SOCIETY OF ACTUARIES

Risk Management

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Risk Management Section

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Chairperson's Corner

The Risk Management Section Needs You!

by David Ingram

The Risk Management Task Force (RMTF) has set a new standard for volunteerism in our profession. Over a third of the 300 members of the RMTF have participated in committees and working groups. That standard needs to be carried over to the new Risk Management Section so that the actuarial profession, the risk management discipline and the individuals who participate in these developments will all reach their maximum potential.

One unique characteristic of actuaries is our long-term perspective. We start our careers by undertaking one of the longest educational and training processes of its kind. We regularly make long-term financial projections that run for decades. We believe both professionally and personally that there are dependable cause-and-effect relationships that hold over long periods of time. We believed that if we put in the work to complete our exams that we would be able to have challenging, interesting and well-paying careers, and our life experience has shown that to be true.

> **Successful volunteer efforts create recognition in the profession, a benefit in and of itself.**

That has been true especially in the traditional actuarial areas of product development rate making and valuation. Every year brings new challenges, but usually those challenges can be met by work that is an incremental extension of recent experience built upon the basic actuarial education.

Risk management is not such an incremental area. Risk management, as defined by financial economists and practiced by bankers, is a process for risk traders who only retain a small fraction of the risks that pass through their hands. Insurance companies are just the opposite: they consist of risk collectors who only lay off a small fraction of their risks. Some of the methods and models of banks and financial economists may produce incorrect signals when applied to insurance companies.

On the other hand, some of the fundamental ideas of risk management have tremendous appeal. Creating a control cycle for risk, attending to net risk after accounting for correlation and looking to the financial markets for information on risk are just a few of the powerful ideas that are fundamental to risk management.

However, the details of applying these ideas to insurance companies are far from easy or obvious. At the same time, these and other risk management ideas are only slowly becoming well known in the insurance community.

The process of building both theoretical and practical bridges between insurance company risk and banking risk management is a monumental undertaking. In two instances, I have participated in prolonged brainstorming sessions to identify manageable steps in that process. In both cases (at the time of the formation of the Risk Management Task Force in 2001 and a few months ago at the first meeting of the Risk Management Section Council) we developed lists of 20 to 30 projects that needed to be done.

From those extended lists, there are now 15 projects at various stages of completion. By the time those have been completed, 15 more will have started, but only if we get enough help. We need volunteers; not just a handful of volunteers, not a dozen, but hundreds! If you have never volunteered, then you are exactly who we need, because fresh perspectives and energy are in high demand.

Chairperson David Ingram, FSA, MAAA, is a consulting actuary at Milliman USA in New York. He can be reached at david.ingram@milliman.com.

Volunteering is a long-term investment, but one with a high number of valuable payoffs. The following is a partial list of the benefits of volunteering:

1. The challenge of working on a problem of your own choosing.
2. Exposure to diverse perspectives from co-volunteers who work with different products and various jobs all over the world with company actuaries, regulators, consultants, analysts and others.
3. Learning new things as co-volunteers share thoughts from a new or classic paper on a subject that interests you.
4. Networking with other volunteers to greatly expand the list of people who you might be in contact with the next time you need help.
5. Learning broadly about the wide range of industry activities long before they are documented in formal meetings or publications.
6. The lowest-cost way to gain these benefits. Almost all meetings are by phone and the SOA even pays for the calls.
7. Leading-edge practices developed by the volunteer groups from combinations of the practices and ideas of the participants.
8. As this volunteer activity produces results that are recognized throughout the financial services industry, the value of the actuarial credentials will be greatly increased.
9. Learning to bring in and use resources from outside industry and to incorporate them into actuarial practices. Often, those resources were completely unknown to the volunteers before the project.

Volunteering forces participants into a different mode of interacting, a more collaborative mode. Improving skills to "play well with others" will pay career dividends. Successful volunteer efforts create recognition in the profession, a benefit in and of itself. And you never know when you will be grateful that having your name on a committee report opens a door that you didn't know existed when you did the work. As these volunteer committees complete different tasks, others will look upon their findings and methods and realize that there are applications far beyond the originators' dreams.

If you are feeling in even a little of a rut, volunteering can provide the satisfaction of accomplishment.

More than one of the RMTF volunteers has found new positions, whether within the same company or at a different firm, at least in part because of what they learned, who they met and their new skills and positive attitude gained from their volunteer accomplishments.

For over 20 years, I lived in an old neighbor-hood of stately Victorian houses. The cost of a typical house was quite modest, but the upkeep was very, very high. Most of the homeowners in the neighborhood paid their pittance for a slightly run down giant of a house and let it slide slowly at first, but more and more with time into further disrepair. Once in a while, someone would come into the neighborhood and take one of the worst houses, and with lots of sweat equity and not a small amount of cash, return it to a reasonable semblance of its former glory. They were always disappointed that the housing market did not support them. The top three factors in house valuation there as everywhere else are Location, Location and Location. To get the value out of their efforts, many, probably most, of the rest of the neighborhood would have to do likewise.

We all own (or want to own) houses in the actuarial and risk management neighborhood. Those houses will all be worth more if we all get out and paint the walls and fix the roofs. Or better yet, read about what is going on in the volunteer committees and join today!✦

Section Council Elections

DON'T FORGET TO VOTE IN THE SECTION COUNCIL ELECTIONS—JULY 12 THROUGH AUGUST 13!!

