methods. It highlights a new formulation of Value at Risk and other capital standards, recognizes the capital usage of losses that do not extend into the tail, and captures the disproportionate capital usage of severe losses.*

As of this writing, an online monograph is being created to house the papers. A link to the monograph, when completed, will be found on the ERM Symposium Web site at *www.ermsymposium.org*. Papers that were not presented at the symposium will also be included in the monograph.

We encourage you to review the monograph and read papers of particular interest to you. You may not agree with everything you read in the monograph; it was our intent to procure papers that would not only inform, but also provoke discussion and spark debate.

We wish to thank all the organizations and committee members for their support and for making this a success. Planning for the 2008 ERM Symposium call for papers has already begun. I invite you to contact me if you have ideas or feedback for next year. Until then, watch the ERM Symposium site for the latest developments! ✦

Information Conveyed in Hiring Announcements of Senior Executives Overseeing Enterprise-Wide Risk Management Processes

by Mark Beasley, Don Pagach, Richard Warr

Editor's note: This article represents an abridged version of the submission to the 2007 ERM symposium, which receives the 2007 Actuarial Foundation ERM Research Excellence Award for Best Overall Paper. The full paper is forthcoming in the Journal of Accounting, Auditing and Finance.

There has been a dramatic change in the role of risk management in corporations (Necco and Stulz, 2006). Recent corporate financial reporting scandals and evolving corporate governance requirements are increasing the expectation that boards of directors and senior executives effectively manage the risks facing their companies (Kleffner et. al., 2003). To meet these expectations, an increasing number of enterprises are embracing an enterprise-wide risk management approach (ERM).

While there has been significant growth in the number of ERM programs, little empirical research has been conducted on the value of such programs (Tufano, 1996; Colquitt et al., 1999; Liebenberg and Hoyt, 2003; Beasley et. al., 2005). In particular, there have been few challenges to the view that ERM provides a significant opportunity for competitive advantage (Stroh, 2005) and that ERM is designed to protect and enhance shareholder value. However, modern portfolio theory suggests that an ERM approach to risk management could be value destroying, as shareholders, through portfolio diversification, can eliminate idiosyncratic risk in a virtually costless manner. According to this view, expending corporate resources to reduce idiosyncratic risk will result in a reduction in firm value and shareholder wealth. However, there are circumstances, driven by market imperfections and agency issues, under which risk management may have a positive net present value (Stulz, 1996, 2003), and therefore the true effect of ERM on shareholder value is uncertain.

Background and Hypotheses Development

One of the challenges associated with ERM implementation is determining the appropriate leadership structure to manage the identification, assessment, measurement, and response to all types of risks that arise across the enterprise. For ERM to be successful, it is critical that the whole organization understand why ERM creates value (Necco and Stulz, 2006). Senior executive leadership over ERM helps communicate and integrate the entity's risk philosophy and strategy towards risk management consistently throughout the enterprise.

To respond to this challenge, many organizations are appointing a member of the senior executive team, often referred to as the chief risk officer or CRO, to oversee the enterprise's risk management process (Economist Intelligence Unit, 2005). Indeed, some argue that the appointment of a chief risk officer is being used to signal both internally and externally that senior management and the board is serious about integrating all of its risk management activities under a more powerful senior-level executive (Lam, 2001). In fact, rating agencies, such as Standard and Poor's, explicitly evaluate organizational structure and authority of the risk management function as part of their assessment of strength and independence of the risk management function (Standard & Poor's, 2005).

Recent empirical research documents that the presence of a CRO is associated with a greater stage of ERM deployment within an enterprise, suggesting that the appointment of senior exec-

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2007 Actuarial Foundation ERM Research Excellence Award for Best Overall Paper

Award

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Mark Beasley, PH.D., is Professor of Accounting and the ERM Initiative Director at North Carolina University. He can be reached at *mark_beasley@ncsu.edu*

Don Pagach, Ph.D., is professor of accounting at North Carolina State University. He can be reached at *don@ncsu.edu*

Richard Warr, Ph.D., is associate professor of finance at North Carolina State University. He can be reached at *richard_warr@ncsu.edu.*

utive leadership affects the extent to which ERM is embraced within an enterprise (Beasley et. al., 2005). Despite the growth in the appointment of senior risk executives, little is known about factors that affect an organization's decision to appoint a CRO or equivalent, and whether these appointments create value.

Because corporations disclose only minimal details of their risk management programs (Tufano, 1996), our focus on hiring announcements of senior risk officers attempts to measure the valuation impact of the firm's signaling of an enterprise risk management process.

The basic premise that ERM is a value creating activity actually runs counter to modern portfolio theory. Portfolio theory shows that under certain assumptions, investors can fully diversify away all firm (or idiosyncratic) risk (Markowitz, 1952). This can usually be achieved costlessly by randomly adding stocks to an investment portfolio. Because investors can diversify away firm-specific risk, they should not be compensated for bearing such risk. As a result, investors should not value costly attempts by firms to reduce firm-specific risk, given an investor's costless ability to eliminate this type of risk. While portfolio theory might suggest a lack of value associated with ERM implementation, markets do not always operate in the manner presented by Markowitz (1952). Stulz (1996, 2003) presents arguments under which risk management activities could be value increasing for shareholders in the presence of agency costs and market imperfections. The motivation behind Stulz's work is to reconcile the apparent conflict between current wide-spread corporate embrace of risk management practices and modern portfolio theory.

Stulz (1996, 2003) argues that any potential value creation role for risk management is in the reduction or elimination of "costly lower-tail outcomes." Lower tail outcomes are those events in which a decline in earnings or a large loss would result in severe negative consequences for the firm. Thus, when a firm is faced with the likelihood of lower tail outcomes, engaging in risk management that reduces the likelihood of real costs associated with such outcomes could represent a positive net present value project. Only firms facing an increased likelihood of these actual negative consequences associated with lower tail events are expected to benefit from risk management, (Stulz, 1996, 2003).

Our study of equity market responses to announcements of appointments of CROs builds upon Stulz (1996, 2003) to examine firm-specific variables that reflect the firm's likelihood of experiencing a lower-tailed event. These variables reflect firm-specific factors that finance theory suggests should explain the value effects of corporate risk management. These variables are described more fully below, and include several factors that may impact earnings volatility such as the extent of the firm's growth options, intangible assets, cash reserves, earnings volatility, leverage, and firm size.

Growth Options. Firms with extensive growth options require consistent capital investment and may face greater asymmetric information regarding their future earnings (Myers, 1984; Myers and Majluf, 1984). When in financial distress, growth options are likely to be undervalued and that distress may lead to underinvestment in profitable growth opportunities. We hypothesize that the firms with greater growth options will have a positive abnormal return around hiring announcements of CROs.

Intangible Assets. Firms that have more opaque assets, such as goodwill, are more likely to benefit from an ERM program because these assets are likely to be undervalued in times of financial distress (Smith and Stulz, 1985). Although this benefit directly accrues to debtholders, stockholders should benefit through lower interest expense charged by the debtholders. We hypothesize that the firms with a large amount of intangible assets will have a positive abnormal return around hiring announcements of CROs:

Cash Ratio: Firms with greater amounts of cash on hand are less likely to benefit from a risk management program, as these firms can protect themselves against a liquidity crisis that might result from some lower tail outcomes. Less cash on hand can increase the likelihood of financial distress for levered firms (Smith and Stulz, 1985). We hypothesize that firms with greater amounts of cash will have a negative abnormal return around announcements of CRO appointments.