The following persons are candidates for the Risk Management Section Council:
Clifford W. Angstman, Berkshire Life Insurance Company of America, Pittsfield, Mass.
Douglas W. Brooks, Sun Life of Canada, Toronto, Ontario
Asutosh Chakrabarti, Actuarial Consortium LLC, Monmouth, NJ
S. Evaronda Chung, IntAct Consulting, Inc., Toronto, Ontario
Leonard Mangini, AXA CS Life Re, New York, NY
John W.C. Stark, Anthem Health Plans of Virginia, Inc., Richmond, Va.
Ken Seng Tan, University of Waterloo, Waterloo, Ontario
Fred Tavan, The Canada Life Assurance Company, Toronto, Ontario

For further information go to **www.soa.org** and click on the election information link.

Editorial

2004 Enterprise Risk Management Symposium—From Cutting Edge Theory to State of the Art Practice

by Valentina Isakina

Nearly 400 chief risk officers and enterprise risk management experts gathered in Chicago on April 26 and 27, 2004 to discuss the latest developments on enterprise risk management (ERM) and share their thoughts on how ERM enables companies to optimize the overall corporate risk exposure and leverage business opportunities more profitably.

Sponsored by the Society of Actuaries and Casualty Actuarial Society, the ERM Symposium brought together enterprise risk managers from a variety of disciplines and industries from all over the world. Guided by its mission statement, " From Cutting Edge Theory to State of the Art Practice," the symposium drew top ERM experts to Chicago to share their experience with colleagues and challenge the audience with thought-provoking issues to address in the future. The Georgia State University's Thomas P. Bowles Symposium and Professional Risk Managers' International Association (PRMIA) were co-sponsors of this event and generously contributed to the program development.

For the two days of the symposium—over the course of five general sessions and 35 concurrent sessions—the attendees discussed and deliberated over the most critical aspects of implementation issues and obstacles for creation of the most effective, yet customized, enterprise risk management framework. Topics discussed spanned across various industries—insurance, banking, energy, retirement systems and beyond and various other disciplines—from technical risk measuring applications to broad operational risk issues and implementation. In the following paragraphs, we offer you a glimpse of the symposium topics. The complete program and presentations are available online at: *http://www.casact.org/coneduc/erm/2004/handouts/*.

CRO Forum

The symposium was launched with a CRO forum moderated by Harry Panjer.

With such panelists as Robert Mark, president and CEO, Black Diamond Inc.; James Lam, president, James Lam & Associates; and Luc Henrard, general manager and chief risk officer, Fortis Group, the forum was a sure hit. These experts were at the cornerstone of the implementation of ERM systems/processes in general and their respective firms in particular, and have written authoritative books and/or articles on ERM. Each of them was able to bring a profound insight to the session.

First, Bob Mark described the components of a proactive risk management function:

- Policies/procedures, including setting risk tolerances and constraints
- Best practice methodologies, including calculating VaR, stress testing, setting of models and the tie-in to performance measurement
- Developing the infrastructure, including an assessment of people skills, operations, data and technology.

Second, James Lam discussed the history and proliferation of the CRO position. In particular, his description of the "good CRO" attributes resonated with the audience:

- Organizational/leadership skills
- Communication skills—to simplify without being simplistic
- Technical skills—need two out of three in credit/market/operational risk
- Balance business and risk requirements
- Courage to push back/say no
- High IQ and high emotional quotient
- Ultimate test: the ability to integrate risk management into the day-to-day business operations.

Valentina Isakina is finance practice area actuary on staff at Society of Actuaries. She can be reached at 847.706.3584 or at visakina@soa.org

James also gave his 10 predictions for the future of ERM, including the line "Economic capital is in, VaR is out!"

Luc Henrard presented to the audience his experience with the risk management of a financial conglomerate and the challenges in bridging the gap between banking and insurance risk management.

In Fortis's framework, risks include insurance risks, investment risks and operational risks. Return measures include ROA (return on assets), ROE and return on risk-adjusted capital (RORAC)/risk-adjusted return on capital (RAROC). Luc also stressed the importance of economic capital (EC) as an economic measure for solvency capital. In his organization, EC is calculated by turning embedded value models into risk models.

All the panelists emphasized the importance of buy-in from senior management and suggested that the actuarial curriculum be expanded to include all-around financial risk management, thereby integrating actuarial and economic sciences.

Closing Remarks

The closing remarks session was one of the most remarkable sessions at the symposium, and those who attended this last session were richly rewarded. Three expert panelists presented to the audience their impressions of the symposium, summarized the results achieved and challenged the participants with thought-provoking issues to address for the next gathering of the symposium in 2005.

1. Observations on ERM Practice:
First, Prakash Shimpi, visiting fellow from the London School of Economics & Political Science, senior fellow at the Wharton School and president at Fraime LLC offered his observations on the ERM practice. He pointed out that the roots of ERM are in both asset-liability management (ALM) and corporate finance and identified the following key challenges that face practitioners striving to implement ERM in their organizations:

Alignment of management
According to Prakash, breaking down the silos that have arisen due to history and jargon across different groups of professionals is one of the most critical steps in moving the ERM profession forward, but it also seems to be the biggest challenge. Learning from each other's best practices and speaking one language makes the ERM process more effective and brings value in ability to communicate between different professional groups and provide management a solid and consistent message.

Problem misspecification
For actuaries or other risk management professionals, it is very important in their modeling work to keep in mind that the relationships used as proxies for the underlying problem remain just that—proxies. There are plenty of favorite risk metrics used in a variety of industries, and some of them are more valuable than others. However, according to Prakash, the lesson remains—it is essential to understand the real problem and not just the proxies.

Margins for error
As with any new discipline, ERM is dealing with various limitations—from systems to data availability—while being asked to provide answers for increasingly complex questions. Prakash suggested that for the process to be successful, it is important to re-examine the traditional statistical methods and consider alternative techniques that help mitigate data limitations through margins in the analysis.

Spurious precision
Spurious precision, stated Prakash, is a natural consequence following from the previous two observations. Being correct to the third decimal place on something with many assumptions built in is not necessarily valuable information. Prakash argued that in ERM, it is more valuable to have a more complete representation of the firm's risks at lower overall precision than to have surgical precision on some risks and no information on others.

Analytics
The last observation Prakash made was to identify the greatest limitations in the progress of ERM—the lack of solid analytics. He argued that in the absence of strong analytics is it difficult, if not impossible to demonstrate value—"Analytics should enable us to convert the raw risk data of a firm into knowledge about how the risks impact the firm and the economic value of the instruments and strategies that can be used

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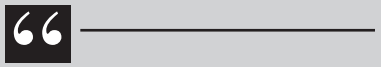

Learning from each other's best practices and speaking one language makes the ERM process more effective and brings value in ability to communicate between different professional groups and provide management a solid and consistent message.

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as mitigants. Such analytics should become an integral, not separate, part of the routine corporate planning process of a firm."

2. Summary Remarks on the ERM Symposium 2004 Chicago

Next, Thomas Ho of the Thomas Ho Company took the microphone and provided a brilliant summary of the story that the general sessions conveyed in the two days of the symposium.

For Thomas, the overwhelming message that came out of the conference was the intense search for the definition of enterprise risk management—the scope of ERM, the responsibility of ERM, how to define the destiny of ERM. First, Shaun Wang challenged the audience to invent a new paradigm of ERM, and stated that ERM is a manifold, a system that relates all the small parts to form the whole. Other symposium speakers described ERM from other perspectives, and, to help describe these perspectives, Thomas invited the audience to join him on a tour of a headquarters of a securities firm.

> "Wang challenged the audience to invent a new paradigm of ERM, and that ERM is a manifold, a system that relates all the small parts to form the whole."

First stop—the trading floor

In the CRO Forum, Bob Mark illustrated how the CRO could have lowered the VaR tolerance level in the months prior to the Russian Crisis August 98—tying the risk measures to performance is key to the success of risk management. This view was extended by Leo Tilman in the second general session, "State of Risk Management Practices." Giving specific derivatives examples, Leo observed that ERM must be aware of the external forces in the marketplace and that the CRO should take a holistic approach and have resources beyond capital markets instruments.

Second stop—up one floor of these corporate headquarters

On this floor, Thomas described how James Lam drew from his experience in ERM to conclude that the CRO must be a leader who leads the main asset in ERM—people. James also stressed a practical perspective, which is the alignment of incentives: GE's success in the Six Sigma campaign owes much to the compensation scheme, which attributes one-third of the compensation to meeting the six sigma targets. Thomas also noted the contribution made by Chuck Lucas, who stated that the CRO has the unique challenge of being a leader in the business sense and a leader in the technical sense. Chuck used the variable annuity product to illustrate how the CRO must understand the technical aspects of hedging the risk of the guaranteed death benefits and at the same time can bet on the disappearance of the reinsurance market for the variable annuity guarantees.

Third stop—taking the elevator to the third floor

Thomas described how the theme of economic capital, first introduced by James Lam and Donald Mango, was appearing throughout the symposium. Don extended Chuck and James' points to suggest that managing all the stakeholders of ERM is the greatest challenge to the CRO and the best way to resolve the issue is to assign economic capital to the units. However, Donald asserted that we need a more dynamic definition of this process and introduced the concept of "renting" capital. In this analogy, the CRO was presented as a hotelier who rents rooms out for use, keeping the optimal balance of the needs of the stakeholders.

Further, Thomas noted Luc Henrard's contribution to the discussion of the challenges facing ERM in setting a uniform standard across businesses. Luc observed that the regulatory capital requirements for banks, insurance companies and other entities are different and challenged the audience to specify the economic capital appropriately for the management of risk across the various industries. To continue the theme of ERM and regulation, Thomas made a connection to the presentation by Darryll Hendricks. Darryll Hendricks described the complexity of setting a uniform required capital that is being negotiated among the regulators. While the European regulators are making progress across the Atlantic in aligning the regulations across different industries, the office of the comptroller currency (OCC), sub-area council (SEC), NAIC, Federal Reserve Board (FRB), and other regulators on this side of the Atlantic are not converging and will have a complex problem to solve. Thomas noted that the luncheon keynote speaker Zvi Bodie also showed con-

cern for the impact of ill-conceived regulations in the arena of pension—the alternative pension liability valuation accounting methods conflict with economic principles. Zvi argued that the asset valuation accounting methods must adhere to the law of one price and urged that our 401(k) plans should be prompted by regulations to invest more in bonds and not equities. Inappropriate regulations affect not only corporations in the small, but the economy in the large.

Last stop—the Board Room

Thomas described the Board's concerns with the shareholders' value and how various speakers addressed this fundamental issue during the conference. Tom Wilson, for example, saw ERM managing all the business processes of the firm. While ERM provides the risk measurements, monitoring and analysis, Tom stressed how important the "soft" aspects of ERM were in relating the analytics to the business processes of the firm. To illustrate his observation, Tom provided a complex and comprehensive map of these processes in a firm. At the same time, Thomas noted that David Ingram, in his 12 points of the best practices of ERM, suggested that one element was missing in the map, which was: "The firm has a process to identify weaknesses of ERM." Thomas noted that Dave's presentation spoke of ERM as a dynamic process, not a map. This process has to have a self-correcting mechanism, and this self-correcting mechanism is the essence of risk management.

3. The Foundations of Enterprise Risk Management

The final speaker of the session was William H. Panning, EVP and Managing Director of Willis Re Inc. Bill focused on an issue that is crucial to ERM but rarely discussed—time.

Bill stated that measures of risk such as (VaR), and its close relatives are like flashlights in a cave, in that they illuminate some aspects of reality but simultaneously conceal others that fall outside their scope. In particular, these measures focus on the distribution of possible outcomes at some particular point in time. In fact, however, firms such as insurers take on risks for a variety of time horizons, and no single point in time is predominant. This has several implications.