Earnings Volatility: Firms with a history of greater earnings volatility are more likely to benefit from ERM. Firms that have large amounts of earnings volatility have a greater likelihood of seeing a lower tail earnings outcome, missing analysts' earnings forecasts, and violating accounting based debt covenants (Bartov, 1993). In addition, managers may smooth earnings to increase firm's share prices by reducing the potential loss shareholders may suffer when they trade for liquidity reasons (Goel and Thakor, 2003). We hypothesize that firms experiencing a high variance of earnings per share (EPS) will have a positive abnormal return around hiring announcements of CROs.

Leverage: Greater financial leverage increases the likelihood of financial distress. Under financial distress, firms are likely to face reductions in debt ratings and consequently higher borrowing costs. More robust ERM practices may lead to lower financing costs. We hypothesize that the firms with high leverage will have a positive abnormal return around hiring announcements of CROs.

Size: Research examining the use of financial derivatives finds that large companies make greater use of derivatives than smaller companies. Such findings confirm the experience of risk management practitioners that the corporate use of derivatives requires considerable upfront investment in personnel, training and computer hardware and software, which might discourage smaller firms from engaging in their use (Stulz, 2003). We hypothesize that larger firms will have a positive abnormal return around hiring announcements of CROs.

Data and Results

Our study method examines the impact of firm-specific characteristics on the equity market response to announcements of appointments of CROs within the enterprise. We searched the period of 1992 through 2003 and identified 120 unique observations. Each observation is unique to a firm, in that it represents a firm's first announcement during the period searched, subsequent announcements by a firm are excluded. By starting our search in 1992, we hope to capture the initial creation of a CRO position, as the presence of CRO positions became more prevalent in the later 1990s.

The security market's response is measured by examining the cumulative abnormal return (CAR) to the CRO announcement. Our study focuses on the cross-sectional firm characteristics previously discussed that we hypothesize may determine the value of effects of risk management. In addition, due to the large number of financial service firms in our sample, we disaggregate our sample into financial service industry firms and non-financial service industry firms.

To examine whether there are cross sectional differences in our hypothesized associations between firm-specific characteristics and the

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equity market reaction to announcements of appointments of CROs, we use multivariate regression analysis. Specifically, the general form of the model is the following:

$$CAR(0,+1) = a_0 + a_1 Market/Book + a_2 Intangibles + a_3 Cash\ Ratio + a_4 EPS\ Vol + a_5 Leverage + a_6 Size + e$$

Given the large portion (39.1 percent) of our sample is from the financial services industries and that these firms have different regulatory expectations with respect to ERM, we examine whether the predicted associations described by our hypotheses differ from non-financial service firms. The results of this analysis are reported separately in Table 1.

Table 1
Regression of Firm Specific Variables on Cumulative Abnormal Returns: Sub-samples of Financial and Non-Financial Firms

Variable	Predicted Sign	Financial Firms sub sample		Non-Financial firms sub sample	
		Parameter Estimate	White T-stat	Parameter Estimate	White T-stat
Intercept		-0.0061	-0.20	-0.0327	-1.92*
Market/Book	+	0.0023	1.49	-0.0006	-1.22
Intangibles	+	0.067	0.56	0.0317	1.48
Cash Ratio	-	-0.0499	-2.49**	-0.0405	-4.49***
EPS Vol	+	-0.0000	0.10	0.0004	3.42***
Leverage	+	0.0004	1.32	-0.0039	-3.84***
Size	+	0.0006	0.25	0.0048	2.59***
N		47		73	
Adj. R-Squared		0.50%		27.9%	
F-Value		1.04		5.66	
Model Significance		0.413		0.001	

Where the dependent variable is CAR, the cumulative abnormal return for the event period, the announcement day plus the following day, computed using the Fama-French three factor model. Market/Book = the market value of the firm divided by its book value of equity reported at the end of the fiscal year-end prior to the announcement. Intangibles = book value of intangible assets divided by total assets reported at the end of the fiscal year-end prior to the announcement. Cash Ratio = the amount of cash as reported at the end of the fiscal year-end prior to the announcement divided by total liabilities. EPSVol = the standard deviation of the change in earnings per share over the eight quarters prior to the announcement. Leverage = total liabilities divided by market value of equity reported at the end of the fiscal year-end prior to the announcement. Size = the natural logarithm of MVE at the end of the fiscal year-end prior to the announcement. ***, **, *, indicates significance at the 1%, 5% and 10% levels

We find that of the six independent variables only the cash ratio variable is found to be significantly associated with the market reaction to announcements of appointments of CROs for the financial services firms in our sample, with the overall model not significant. This result is consistent with the belief that regulatory pressures and requirements drive financial services institutions to embrace enterprise-wide risk management processes, not firm-specific financial characteristics.

In contrast, the results shown in Table 1 for the sample of firms in industries other than financial services indicate that, in the absence of regulatory expectations, several of the firm's financial characteristics may explain the firm's value enhancement due to ERM adoption.

For our sample non-financial firms, we find that announcement period market returns are positively associated with the firm's prior earnings volatility and size, while negatively associated with the extent of cash on hand and leverage. There is no statistical association between the announcement period returns and the firm's growth or extent of intangible assets.

While the results for earnings volatility, size and cash on hand are consistent with our expectations, the findings for leverage are opposite our expectations. One explanation for this result is that shareholders of highly leveraged firms may not want risk reduction as it reduces the value of the option written to them by debtholders. In this case, the option value outweighs the dead weight costs of bankruptcy that are increased with high leverage.

Conclusions and Limitations

This study provides evidence on how the perceived value of enterprise risk management processes varies across companies. While ERM practices are being widely embraced within the corporate sector, not all organizations are embracing those practices and little academic research exists about the benefits and costs of ERM.

In cross section analysis, we find that a firm's shareholders respond largely in accordance with our expectations and value ERM where the program can enhance value by overcoming market distortions or agency costs. Specifically, we find that shareholders of large firms that have little cash on hand value ERM. Furthermore, shareholders of large non-financial firms, with volatile earnings, low amounts of leverage and low amounts of cash on hand also react favorably to the implementation of ERM. These findings are consistent with the idea that a well implemented ERM program can create value when it reduces the likelihood of costly lower tail outcomes such as financial distress.

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New Frontiers Award Winner

Multivariate Operational Risk: Dependence Modelling with Lévy Copulas

by Claudia Klüppelberg and Klaus Böcker

Claudia Klüppelberg, Ph.D., holds the chair of Mathematical Statistics at the Center for Mathematical Sciences of the Munich University of Technology, Germany. She can be reached at *cklu@ma.tum.de.*

Klaus Böcker, Ph.D., is senior risk controller at HypoVereinsbank AG, München. He can be reached at *klaus.boecker@hvb.de*.

Abstract: Simultaneous modelling of operational risks occurring in different event type/business line cells poses the challenge for operational risk quantification. Invoking the new concept of Lévy copulas for dependence modelling yields simple approximations of high quality for multivariate operational VAR.

A required feature of any advanced measurement approach (AMA) of Basel II for measuring operational risk is that it allows for explicit correlations between different operational risk events. The core problem here is multivariate modelling encompassing all different event type/business line cells, and thus the question how their dependence structure affects a bank's total operational risk. The prototypical loss distribution approach (LDA) assumes that, for each cell $i = 1, \ldots, d,$ the cumulated operational loss $S_i(t)$ up to time t is described by an aggregate loss process

(1.1)
$$S_i(t) = \sum_{k=1}^{N_i(t)} X_k^i , \quad t \geq 0 ,$$

where for each i the sequence $(X_k^i)_{k\in\mathbb{N}}$ are independent and identically distributed (iid) positive random variables with distribution function F_i describing the magnitude of each loss event (loss severity), and $(N_i(t))_{t\geq0}$ counts the number of losses in the time interval [0, t] (called frequency), independent of $(X_k^i)_{k\in\mathbb{N}}$. The bank's total operational risk is then given as:

(1.2)
$$S^+(t) := S_1(t) + S_2(t) + \cdots + S_d(t) , \quad t \geq 0 .$$

The present literature suggests to model dependence between different operational risk cells by means of different concepts, which basically split into models for frequency dependence on the one hand and for severity dependence on the other hand.