First, Bill suggested that for insurance companies, a more appropriate approach to risk measurement should be three-dimensional: "Instead of thinking about risk as some feature of a probability distribution at some particular point in time, an insurer should think about a surface constructed from a probability distribution of outcomes one day from now, behind which is another distribution for outcomes two days from now, and so on, extending out to infinity. The result is a three-dimensional surface, where the dimensions are percentage change in value on the horizontal axis, probability on the vertical axis and time on the axis projecting into the future." What is needed is a more adequate measure of risk that reflects the time dimension.

Second, Bill argued that looking at risk metrics from such time prospective brings the importance of strategy into clearer focus. Enterprise risk management is not just enterprise risk measurement. One way ERM can benefit senior management is by assisting them in identifying appropriate strategies for responding to events or conditions that potentially affect the value of the firm. Ultimately, by making appropriate strategy choices, managers can change the shape of the three-dimensional surface.

Third, the ability to manage this three-dimensional surface should likewise enable managers to enhance shareholder value. Bill stressed the importance of creating valuation models able to link the shape of the three-dimensional risk surface to the market value of the firm. At the present time, such valuation models are relatively primitive.

In his summary, Bill identified the following opportunities for managers to make ERM a clear value-adding tool for executive decisions:

- focus on the time dimension of outcome distributions;
- identify ways in which this return surface can be altered by adopting appropriate corporate strategies; and

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Risk Management Task Force Subgroup Updates

The Risk Management Task Force consists of several subgroups, and other sub-subgroups or grouplets. Below are brief summaries from six of the groups. More information on all subgroups can be found on the Society Web site.

Health Risk Management Subgroup

The Health Risk Management (HRM) subgroup of the RMTF was formed to ensure that the health area was represented as risk management at the SOA evolved. There are many areas in health insurance that correspond to those in life insurance but that do not have the same degree of importance. One of the best examples is interest rate risk. Another example is provider networks, which do not have a parallel in life insurance. At its inception, the HRM subgroup took a poll to determine its direction. Three major areas emerged: the need for a specialty guide; the need to focus on solvency issues unique to health coverage; and the need to improve models used by health actuaries.

Rajeev Dutt of Milliman USA is in charge of the group putting together the specialty guide. This group has already developed a health risk mapping process which is available on the HRM section of the Risk Management Web site.

Trevor Pollitt of American Republic Insurance Co. heads the charge on solvency. His group is putting together an RFP to have research done on the risks that provider networks pose to solvency.

Doug Fearrington of Anthem is leading the effort to improve our models. He is devoting his efforts to applying stochastic techniques to health insurance models. He will be speaking on this topic at the spring meeting in Anaheim. If anyone is interested in joining any of these groups please contact me or the appropriate group leader.

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Modeling Equity Risk Subgroup

Before the Risk Management Section existed, there was a special task force on Risk Management that was formed and headed up by David Ingram in 2001. One of the first activities of this task force was to create some working groups with various risk topics to address on behalf of, and through the extensive resources of, the SOA membership.

The working group on modeling equity risk first met in May 2002 with the following mandate:

"Prepare a guide to modeling and managing equity risk. Such a guide would include explanations of modeling tools and techniques, discussions of limitations and applications of these tools, review of equity-based products and risks, commentary on tools and approaches to manage equity risk and descriptions of hedging techniques."

Accordingly the group set out to prepare an annotated reading list, covering four main topics—theoretical background, modeling returns, measuring risk and managing risk for equity-based products commonly offered in the life insurance industry. The reading list has now been prepared and edited and is available to the SOA membership on the Web site at *http://rmtf.soa.org/rmtf_em.html*.

The work of modeling equity risk is an ongoing challenge to the profession, and practitioners are urged to contact David Ingram or Valentina Isakina at the Society of Actuaries (***visakina@soa.org***) if they wish to carry on the torch. Topics would include more analysis of equity models and their use, the generation of long-term equity returns for models, historical versus arbitrage-free models and comparison of insurance markets to the options and futures markets. Possible initiatives could include the development of a prototype model for use by the SOA membership.

While many SOA members were correspondents for the working group on equity modeling,

special thanks are owed to the following group members who were active participants at various points in time in developing the work product: Michael Bean, Kitty Ching, Andy Chua, Martin Hall, Geoff Hancock, Charles Hill, Novian Junus, Martin le Roux, Rob Stone and Darin Zimmerman.
—Josephine Marks

Risk Metrics Subgroup

The Risk Metrics Subgroup is led by Fred Tavan who can be reached at ***fred_tavan@canadalife.com***. It is made up of members from both the SOA and CAS. It meets every three weeks through a conference call organized by the SOA. The main objective of the Risk Metrics Subgroup is to identify different metrics that can be used to quantify the level of various risks across an organization. The group's scope goes beyond financial risks such as credit, market and insurance risks into operational, reputational, regulatory and litigation risks in order to take an enterprise view of risk. There are a variety of risk metrics available on financial risks, and this is typically a good place for companies to start building their ERM program, however, the actuarial profession also needs to educate itself on other types of risk that have an impact on financial institutions. One of the main goals of the Risk Metrics Subgroup is to facilitate this educational process for members of the SOA and CAS.

The subgroup has developed a number of papers on various risk metrics, and these are posted on the Web at ***http://rmtf.soa.org***. Once at the Web site the user needs to select Subgroup and then Risk Management Metrics to see the list of papers.