Here we suggest a model based on the new concept of Lévy copulas (see e.g. Cont & Tankov (2004)), which models dependence in frequency and severity simultaneously, yielding a model with comparably few parameters. Moreover, our model has the same advantage as a distributional copula: the dependence structure between different cells can be separated from the marginal processes S_i for $i = 1, \ldots, d$. This approach allows for closed-form approximations for operational VAR (OpVAR).

Dependent Operational Risks and Lévy Copulas

In accordance with a recent survey of the Basel Committee on Banking Supervision about AMA practices at financial services firms, we assume that the loss frequency processes N_i in (1.1) follows a homogeneous Poisson process with rate $\lambda_i > 0$. Then the aggregate loss (1.1) constitutes a compound Poisson process and is therefore a Lévy process (actually, the compound Poisson process is the only Lévy process with piecewise constant sample paths).

A key element in the theory of Lévy processes is the notion of the so-called Lévy measure. A Lévy measure controls the jump behaviour of a Lévy process and, therefore, has an intuitive interpretation, in particular in the context of operational risk. The Lévy measure of a single operational risk cell measures the expected number of losses per unit time with a loss amount in a prespecified interval. For our compound Poisson model, the Lévy measure Π_i of the cell process S_i is completely determined by the frequency parameter $\lambda_i > 0$ and the distribution function F_i of the cell's severity:

$$\Pi_i([0,x)) := \lambda_i P(X^i \leq x) = \lambda_i F_i(x) \text{ for } x \in [0,\infty).$$

The corresponding one-dimensional tail integral is defined as

(2.1)

$$\overline{\Pi}_i(x) := \Pi_i([x,\infty)) = \lambda_i P(X^i > x) = \lambda_i \overline{F}_i(x)\,.$$

Our goal is modelling multivariate operational risk. Hence, the question is how different one-dimensional compound Poisson processes $S_i(\cdot) = \sum_{k=1}^{N_i(\cdot)} X_k^i$ can be used to construct a $\boldsymbol{d}$-dimensional compound Poisson process $S = (S_1, S_2, \dots, S_d)$ with in general dependent components. It is worthwhile to recall the similar situation in the case of the more restrictive setting of static random variables. It is well-known that the dependence structure of a random vector can be disentangled from its marginals by introducing a distributional copula. Similarly, a multivariate tail integral

$$\overline{\Pi}(x_1,\dots,x_d) = \Pi([x_1,\infty)\times\cdots\times[x_d,\infty))\,, \quad x\in[0,\infty]^d\,,$$

can be constructed from the marginal tail integrals (2.1) by means of a Lévy copula. This representation is the content of Sklar's theorem for Lévy processes with positive jumps, which basically says that every multivariate tail integral $\overline{\Pi}$ can be decomposed into its marginal tail integrals and a Lévy copula $\widehat{C}$ according to

$$\overline{\Pi}(x_1,\dots,x_d) = \widehat{C}(\overline{\Pi}_1(x_1),\dots,\overline{\Pi}_d(x_d))\,, \qquad x\in[0,\infty]^d\,.$$

For a precise formulation of this Theorem we refer to Cont & Tankov (2004), Theorem 5.6. Now we can define the following prototypical LDA model.

Definition 2.1.
[Multivariate Compound Poisson model]

(1) *All aggregate loss processes S_i for $i = 1,\dots,d$ are compound Poisson processes with tail integral $\overline{\Pi}_i(\cdot) = \lambda_i F_i(\cdot)$.*

(2) *The dependence between different cells is modelled by a Lévy copula $\widehat{C} : [0,\infty)^d \to [0,\infty)$, i.e., the tail integral of the d-dimensional compound Poisson process $S = (S_1,\dots,S_d)$ is defined by $\overline{\Pi}(x_1,\dots,x_d) = \widehat{C}(\overline{\Pi}_1(x_1),\dots,\overline{\Pi}_d(x_d))$.*

The Bivariate Clayton Model

A bivariate model is particularly useful to illustrate how dependence modelling via Lévy copulas works. Therefore, we now focus on two operational risk cells as in Definition 2.1(a). The dependence structure is modelled by a Clayton Lévy copula, which is similar to the well-known Clayton copula for distribution functions and parameterized by $\vartheta > 0$ (see Cont & Tankov (2004), Example 5.5):

$$\widehat{C}_\vartheta(u,v) = (u^{-\vartheta} + v^{-\vartheta})^{-1/\vartheta}\,, \quad u,v \ge 0\,.$$

This copula covers the whole range of positive dependence. For $\vartheta \to 0$ we obtain independence and then, as we will see below, losses in different cells never occur at the same time. For $\vartheta \to \infty$ we get the complete positive dependence Lévy copula given by $\widehat{C}_\parallel(u,v) = \min(u,v)$. We decompose now the two cells' aggregate loss processes into different components (where the time parameter t is dropped for simplicity):

(3.1)

$$\begin{aligned} S_1 &= S_{\perp 1} + S_{\parallel 1} = \sum_{k=1}^{N_{\perp 1}} X_{\perp k}^1 + \sum_{l=1}^{N_\parallel} X_{\parallel l}^1\,, \\ S_2 &= S_{\perp 2} + S_{\parallel 2} = \sum_{m=1}^{N_{\perp 2}} X_{\perp m}^2 + \sum_{l=1}^{N_\parallel} X_{\parallel l}^2\,, \end{aligned}$$

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where $S_{\|1}$ and $S_{\|2}$ describe the aggregate losses of cell 1 and 2 that is generated by "common shocks," and $S_{\perp 1}$ and $S_{\perp 2}$ describe aggregate losses of one cell only. Note that apart from $S_{\|1}$ and $S_{\|2}$, all compound Poisson processes on the right-hand side of (3.1) are mutually independent. The frequency of simultaneous losses is given by

$$\widehat{C}_\vartheta(\lambda_1,\lambda_2)=\lim_{x\downarrow 0}\overline{\Pi}_{\|2}(x)=\lim_{x\downarrow 0}\overline{\Pi}_{\|1}(x)=(\lambda_1^{-\theta}+\lambda_2^{-\theta})^{-1/\theta}=:\lambda_{\|}\,,$$

which shows that the number of simultaneous loss events is controlled by the Lévy copula. Obviously, $0\le\lambda_{\|}\le\min(\lambda_1,\lambda_2)$, where the left and right bounds refer to $\vartheta\to 0$ and $\vartheta\to\infty$, respectively. Consequently, in the case of independence, losses never happen at the same instant of time.