The subgroup is currently working on developing a risk metrics database that allows a user to query and report on different risk metrics that can be used for a specific risk subcategory within a predefined risk management framework. The federal reserve risk management framework with AAA extension has been chosen as the risk management framework for doing the mapping, however, the database also contains the COSO framework and the IAA framework. About 60 different risk metrics have been identified so far and work is ongoing to add to this list. The database will also ultimately contain references to various sources of reading material on how each risk metric can be applied in measuring risk within an organization. These tools will allow a user to identify quickly which risk metrics can be relevant to their work and then learn about how to start using them in practice. The database is a work in progress and thanks to all the volunteers who have helped in getting it off the ground. Special thanks go to the key contributors to the database so far and these individuals are: Cliff Angstman (Berkshire Life), Ellen Hall (ING), David Ingram (Milliman), Julie Perks (Sun Life), David Ruhm (The Hartford) and Fred Tavan (Canada Life Re.).

Subgroups

Credit Risk Management—Dave Ingram
Economic Capital—Jenny Bowen
Enterprise Risk Management—Mark Shaw
Equity Modeling—Josephine Marks
Extreme Value Models—Tom Edwalds
Health Risk Management—John Stark
Policyholder Behavior in the Tail—Jim Reiskytl
Pricing for Risk—Novian Junus
Risk-Based Capital Covariance— Jim Reiskytl
Risk Management Metrics—Fred Tavan

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2004 ERM Symposium

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- identify how the consequent changes in this return surface affect shareholder value.

Next Steps for the Symposium

The attendance, the quality of the sessions, the profoundness of the issues discussed and the variety of different perspectives offered at the symposium—all confirmed that ERM is here to stay and that the subject is worthy of more symposiums to come.

The 2005 ERM Symposium Organizing Committee has been formed, and it is pleased to announce that the tradition will continue: the 2005 ERM Symposium will be held in Chicago in late April.

Mark your calendars and bring your ideas!!! ✦

RMTF Subgroup

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New volunteers are encouraged to join the subgroup. You may join the Risk Metrics Subgroup listserve by contacting Julie Young at the SOA (*jyoung@soa.org*). The listserve provides its members with the conference call dates/times, meeting materials, and minutes to the meetings.
—Fred Tavan

Economic Capital Subgroup

The Economic Capital Calculations and Allocation (ECCA) subgroup has been very productive in its two years of existence. It has been a vital forum for the exchange of views and news regarding both the development of economic capital (EC) as a concept and its acceptance in practical settings.

Under the leadership of Hubert Mueller, the ECCA subgroup produced an ECCA specialty guide, which can be accessed from the ECCA Web page at *http://www.soa.org/sections/rmtf/rmtf_ecca.html*. The specialty guide is an overview of several aspects of economic capital. It is a great starting point, but it also situates economic capital in the context of its many possible uses, going so far as even offering alternative definitions that are currently in use.

The body of the document is very straightforward, while the annotated bibliography provides thoughtful guidance to those seeking more in-depth treatment of particular topics. The body of the document treats economic capital primarily from a practical viewpoint, while the bibliography includes resources that can offer more rigorous theoretical treatment. Many people contributed to the review of the literature covered in the bibliography. The annotations offer meaningful guidance regarding how helpful each publication might be toward meeting particular needs. Brett Roush not only contributed to the annotations, but also brought the bibliography to life as a high-quality, finished product.

It is no surprise that the ECCA specialty guide has been included in the syllabus for the new SOA Risk Management exam, which will be offered this fall under the Investment Track.

“The Economic Capital Calculations and Allocation (ECCA) subgroup has been very productive in its two years of existence. It has been a vital forum for the exchange of views and news regarding both the development of Economic Capital (EC) as a concept and its acceptance in practical settings.”

We included non-actuaries in the ECCA subgroup, particularly representatives of all major rating agencies, whose insights and updates expanded members’ perspectives. It also became apparent that all rating agencies are very interested in developments in this area.

We found that there were many people thirsting for knowledge about practical approaches to ECCA. We agreed that it was difficult to extract from the available literature specific methodologies that could be generalized or even compared. It seemed as though each demonstration was either too specialized and included too many non-transferable assumptions or was just too complicated to break down into comparable elements.

We attempted to enlist the help of practitioners who would apply their ECCA methodology to relatively simple sample case studies, so that the differences could be compared and explained. What we found was that most practitioners either had not yet found just the right method to meet their own needs, or were not yet ready to share them.

We have concluded that the discipline of ECCA is still too immature for us to find meaningful, dependable “best practices” that we can analyze and share in an effort to help actuaries bridge the gap between theory and the “real world.” Therefore, we have decided to disband our subgroup for now, with the idea that in 12 to 18 months there may have been sufficient progress in this area to support a survey of best practices.

As evidence that EC is a vital topic that continues to gain attention, Hubert and Brett have provided the following updates regarding recent regulatory efforts to determine risk-based capital, using proprietary company models consistent with the determination of EC.
—Jenny Bowen

Extreme Value Models (EVM)

The main objective of the Extreme Value Models (EVM) subgroup of the Risk Management Task Force (RMTF) is to enhance the knowledge base of the actuarial profession concerning extreme event risks. Extreme events have very low frequencies (e.g., once-a-century) but extraordinarily high costs. In

pursuing this objective, the EVM subgroup has two goals:

- to increase the actuarial profession's awareness of these extreme risks and of the pitfalls of using simplistic methods to assess these risks; and
- to provide education and tools needed to quantify, manage and price the risks associated with extreme-valued outcomes.

At the recent Bowles Symposium on Enterprise Risk Management, jointly sponsored by Georgia State University, the Society of Actuaries and the Casualty Actuarial Society, the EVM subgroup organized an embedded mini-seminar on Extreme Value Theory. Professor H. N. Nagaraja, Ph.D., of Ohio State University and Steve Craighead, FSA, of Nationwide Insurance presented three breakout sessions, instructing attendees about actuarial applications of the theory of order statistics, the three basic extreme value models and their generalization and methods of inference using extreme value models. Handouts from these sessions, including a spreadsheet illustrating the techniques covered, are available on the Web at ***http://www.casact.org/coneduc/erm/2004/handouts/***.