Also the severity distributions of $X_{\|}^1$ and $X_{\|}^2$ as well as their dependence structure are determined by the Lévy copula. To see this, define the joint survival function as:

(3.2)

$$\overline{F}_{\|}(x_1,x_2):=P(X_{\|}^1>x_1,X_{\|}^2>x_2)=\frac{1}{\lambda_{\|}}\widehat{C}_\vartheta(\overline{\Pi}_1(x_1),\overline{\Pi}_2(x_2))$$

with marginals

(3.3)

$$\overline{F}_{\|1}(x_1)\;=\;\lim_{x_2\downarrow 0}\overline{F}_{\|}(x_1,x_2)=\frac{1}{\lambda_{\|}}\widehat{C}_\vartheta(\overline{\Pi}_1(x_1),\lambda_2)$$

(3.4)

$$\overline{F}_{\|2}(x_2)\;=\;\lim_{x_1\downarrow 0}\overline{F}_{\|}(x_1,x_2)=\frac{1}{\lambda_{\|}}\widehat{C}_\vartheta(\lambda_1,\overline{\Pi}_2(x_2))\,.$$

In particular, it follows that $F_{\|1}$ and $F_{\|2}$ are different from F_1 and F_2, respectively. To explicitly extract the dependence structure between the severities of simultaneous losses $X_{\|}^1$ and $X_{\|}^2$ we use the concept of a distributional survival copula. Using (3.2)-(3.4) we see that the survival copula S_ϑ for the tail severity distributions $\overline{F}_{\|1}(\cdot)$ and $\overline{F}_{\|2}(\cdot)$ is the well-known distributional Clayton copula; i.e.

$$S_\vartheta(u,v)=(u^{-\vartheta}+v^{-\vartheta}-1)^{-1/\vartheta},$$

$$0\le u,v\le 1\,.$$

For the tail integrals of the independent loss processes $S_{\perp 1}$ and $S_{\perp 2}$. we obtain for $x_1,x_2\ge 0$

$$\begin{aligned}\overline{\Pi}_{\perp 1}(x_1)&=\overline{\Pi}_1(x_1)-\overline{\Pi}_{\|1}(x_1)=\overline{\Pi}_1(x_1)-\widehat{C}_\vartheta(\overline{\Pi}_1(x_1),\lambda_2)\,,\\ \overline{\Pi}_{\perp 2}(x_2)&=\overline{\Pi}_2(x_2)-\overline{\Pi}_{\|2}(x_2)=\overline{\Pi}_2(x_2)-\widehat{C}_\vartheta(\lambda_1,\overline{\Pi}_2(x_2))\,,\end{aligned}$$

so that $\lambda_{\perp 1}=\lambda_1-\lambda_{\|}\,,\qquad \lambda_{\perp 2}=\lambda_2-\lambda_{\|}.$

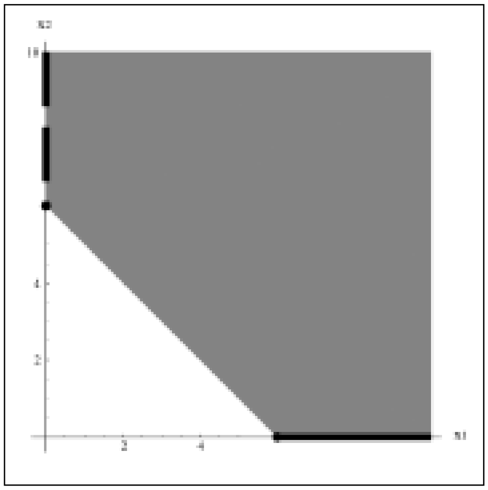

Figure 4.1.

Decomposition of the domain of the tail integral $\overline{\Pi}^+(z)$ for $z=6$ into a simultaneous loss part $\overline{\Pi}_{\|}^+(z)$ (shaded area) and independent parts $\overline{\Pi}_{\perp 1}(z)$ (solid black line) and $\overline{\Pi}_{\perp 2}(z)$ (dashed black line).

Analytical Approximations for Operational VAR

In this section we turn to the quantification of total operational loss encompassing all operational risk cells and, therefore, we focus on the total aggregate loss process S^+ defined in (1.2). Our goal is to provide some general insight to multivariate operational risk and to find out, how different dependence structures (modelled by Lévy copulas) affect OpVAR, which is the standard metric in operational risk measurement. The tail integral associated with S^+ is given by

(4.1)

$$\overline{\Pi}^+(z) = \Pi(\{(x_1,\ldots,x_d) \in [0,\infty)^d : \sum_{i=1}^d x_i \geq z\}), \quad z \geq 0 .$$

For $d=2$ we can write

(4.2)

$$\overline{\Pi}^+(z) \;=\; \overline{\Pi}_{\perp 1}(z) + \overline{\Pi}_{\perp 2}(z) + \overline{\Pi}_{\|}^+(z), \qquad z \geq 0 ,$$

where $\overline{\Pi}_{\perp 1}(\cdot)$ and $\overline{\Pi}_{\perp 2}(\cdot)$ are the independent jump parts and

$$\overline{\Pi}_{\|}^+(z) \;=\; \Pi(\{(x_1,x_2) \in (0,\infty)^2 : x_1 + x_2 \geq z\}), \qquad z \geq 0 ,$$

describes the dependent part due to simultaneous loss events; the situation is depicted in Figure 4.1.

Since for every compound Poisson process with intensity $\lambda > 0$ and positive jumps with distribution function F, the tail integral is given by $\overline{\Pi}(\cdot) = \lambda \overline{F}(\cdot)$, it follows from (4.2) that the total aggregate loss process S^+ is again compound Poisson with frequency parameter and severity distribution

(4.3)

$$\lambda^+ = \lim_{z \downarrow 0} \overline{\Pi}^+(z) \quad \text{and} \quad F^+(z) = 1 - \overline{F}^+(z) = 1 - \frac{\overline{\Pi}^+(z)}{\lambda^+}, \quad z \geq 0 .$$

This result proves now useful to determine a bank's total operational risk consisting of several cells. Before doing that, recall the definition of OpVAR for a single operational risk cell (henceforth called stand-alone OpVAR.) For each cell, stand-alone OpVAR at confidence level $\kappa \in (0,1)$ and time horizon t is the κ-quantile of the aggregate loss distribution, i.e. $\mathrm{VAR}_t(\kappa) = G_t^{\leftarrow}(\kappa)$ with $G_t^{\leftarrow}(\kappa) = \inf \{x \in \mathbb{R} : P(S(t) \leq x) \geq \kappa\}$.

In Böcker & Klüppelberg (2005, 2006, 2007) it was shown that OpVAR at high confidence level can be approximated by a closed-form expression, if the loss severity is subexponential, i.e. heavy-tailed. As this is common, we consider in the sequel this approximation, which can be written as

(4.4)

$$\mathrm{VAR}_t(\kappa) \sim F^{\leftarrow}\left(1 - \frac{1-\kappa}{EN(t)}\right), \quad \kappa \uparrow 1 ,$$

where the symbol "~" means that the ratio of left and right hand side converges to 1. Moreover, $EN(t)$ is the cell's expected number of losses in the time interval $[0, t]$. Important examples for subexponential distributions are lognormal, Weibull, and Pareto. Here, we extend the idea of an asymptotic OpVAR approximation to the multivariate problem. In doing so, we exploit the fact that S^+ is a compound Poisson process with parameters as in (4.3). In particular, if F^+ is subexponential, we can apply (4.4) to estimate total OpVAR. Consequently, if we are able to specify the asymptotic behavior of $\overline{F}^+(x)$ as $x \to \infty$ we have automatically an approximation of $\mathrm{VAR}_t(\kappa)$ as $\kappa \uparrow 1$.