Other resources on extreme risks, including the essays entered into the X-treme Actuary contest sponsored by the EVM subgroup last summer, can be found on the EVM subgroup page of the RMTF section of the Society of Actuaries Web site, ***http://rmtf.soa.org/rmtf_evm.html***.
—Tom Edwalds

Pricing for Risk

The stated goals of the Pricing for Risk subgroup (PFR) are to:

- Evaluate the effectiveness of different pricing techniques as to their ability to capture and quantify the risks associated with the sale and administration of life and annuity products
- Document and provide guidance to actuaries for when a given technique or measure may be appropriate and the limitations of its use

In fall of 2002 the PFR, under the leadership of Todd Henderson, performed a survey of how actuaries currently reflect risk in pricing. The actuaries surveyed are members of the Investment and Individual Life and Annuity Product Development sections. The completed survey and results can be found in the PFR section of the Risk Management Task Force (RMTF) Web site. The general observation is that asset-related risk has a higher tendency to be modeled, but liability-related risk is more often stress tested; relying more heavily on judgment in assessing risk.

The PFR's current proposed objective is to develop a specialty guide that:

- Identifies the common profit measures used in the insurance industry and the common methods for reflecting risk
- Provides actuaries with relevant information on those risks that have not been traditionally considered in their pricing models
- Include recommended readings that provide indications of how to price each of the risks and how they should be incorporated directly and interactively or independently with traditional actuarial risk models
- Identifies gaps in current literature and practice with regard to pricing for risk.

The PFR is currently discussing the scope of the specialty guide; whether it is in the form of an annotated reading list or as comprehensive as the ALM specialty guide. We are also looking into the possibility of funding a research project to develop the specialty guide that the PFR will direct.

The stated goals of the subgroup seem rather daunting and the current objective is a step toward achieving those goals. The results of the survey and the regulatory movement toward stochastic reserving and capital (C3 RBC Phase II, AG 39, etc.) indicate that the goals are relevant. If you feel the same and are interested in participating please e-mail ***pfrlistserv@list.soa.org***. ✦
—Novian Junus

Risk Management Skills and Aptitudes

by H. Felix Kloman

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Skills and Aptitudes

What are the skills we need in the future? I heard this question twice in the past eight months, first from a parent of a junior enrolled in a sailing program in Tenants Harbor, Maine, and later from a risk manager in Seattle, Wash. The answer, I think, is found not so much in specific skills as in aptitudes.

Take sailing, for example. The skills that we teach and that are required to handle a small boat successfully in various types of weather and sea conditions include being able to swim, knowing the parts of a boat and its rigging, understanding how sails work, sailing a boat both upwind and downwind, knowing what to do in the event of a person overboard or a capsize, leaving and returning from docks and mooring, tying the correct knots and understanding weather, tides and currents. These are specific and necessary skills that are easily taught. More important, however, are the aptitudes that serve as the foundation for these skills. Independence is the first: the willingness to step out on your own. Patience is the second: understanding that a sailboat cannot go directly upwind, nor can it move when there is no wind. And third is teamwork: sailing and racing a small boat requires exquisite timing and cooperation in order to do well. Without these three aptitudes, a sailor literally may be lost at sea.

My sailing analogy applies equally to the discipline of risk management. Again, independence comes first. In its current evolution as an integrated and strategic process throughout any enterprise, its "champion" and guide ***must*** be independent of conventional staff and operating functions. Too many organizations attempt to force risk management into finance where it becomes both dependent and restricted. Independence begins with a fresh and broad view of "risk" itself. It is not, as too many safety, finance and insurance practitioners construe it, merely a "chance of loss." It must be viewed as encompassing the unexpected, both favorable and unfavorable. Risk is "a measure of the possibility of unexpected outcomes." Under this definition risk management becomes "a discipline for dealing with uncertainty," a far more strategic approach than as construed by the narrow confines of finance, insurance, safety, quality control and business recovery planning. Risk management independence thus requires a leader who has a direct reporting relationship to ***both*** the CEO and the organization's governing board. Only in this way can that leader raise unpopular and even dangerous risk issues, those risk issues that are truly material to the future of the organization.

As an example, the most pressing current issue is that of excessive executive compensation. Too many organizations have allowed their senior management reward systems to skyrocket out of control, to obscene levels. CEOs are naturally unwilling to take action and compliant boards exacerbate the problem. The result: regulators, shareholders and stakeholders lose confidence in management. We need chief risk officers who are both able and willing to address these and similar, larger strategic issues and who, at the same time, can present these issues intelligently and dispassionately to critical board committees. Otherwise, we will continue to focus on relatively minor risks to the exclusion of those that materially affect our futures. As David Godfrey, the CRO for Swiss Reinsurance Company, said recently, "And from time to time you (the CRO) need the ability to say, 'I'm sorry, but I don't agree with what you say.' If you (the CRO) only report to the CEO, it's very difficult to go beyond that in order to express disagreement, if the channels aren't there already to do so." (See "ERM, Operational Risk and Risk Management Evolution," in *GARP Risk Review,* March/April 2004).

Lesley Daniels Webster, the executive vice president and global head of market risk at JPMorganChase, echoed this theme when she emphasized the necessity of a CRO having the

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"willingness and ability to criticize senior and operating management when required" (speech at the GARP 2004 Conference, February 25, 2004).

The Economist stated the issue of trust and independence most succinctly in its April 22, 2000 issue (I quoted it earlier in *RMR* April 2001): "There may be two good reasons for companies to worry about ethical behavior. One is anticipation: bad behavior, once it stirs up a public fuss, may provoke legislation that companies will find more irksome than self-restraint. The other, more crucial, is trust. A company that is not trusted by its employees, partners and customers will suffer."

Independence of risk management is necessary to permit and stimulate both strategic perspective and the courage to speak out when required. It is an aptitude that transcends specific skills.

My second aptitude, drawn from sailing, is patience. When the wind isn't favorable, you may have to anchor and wait for it to change. For centuries the Chinese used bamboo as a comparable example. In a storm the bamboo shaft bends but doesn't break, springing back to its normal position when the winds subside. Patience implies a long-term view of an organization and its future. One of the most pernicious current problems is the overfocus, even paranoia, on "shareholder value" and near-term stock prices. We have succumbed to a mass frenzy trying to outdo each other in managed earnings and artificial stimulation of the daily prices posted in New York, London, Frankfurt and Sydney. The patient CRO understands the long-view of an organization's responsibility to its stakeholders, including shareholders, one that may reach out as far as 20 to 30 years. Patience means revising the goal of risk management (and the organization itself) to "building and maintaining stakeholder confidence." "Shareholder value" is only a piece of this equation, with all respect to the University of Chicago theories of economic practice.

If a CRO accepts this basic thesis, then it follows that the three basic objectives of risk management must be:

- **Credibility:** Communicating the nature of risks, both favorable and unfavorable, with stakeholders, and their responses, to enhance the support of these groups for the organization.

- **Resilience:** Building an internal and external flexibility so that the organization can respond to whatever unexpected event may occur, and in many cases actually taking advantage of a downside event to improve market position.

- **Perspective:** Countering the prevailing over-focus on the short-term. Here Peter Schwartz's *The Art of the Long View* (Doubleday, 1991) remains one of the best expositions of long-term perspective.

Patience, however, has an Achilles heel. Most of the prevailing metrics for measuring the success or failure of a risk management function are cast in short-term numbers. VaR is one of these, and it, like many others, is flawed. No one has yet developed a consistent and accepted metric for measuring the longer-term results of risk management. We need one and we may be condemned to the short-term until and unless we can create a new measure.

My third aptitude is teamwork. Because tactical risk management embodies so many different skills, it makes good sense for its practitioners to reach out and try and understand the problems and solutions of others. While we are making some progress within organizations toward breaking down the artificial barriers that kept us from communicating with one another, too many of our major associations of risk management players continue to operate behind impregnable fortresses. Most are unable, even unwilling, to bring representatives of their counterpart groups to their annual conferences and local chapter meetings. The result is an appalling lack of knowledge of the work of others. Last December, I asked an audience of some 40 members of the Society for Risk Analysis how many had even heard of GARP, Professional Risk Manager's International Association (PRMIA) or RIMS. Two hands were raised. I questioned registrants

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My second aptitude, drawn from sailing, is patience. When the wind isn't favorable, you may have to anchor and wait for it to change.

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at the February 2004 GARP meeting: few had heard of SRA or RIMS. Then, at a RIMS chapter meeting in Seattle in March, I asked the same question of over 100 registrants. Only one was also a member of GARP; none were members of PRMIA or SRA. Many members of one association had not even heard of the other groups. This is the worst sort of parochialism.

Many specialist skills are required for risk analysis, the first step in the process (the identification of possible unexpected events; their measurement in terms of likelihood, timing, consequences and public perception; and their assessment relative to an organization's objectives). They include scenario analysis, quantitative and probabilistic analysis, actuarial science, data management, knowledge of the law, econometric modeling, intuition and the use of heuristics and, of course, the value of experience. Similarly, another set of skills is employed in risk response, the second step in the process (controls adopted to balance upside and downside risk; measuring and monitoring performance; and communicating with stakeholders). These skills include knowledge of safety and quality systems (Six Sigma), audit and accounting controls, environmental controls, behavioral economics (financial incentives and penalties), contingency and crisis management (business recovery planning), and financing (credit, derivatives, hedging, pooling, use of capital markets, insurance and claims management). It is too much to ask any one person to be fully conversant and expert in all these fields. This makes teamwork the mandatory aptitude. It is high time that the IIA, GARP, PRMIA, RMA, CAS/SOA, SRA, RIMS/International Federation of Risk and Insurance Management Associations (IFRIMA) and American Society of Safety Engineers (ASSE), among others, cease their guild-like restrictiveness and reach out to their counterparts, expanding the scope of our discipline.

Swiss Re's David Bothwell addressed the question of skills in a similar fashion: "They (risk officers) have to have skills that are seen to be relevant and at a high level. They have to be seen to be balanced, to look at the total picture, assessing the opportunity, which the deal-doer is telling you is the greatest thing since sliced bread, while at the same time balancing that with the broader picture. Risk managers have to be able to articulate well their reasoning for a particular position or view-point. Risk managers have to be consistent—or they will lose respect, but in the final analysis, they ultimately have to be prepared to stand up and say no."

> "The major chanllenge for any risk management team is the prevailing failure to communicate intelligently and coherently with all of our stakeholder groups."

The major challenge for any risk management team is the prevailing failure to communicate intelligently and coherently with all of our stakeholder groups. Last month (April 2004), I described the Bank of Montreal's exceptional eight-page description of its internal risk management program. Too few organizations attempt even this. I know of no organization that employs a consistent and effective continuing two-way dialogue with its stakeholder groups on its analysis of risks and its responses. Perhaps improved teamwork among the existing risk management groups can develop a better means of communication.

Academic institutions are a critical part of the teamwork equation. More are beginning to stretch their formerly narrow programs (finance, insurance, public policy, engineering) to incorporate ideas and methods from the other sub-disciplines. I hope that many of the association-run certification programs will also acknowledge their competitors and expand their curricula to include, as least nominally, other ideas and techniques.