To make more precise statements about OpVAR, we focus our analysis on Pareto distributed severities with distribution function

$$\overline{F}(x) = \left(1 + \frac{x}{\theta}\right)^{-\alpha}, \quad x > 0 ,$$

with shape parameters $\theta > 0$ and tail parameter $\alpha > 0$. Pareto's law is the prototypical parametric example for a heavy-tailed distribution and suitable for operational risk modelling. As a

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simple consequence of (4.4), in the case of a compound Poisson model with Pareto severities (Pareto-Poisson model) the analytic OpVAR is given by

(4.5)

$$\mathrm{VAR}_t(\kappa) \sim \theta\left[\left(\frac{\lambda\, t}{1-\kappa}\right)^{1/\alpha} - 1\right] \sim \theta\left(\frac{\lambda\, t}{1-\kappa}\right)^{1/\alpha}, \quad \kappa \uparrow 1 .$$

To demonstrate the kind of results we obtain by such approximation methods we consider a Pareto-Poisson model, where the severity distributions F_i of the first (say) $b \le d$ cells are tail equivalent with tail parameter $\alpha > 0$ and dominant to all other cells, i.e

(4.6)

$$\lim_{x\to\infty} \frac{\overline{F}_i(x)}{\overline{F}_1(x)} = \left(\frac{\theta_i}{\theta_1}\right)^{\alpha}, \; i = 1, \ldots, b ,$$

$$\lim_{x\to\infty} \frac{\overline{F}_i(x)}{\overline{F}_1(x)} = 0 , \; i = b+1, \ldots, d .$$

In the important cases of complete positive dependence and independence, closed-form results can be found and may serve as extreme cases concerning the dependence structure of the model.

Theorem 4.2. *Consider a compound Poisson model with cell processes $S_1, \ldots, S_d$ with Pareto distributed severities satisfying (4.6). Let $\mathrm{VAR}_t^i(\cdot)$ be the stand-alone OpVAR of cell i.*

(1) If all cells are completely dependent with the same frequency λ for all cells, then S^+ is compound Poisson with parameters

$$\lambda^+ = \lambda \qquad \textit{and}$$

$$\overline{F}^+(z) \sim \left(\sum_{i=1}^{b} \theta_i\right)^{\alpha} z^{-\alpha}, \quad z \to \infty ,$$

and total OpVAR is asymptotically given by

(4.7)

$$\mathrm{VAR}_{\|t}^+(\kappa) \sim \sum_{i=1}^{b} \mathrm{VAR}_t^i(\kappa), \qquad \kappa \uparrow 1 .$$

(2) If all cells are independent, then S^+ is compound Poisson with parameters

$$\lambda^+ = \lambda_1 + \cdots + \lambda_d$$

and

$$\overline{F}^+(z) \sim \frac{1}{\lambda^+} \sum_{i=1}^{b} \left(\frac{\theta_i}{z}\right)^{\alpha} \lambda_i , \quad z \to \infty ,$$

and total OpVAR is asymptotically given by

(4.8)

$$\mathrm{VAR}_{\perp t}^+(\kappa) \sim \left[\sum_{i=1}^{b} \left(\mathrm{VAR}_t^i(\kappa)\right)^{\alpha}\right]^{1/\alpha}, \qquad \kappa \uparrow 1 .$$

On the one hand, Theorem 4.2 states that for the completely dependent Pareto-Poisson model, total asymptotic OpVAR is simply the sum of the dominating cell's asymptotic stand-alone OpVARs. Recall that this is similar to the new proposals of Basel II, where the standardprocedure for calculating capital charges for operational risk is just the simple-sum VAR. To put it another way, regulators implicitly assume complete dependence between different cells, meaning that losses within different business lines or risk categories always happen at the same instants of time.

Very often, the simple-sum OpVAR (4.7) is considered to be the worst case scenario and, hence, as an upper bound for total OpVAR in general, which in the heavy-tailed case can be grossly misleading. To see this, assume the same frequency λ in all cells also for the independent model, and denote by $\mathrm{VAR}_{\|}^+(\kappa)$ and

$\mathrm{VAR}^+_\perp(\kappa)$ completely dependent and independent total OpVAR, respectively. In this case we

$$\mathrm{VAR}^+_\perp(\kappa) \sim \left(\frac{\lambda\, t}{1-\kappa}\right)^{1/\alpha} \left(\sum_{i=1}^{b} \theta_i^\alpha\right)^{1/\alpha}, \quad \kappa \uparrow 1,$$

obtain from (4.8) in the situation (4.6) from Theorem 4.2(2)

whereas $\mathrm{VAR}^+_\parallel(\kappa)$ is given by (4.7). Then, as a consequence of convexity ($\alpha > 1$) and concavity ($\alpha < 1$) of the function $x \mapsto x^\alpha$,

$$\frac{\mathrm{VAR}^+_\perp(\kappa)}{\mathrm{VAR}^+_\parallel(\kappa)} = \frac{\left(\sum_{i=1}^b \theta_i^\alpha\right)^{1/\alpha}}{\sum_{i=1}^b \theta_i} \quad \begin{cases} < 1, & \alpha > 1 \\ = 1, & \alpha = 1 \\ > 1, & \alpha < 1. \end{cases}$$

This result says that for heavy-tailed severity data with $\overline{F}_i(x_i) \sim (x_i/\theta_i)^{-\alpha}$ as $x_i \to \infty$, subadditivity of OpVAR is violated because the sum of stand-alone OpVARs is smaller than independent total OpVAR.

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Best Paper Award Winner

2007 Risk Management Section Award for Best Paper Award for Practical Risk Management Applications: Capital Allocation by Percentile Layer

by Neil Bodoff

Neil Bodoff, FCAS, MAAA, is senior vice president at Willis Re in New York, N.Y. He can be reached at *Neil.Bodoff@willis.com*.

Editor's note: This article represents an abridged version of the submission to the 2007 ERM Symposium, which received the 2007 Risk Management Section Award for Best Paper Award for Practical Risk Management Applications. The full paper can be found at http://www.ermsymposium.org/papers.php

The goal of this paper is to propose a new approach to capital allocation within a financial conglomerate.

Context

What motivates a financial firm (e.g., a commercial bank, insurance company, hedge fund, investment bank, etc.) to allocate capital? Usually, the firm comprises many business units, products, asset managers, traders, underwriters, etc.; the firm desires to measure the profitability of these various components. However, because these units engage in activities of varying degrees of risk, the firm wishes to deploy a methodology that accounts for risk when measuring profitability. Thus, the challenge of capital allocation usually arises within the context of a firm wishing to measure "risk-adjusted profitability." Additionally, implementing a framework to measure profitability retrospectively can ultimately lead to its integration into prospective situations. In other words, the methodology for measuring profitability can also become part and parcel of how a firm's business units set prices. Thus, capital allocation can affect both pricing methodology as well as profitability measurement.

Scope

In this paper we will narrow the scope in order to streamline the discussion. Therefore, we make the following assumptions:

- The financial firm we will deal with is a publicly traded insurance company that writes property catastrophe business.
- The company writes only single year policies.
- The company's regulators, rating agencies, and investors demand that the firm holds capital equal to Value-at-Risk (VaR) at the 99th percentile (with a one-year time horizon).
- The company's investors demand that the firm achieve profit from its underwriting activities; the required profit equals the amount of the firm's capital multiplied by a required percentage rate of return.

Therefore, while there is in theory an important question of how much capital a firm should hold, we assume that the operating environment (regulators, rating agencies, investors) imposes an answer. Similarly, while there is in theory an important question regarding what should be the required rate of return on capital, we assume that the operating environment (investors) imposes an answer. Thus, forces external to the firm require it both to hold an amount of capital and also to achieve a required rate of return on this capital. Thus, the questions of how much capital to hold and what rate of return to earn on this capital are outside the scope of our discussion; the only question we seek to address is how the firm should allocate capital.

Background

Mango[1], among others, has highlighted that all of the capital of the firm is available to pay any one claim of any single insurance policy. Therefore, by definition, all of the capital relates to the total firm and cannot be allocated to its components. This concept has two important ramifications. First, as Kreps[2] has clarified, when we talk about

[1] Mango, Donald F., "Capital Consumption: An Alternative Methodology for Pricing Reinsurance," CAS 2003 Winter Forum, 351-378.
[2] Kreps, Rodney, "Riskiness Leverage Models," paper accepted by Casualty Actuarial Society (CAS), 2005.

allocating capital we are really talking about taking the cost of the total firm's capital and allocating this cost. Essentially, we are taking the required rate of return on capital and allocating it to components of the firm; we say "capital allocation" merely as shorthand.

Second, because capital relates to the total firm, any discussion of risk, capital and capital allocation must relate to loss scenarios for the total firm. For example, many existing methods of capital allocation begin by measuring capital for each business unit on a standalone basis and then attempt to somehow "roll up" all of these capital amounts into a total capital figure. Essentially, all of these methods are inappropriate because they fail to measure risk and capital in the proper context of the loss to the total firm.

On the other hand, some capital allocation methods do properly account for the fact that individual business units or other components of the firm must be evaluated based upon their contribution to the total firm loss. One notable example of such an approach is the "co-measures" framework developed by Kreps[3]. Essentially, Kreps requires that one evaluate risk and capital for each scenario of total loss to the firm and, simultaneously, keep track of which components contribute to the total firm loss. Once capital is allocated to loss scenario at the total firm level, it can then be further allocated to those business units, perils, policies, product types, etc. that are the "culprits" that contribute to these loss scenarios. The question that remains, then, is how one should allocate the cost of capital to the various "total firm loss scenarios." In particular, what about our situation in which the firm holds capital based upon VaR (99 percent)?

Current Approach

Here one often encounters the following logic. When a firm holds capital based upon VaR (99 percent), it means the firm is holding capital for the 99th percentile loss scenario, or the "1-in-100 year" loss scenario. Therefore, we allocate the cost of capital to those business units, products, perils, policies, underwriters, etc. that produce losses that contribute to this loss scenario. Or, similarly, if the firm is holding capital based upon Tail Value at Risk (TVaR (99 percent)), then it means that the firm is holding capital for the average loss beyond the 99th percentile; therefore, according to this reasoning, allocate capital to those business units that contribute to these loss scenarios beyond the 99th percentile. The result is to allocate capital to components of the firm only to the extent that they contribute to extremely severe losses in the "tail" of the distribution.

Problems with Current Approach

As Mango has pointed out, however, there are many different loss scenarios that are less severe than the 99th percentile loss that require the use of the company's capital. For example, if the company holds 900 million of capital based upon VaR (99 percent), consider the scenario in which the firm sustains only a "moderately severe" downside scenario, a loss of 500 million. While this loss scenario is not a 99th percentile loss, it certainly requires, uses and "consumes" capital. Shouldn't we allocate, therefore, at least some portion of the cost of the firm's capital to these loss scenarios and the units that contribute to them?

A New Formulation of the Meaning of VaR

It therefore appears that we need to clarify what it means for a firm to hold capital equal to VaR. The conventional wisdom suggests that when a firm holds capital based upon VaR (99 percent), the firm is holding capital "for the 99th percentile loss." This imprecise formulation leads to the flawed assumption that the firm is holding capital "only for the 99th percentile loss" and leads to the inappropriate allocation of capital only to the components of the firm that contribute to the 99th percentile loss. I believe, however, that a better formulation of the meaning of the VaR capital requirement is that the firm holds sufficient capital "even for the 99th percentile loss." In other words, much of a firm's capital is intended not only for the 99th percentile loss scenario, but for

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[3] Kreps, Rodney, "Riskiness Leverage Models", paper accepted by Casualty Actuarial Society (CAS), 2005

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other moderately severe losses as well. Similarly, we can also apply this logic to TVaR; using TVaR (99 percent) to set capital means we are holding capital "even for the average loss beyond the 99^{th} percentile," but not "only for" these events.

Ramifications of New Formulation of VaR

Based upon our new formulation that the firm holds capital "even for" the 99^{th} percentile loss, we can begin to develop a new approach to allocating the cost of capital. Why does the firm hold capital equal to the 99^{th} percentile rather than the lesser amount of the 98^{th} percentile? For most losses, capital equal to the 98^{th} percentile would be sufficient. Only loss scenarios (for the total firm) that exceed the 98^{th} percentile require that the firm holds more capital than VaR (98 percent). Therefore, we can see that the incremental difference between capital at the 99^{th} percentile and the 98^{th} percentile is solely attributable to loss scenarios that exceed the 98^{th} percentile. By similar logic, the amount of capital equal to the 98^{th} percentile minus the 97^{th} percentile can be allocated only to the loss scenarios that exceed the 97^{th} percentile. Let's call this difference between capital amounts at sequential percentiles a "percentile layer of capital." One can apply this procedure sequentially to all "percentile layers of capital" and thus allocate the entire capital of the firm.

The key to the allocation procedure is to view the firm's capital as the sum of many granular pieces of capital, or "layers of capital." Each layer of capital is needed and potentially used by a different set of loss scenarios. Therefore, we must allocate each layer of capital individually to those loss scenarios that will use each layer of capital—in other words, to those loss scenarios that exceed the lower bound of the layer of capital (which can also be described as hitting the layer or penetrating the layer). Of course, many layers of capital will be potentially used by many different loss scenarios. In such a case, we can use conditional probability to allocate the layer of capital to the various loss scenarios. In other words, for any given layer of capital, each loss scenario receives allocation based upon: 1) probability of loss scenario exceeding the lower bound of the layer of capital or 2) probability of all loss scenarios exceeding the lower bound of the layer.

Graphical Depiction and Numerical Example

A numerical example, together with a graphical depiction, may help clarify the approach. The graph below (also known as a "Lee Diagram" based upon the contribution of Lee[4], plots 20 loss scenarios in size order from smallest to largest (in the continuous case, this is the inverse of the cumulative distribution function). The loss amount is plotted on the Y-axis:

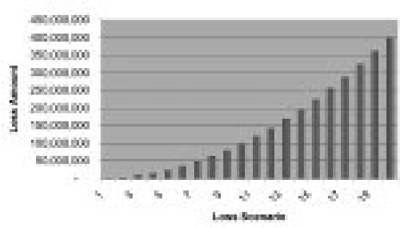
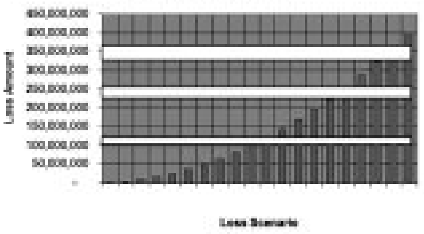


Exhibit 1: Lee Diagram

In Exhibit 1 there are 20 loss scenarios and we'll assume the firm holds capital equal to the 19^{th} worst loss scenario, 360 million Why is it that the firm needs to hold 360 million of capital rather than just 100 million of capital? It appears that loss scenarios one through 10, which are all less than or equal to 100 million, do not require this layer of capital. In contradistinction, loss scenarios 11 through 20, which exceed 100 million, clearly do utilize this layer of capital in excess of 100 million. Examining in further detail, we see that all of scenarios 11 through 20 utilize the 1million x 100 million layer, but not all of them require the 1 million x 200 million layer, and even fewer require the 1 million x 300 million layer. Thus, we must allocate each individual layer of capital to the loss events that penetrate the layer in proportion to the relative usage of the layer of capital; i.e., in proportion to the relative exceedance probability, as per Exhibit 2:

4 Lee, Yoong-Sin., "The Mathematics of Excess of Loss Coverages and Retrospective Rating-A Graphical Approach," Proceedings of the CAS (PCAS) LXXV, 1988, 49-77.

Exhibit 2: Lee Diagram



Numerical example:

- Loss scenario #19 is one of two events (scenarios 19 and 20) that require the 35 million x 325 million layer of capital.
  - Thus scenario #19 receives 1/2 allocation of this 35 million of capital.

- Loss scenario #19 also is one of five events (scenarios 16 through 20) that require the firm to hold the 25 million x 230 million layer of capital.
  - Thus it receives 1/5 allocation of this 25 million of capital.

- Apply the procedure to all layers, allocate to all loss events that exceed the lower bound of the layer via conditional exceedance probability.

Note that a loss scenario tends to receive a larger percentage allocation in the upper layers than in the lower layers for two reasons:

1) In the upper layers, we are allocating a full layer of capital to fewer loss events (i.e., the exceedance probability decreases as the loss amount increases); therefore, each loss scenario gets a larger share of the "overhead" of the total layer of capital.
2) In the upper layers, we are allocating a wider layer of capital because the severity of each loss scenario tends to outstrip the prior loss scenario by a greater amount (i.e., the percentile layer of capital tends to widen as the loss amount increases). There can be situations, however, in which this relationship between layers is not the case; this behavior depends on the particular shape of the size of loss distribution.

Implementation

The methodology described above, "Capital Allocation by Percentile Layer," can easily be implemented using loss scenario output within several common contexts. One example is using simulated loss output from a property catastrophe model (e.g., one has annual aggregate losses for one year). Another example is loss output from a DFA model or other simulation engine. Of course, the capital allocation procedure described here relates only to allocating total firm capital to each total loss scenario; but once we allocate capital to each total loss scenario, we can then (per Kreps, others) further allocate the capital for each total loss scenario to those individual components (operating units, lines of business, insurance policies, etc.) that are the "culprits" that contribute to each total loss scenario.

Additional Areas of Application

The application highlighted here focuses on property catastrophe risk and allocating the cost of equity capital, but the reformulation of the meaning of VaR should have ramifications in other areas as well.

1) Assets–risk and capital for assets such as equities and fixed income securities have traditionally been defined based upon VaR metrics; as a result, methods that allocate capital among various asset classes and operating units may benefit from implementing capital allocation by percentile layer.

2) Other sources of capital–capital allocation by percentile layer may also be germane when the firm's total capital does not reside in one "indivisible bucket of equity capital," but rather is split into different types of capital.

   a. Multiple tranches of capital–firms often have sources of capital beyond equity capital, sometimes in the form of tranches. Because these tranches sustain capital depletion in a predetermined sequential order and, as a result, carry different cost of capital rates, it would seem appropriate to

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allocate capital with a procedure that explicitly accounts for the varying layers of capital and their costs. Thus, capital allocation by percentile layer, which provides a framework for explicitly allocating capital by layer, appears to offer an appealing alternative to almost all traditional methods (VaR, TVaR, TCE, coTVaR, etc.), which do not seem to adapt well to such a situation (with the notable exception of transformed probability functions).

b. In addition, alternative forms of capital that apply on a "layered" basis (e.g., excess of loss reinsurance) and their costs (e.g., the amount of "risk load" or "margin" in the reinsurance price) would also appear to be candidates for capital allocation by percentile layer.

Interpretation and Comments

The procedure for capital allocation by percentile layer outlined above generates allocations that are different than many other methods, with ramifications for measuring the relative risk and profitability of various lines of business. Tail based methods, such as coTVaR, tend to allocate the overwhelming amount of capital only to perils that contribute to the very worst scenarios; capital allocation by percentile layer, however, recognizes that when the firm holds capital even for an extremely catastrophic scenario, some of the capital also benefits other, more likely, more moderately severe downside events. On the other hand, other methods (e.g., Mango's "capital consumption," XTVaR at the mean, etc.) allocate capital to a broader range of loss events that consume capital; the allocation varies proportionately based upon conditional probability. These methods, however, often allocate insufficient capital to unlikely yet most severe events. They fail to note that the potentially extreme loss of such scenarios causes firms to hold an amount of capital that far outstrips the amount required by other loss events; although the actual occurrence of one of these events is very unlikely, the cost of holding precautionary capital is quite definite. Capital allocation by percentile layer, on the other hand, appropriately allocates more capital cost to those unlikely, severe events that require the firm to hold additional capital.

Capital allocation by percentile layer as delineated above assumes that required capital is based upon VaR, but a similar model can also apply to TVaR. In other words, we can view TVaR as saying we want to hold enough capital "even for {the 99^{th} percentile loss + the average amount by which losses above the 99^{th} percentile tend to exceed the 99^{th} percentile}." In such a case, capital allocation by layer would be nearly the same, allocating capital up to the 99^{th} percentile. The only additional step would then be to allocate one additional layer of capital (i.e., TVaR – VaR) to the losses that exceed the TVaR threshold. Consistent with TVaR's meaning as well as the layer allocation approach, this additional layer of capital should be allocated to loss events in proportion to each event's average amount of loss excess of the TVaR threshold.

Extension to Continuous Formulas

The approach to capital allocation discussed above essentially entails allocating capital on many discrete layers of capital, from zero to VaR(99 percent). By viewing the width of each layer of capital to be infinitesimally small, we can express Capital Allocation by Percentile Layer in continuous formulas.

First we will take the perspective of allocating a layer of capital to the various loss scenarios that potentially use this capital. Let x represent the amount of the loss scenario and let y represent the capital. First we take an infinitesimally small layer of capital spanning from y to y+dy and allocate it across loss scenarios. The amount of capital we wish to allocate, the "width" of the layer, is dy. We allocate this capital based upon each loss scenario's conditional probability of "penetrating the layer," namely, exceeding the lower bound of the layer. Thus the allocation weight to a loss scenario, given that $x > y$, equals $f(x)/(1-F(y))$.

The sum of all allocation weights on this particular layer of capital is then

$$\int_{x=y}^{y=max} f(x)/(1-F(y))dx$$

Note that the allocation weights sum to 100 percent. Then we perform this procedure for all layers of capital, from y = 0 to y = total capital = VaR(99 percent):

The sum equals VaR(99 percent).

$$\int_{y=0}^{y=VaR(99\%)} \int_{x=y}^{y=max} f(x)/(1-F(y))dxdy$$

We now can realize that each loss scenario of amount x receives allocations of varying portions from many different layers of capital. We can express the total capital allocated to a loss scenario of amount x as follows:

As before, the allocation weight to a loss scenario on a layer of capital, given that $x > y$, equals $f(x)/(1-F(y))$. Now, if we sum across all layers of capital that the loss scenario penetrates, we have

$$\int_{y=0}^{y=x} f(x)/(1-F(y))dy$$

Of course, we remember that if the loss amount x exceeds the total capital amount of VaR(99 percent), then (because the firm's capital is a finite amount), the formula for the loss scenario's total allocated capital must be amended to:

$$\int_{y=0}^{y=VaR(99\%)} f(x)/(1-F(y))dy$$

In general, though, for loss amounts below the VaR threshold, we can say that the Allocated Capital to Loss Amount x =

$$AC(x) = f(x)\int_{y=0}^{y=x} 1/(1-F(y))dy$$

According to this equation, the procedure of capital allocation by percentile layer says that any loss scenario's allocated capital depends upon:

1) The probability of the event occurring (i.e., f(x))
2) The severity of the loss event, or the extent to which the loss event penetrates layers of capital (i.e., the upper bound of integration is x, the loss amount)
3) The loss event's inability to share the burden of its required capital with other loss events (i.e., $\int 1 / [1-F(y)]$). We can think of this factor as a mathematical measurement of the loss scenario's "dissimilarity" in severity to other potential loss scenarios.

We can also formulate the allocated cost of capital as a utility function. If we let r = required percent rate of return on capital, then the cost of capital equals r multiplied by allocated capital. Then the cost of capital associated with loss scenario of amount x =

$$r * f(x)\int_{y=0}^{y=x} 1/(1-F(y))dy$$

Of course, the loss scenario also contributes expected loss of f(x) * x, so the total cost attributable to a loss scenario of amount x is

$$f(x)(x + r\int_{y=0}^{y=x} 1/(1-F(y))dy)$$

We note that f(x) is simply the probability of the loss scenario occurring. Using conditional probability, we can then say that conditional on the loss scenario, or "given" the loss scenario, the utility of a loss amount x equals:

$$x + r\int_{y=0}^{y=x} 1/(1-F(y))dy$$

Conclusion

Capital Allocation by Percentile Layer has several advantages, both conceptual and functional, over existing methods for allocating capital. It emerges organically from a new formulation of the meaning of holding Value at Risk capital; allocates capital to the entire range of loss events, not only the most extreme events in the tail of the distribution; tends to allocate more capital, all else equal, to those events that are more likely; tends to allocate disproportionately more capital to those loss events that are more severe; renders moot the question of which arbitrary percentile threshold to select for allocation purposes by using all relevant percentile thresholds; produces allocation weights that always add up to 100 percent; explicitly allocates the entire amount of the firm's capital, in contrast to other methods that allocate based upon the last dollar of "marginal" capital; and provides a framework for allocating capital by layer and by tranche.

Capital Allocation by Percentile Layer has the potential to generate significantly different allocations than existing methods, with ramifications for calculating risk load and for measuring risk adjusted profitability. ✦

A Full Line-Up of ERMAP Sponsored Sessions is Slated for the Annual Meeting in Washington, D.C.

by Todd Henderson

ERMAP (the Joint Risk Management Section) is planning an exciting program for the 2007 Annual Meeting that will be held at the Marriott Wardman Park Oct. 14-17. The sessions for this year's meeting cover current, timely topics that will be useful to the risk management professional as well as those interested in learning more about ERM. Current thought leaders from within the actuarial profession, in addition to other experts, will discuss a range of issues from current pandemic research to economic capital to defining and classifying operational risks.

Look For …

Pandemic Research Study

A panel of industry experts will discuss the findings of the recently (summer of 2007) released Pandemic Research Project sponsored by the Society of Actuaries. Attendees will gain a focused insight into the pandemic threat and better understand how this risk can affect earnings, balance sheets and operations of their organizations.

Economic Capital Models

This session discusses current trends for developing company-specific EC, as well as best practices for its uses and applications. Panelists will cover recent changes in the regulatory and rating agency landscape for determining capital adequacy,

Effective Stress Testing

What are those scenarios that should be keeping us up at night? How will your company fair should they materialize? In this session you'll learn about identifying and modeling the outlying possibilities and correlated events. Also discussed will be how to model the impact of these scenarios on your organization, as well as how to incorporate this analysis into your risk management framework.

Operational Risk of Hedging Programs

Hedging programs are put in place to hedge risk, but there are many aspects of the execution which put the effectiveness of the program at risk. In this session you'll learn about the key, practical considerations to understand when modeling these programs, how to quantify the associated operational risk, and most importantly how to manage it.

Defining and Classifying Operational Risk

In this session you'll learn the true nature of the word risk, the fundamental characteristics of operational risk, the differences in definitional standards, the evolution of this field over the past decade, and different approaches and methods used in an advanced measurement and management framework.

ERMAP is also sponsoring a Hot Breakfast and the Chief Risk Officer's Forum. See you in DC. ✦

Todd Henderson, FSA, CERA, MAAA, is vice president & chief risk officer with Western & Southern Financial Group in Cincinnati, Ohio. He can be reached at *todd.henderson@westernsouthernlife.com.*

Moving Ideas Forward

Mark your calendar and plan to participate in the SOA '07 Annual Meeting & Exhibit, where we'll be offering insights into how to move your ideas off of paper and into action. We're also planning more great seminars and networking opportunities—and of course, a few surprises.

WE'VE ALREADY LINED UP:

POTENTIAL IMPACT OF A PANDEMIC ON THE U.S. HEALTH INSURANCE SYSTEM

An influenza pandemic occurs when a virus, easily transmissible between humans, mutates into a new strain for which there is no prior immunity. These events typically occur several times each century with varying degrees of virulence. Experts project that a similar event today would infect as many as 100 million people in the United States alone. The Society of Actuaries recently sponsored research to better understand the potential impact of a pandemic on the U.S. health insurance industry. This session will present the results of that research, leaving ample time to engage the audience around the issue of preparedness and the role of the health insurance industry.

DEFINING AND CLASSIFYING OPERATIONAL RISK

In this session, you'll learn the true nature of the word "risk," the fundamental characteristics of operational risk, the differences in definitional standards, the evolution of this field over the past decade, and different approaches and methods used in an advanced measurement and management framework.

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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 Ken Seng Tan, editor, at *kstan@uwaterloo.ca* or Ron Harasym, co-editor, at *ronald_j_harasym@newyorklife.com*.

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

Publication Date	*Submission Deadline*
December 2007	October 1, 2007

Preferred Format

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

Please e-mail your articles as attachments in either MS Word (.doc) or Simple Text (.txt) files. We are able to convert most PC-compatible software packages. Headlines are typed upper and lower case. Please use a 10-point Times New Roman font for the body text. Carriage returns are put in only at the end of paragraphs. The right-hand margin is not justified.

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:

Ken Seng Tan, ASA, CERA, Ph.D.
University of Waterloo
Waterloo, Ontario
Canada N2L 3G1
phone: (519) 888-4567 ext. 36688
e-mail: *kstan@uwaterloo.ca*

Ron Harasym, FSA, CERA, FCIA, MAAA
New York Life Insurance Company
51 Madison Avenue
7th Floor
New York, NY 10010
phone: (212) 576-5345
e-mail: *ronald_j_harasym@newyorklife.com*

SOCIETY OF ACTUARIES

475 N. Martingale Rd., Suite 600
Schaumburg, IL 60173

(847) 706-3500 main
(847) 706-3599 fax
www.soa.org

Canadian Institute of Actuaries
Institut canadien des actuaires

Risk Management
Issue Number 11
September 2007

Published by the Society of Actuaries
475 N. Martingale Road, Suite 600
Schaumburg, IL 60173-2226
phone: 847.706.3500
fax: 847.706.3599
www.soa.org

This newsletter is free to section members. Current-year issues are available from the Communications Department. Back issues of section newsletters have been placed in the SOA library and on the SOA Web site: (*www.soa.org*). Photocopies of back issues may be requested for a nominal fee.

2006-2007 SECTION LEADERSHIP

Editor
Ken Seng Tan, ASA, CERA
e: *kstan@uwaterloo.ca*

Co-Editor
Ron Harasym, FSA, CERA, FCIA, MAAA
e: *ronald_j_harasym@newyorklife.com*

Council Members
Douglas W. Brooks, FSA, CERA, FCIA, MAAA
Anthony Dardis, FSA, FIA, MAAA
Kevin Dickson, FCAS, MAAA
David Gilliland, FSA, FCIA, MAAA
Ron Harasym, FSA, CERA, FCIA, MAAA
Todd Henderson, FSA, CERA, MAAA
Valentina Isakina, ASA, MAAA
Hank McMillan, FSA, CERA, MAAA
Larry Rubin, FSA, MAAA
Ken Seng Tan, ASA, CERA
Fred Tavan, FSA, FCIA
Bob Wolf, FCAS, MAAA

Society Staff Contacts
Kara Clark, Staff Partner
e: *kclark@soa.org*

Kathryn Wiener, Staff Editor
e: *kwiener@soa.org*

Newsletter Design
Angie Godlewska
Julissa Sweeney
e: *jsweeney@soa.com*

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