Independence, patience and teamwork are three critical aptitudes for those who purport to practice this evolving discipline of risk management. Within them one can develop other technical skills; without them, these skills are meaningless. ✦

A Case Study in Risk Management: U.S. Monetary Policy

by Henry McMillan

In January 2004, Chairman Alan Greenspan spoke to the American Economic Association about "Risk and Uncertainty in Monetary Policy." In this speech, Chairman Greenspan referred to risk management as a central element in the conduct of monetary policy in the United States. The complete text is at *http://www.federalreserve.gov/boardocs/speeches/2004/20040103/default.htm* and is easy and insightful reading.

I attended the talk and thought it would be interesting to our section membership to hear how the Fed Chairman views risk management. As we define and delineate the scope of risk management in the actuarial profession and our traditional industries and seek to expand our influence beyond the traditional boundaries, we need to remember that many other industries also use "risk management" to describe their activities. We should understand how we view risk management similarly to and differently from others. In this note I quote Chairman Greenspan liberally and provide my interpretation of his comments.

Chairman Greenspan gave his talk in a hotel ballroom in front of several hundred academic, government and private sector economists. He began by recounting the "key developments of the past decade and a half of monetary policy in the United States from the perspective of someone who has been in the policy trenches." He discussed major policy events and decisions during his tenure and during that of his predecessor, Chairman Paul Volcker.

Midway through his talk, he began to explain in general why decisions were made—that they were an application of risk management.

> *"As a consequence, the conduct of monetary policy in the United States has come to involve, at its core, crucial elements of risk management. This conceptual framework emphasizes understanding as much as possible the many sources of risk and uncertainty that policymakers face, quantifying those risks when possible, and assessing the costs associated with each of the risks. In essence, the risk management approach to monetary policymaking is an application of Bayesian decision making."*

It is noteworthy that Chairman Greenspan emphasizes risk management as a conceptual framework, not as a task or modeling exercise. It is a way of formulating and addressing questions, a way of thinking that we, as actuaries, do as part of our professional existence, with or without formally recognizing it.

Our Bayesian decision making may not be done formally, with priors and posteriors and conjugate distributions, but we all intuitively put more or less weight on recent experience in some proportion to the extent of our prior experience. And I presume that is what policymakers at the Fed do also.

Greenspan next discussed the notion of strategy as applied to risk management.

> *This framework also entails devising, in light of those risks, a strategy for policy directed at maximizing the probabilities of achieving over time our goals of price stability and the maximum sustainable economic growth that we associate with it. In designing strategies to meet our policy objectives, we have drawn on the work of analysts, both inside and outside the Fed, who over the past half century have devoted much effort to improving our understanding of the economy … A critical result has been the identification of a relatively small set of key relationships that, taken together, provide a useful approximation of our economy's dynamics….*

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Risk management involves strategy, not merely risk assessment, which involves measurement. Objectives and measurement are all part of the process, and the process is inherently an approximation.

> *However, despite extensive efforts to capture and quantify what we perceive as the key macroeconomic relationships, our knowledge about many of the important linkages is far from complete and, in all likelihood, will always remain so. Every model, no matter how detailed or how well designed, conceptually and empirically, is a vastly simplified representation of the world that we experience with all its intricacies on a day-to-day basis.*

We have enough problems trying to model policyholder behavior. Imagine trying to think of everything that everyone does. You come to accept that it's not the size of your model, but the huge uncertainty surrounding what you're trying to model.

Earlier in his talk Greenspan had referenced a commonly used distinction between risk and uncertainty due to Frank Knight, an economist active in the '20s and '30s.

> *The term "uncertainty" is meant here to encompass both "Knightian uncertainty," in which the probability distribution of outcomes is unknown, and "risk," in which uncertainty of outcomes is delimited by a known probability distribution. In practice, one is never quite sure what type of uncertainty one is dealing with in real time, and it may be best to think of a continuum ranging from well-defined risks to the truly unknown.*

In our models we have to define and use a distribution, even though we may not know that it is the correct distribution. We shouldn't lose sight of the fact that quantified may only mean that some quantity has been determined, conditional on the assumed underlying distributions, behavioral assumptions and institutional arrangements, which may be unknown or uncertain in the above sense.

"We shouldn't lose sight of the fact that quantified may only mean that some quantity has been determined, conditional on the assumed underlying distributions, behavioral assumptions and institutional arrangements, which may be unknown or uncertain in the above sense."

Greenspan then turns to how one makes decisions if everything is not known.

> *Given our inevitably incomplete knowledge about key structural aspects of an ever-changing economy and the sometimes asymmetric costs or benefits of particular outcomes, a central bank needs to consider not only the most likely future path for the economy but also the distribution of possible outcomes about that path. The decision makers then need to reach judgment about the probabilities, costs and benefits of the various possible outcomes under alternative choices for policy.*

One should not be surprised to hear an economist use the phrase "costs and benefits" in a public address. Indeed there was an almost palpable relief among the audience when Greenspan anchored his ship to the solid rock of economic orthodoxy.

Chairman Greenspan did not say that stochastic analysis is necessary for effective monetary policy. However, it is quite clear that single-path analysis is not sufficient for monetary policy. Actuaries would probably agree that single path analysis is not adequate for pricing insurance products or for selecting investment strategies to back pension liabilities. What Greenspan is leading up to is that the extent of uncertainty and risk causes us to choose actions that would not be optimal if we knew more—more about the true nature of the economy and more about where the economy is headed in the absence of the Federal Reserve's actions.

> *A policy action that is calculated to be optimal based on a simulation of one particular model may not, in fact, be optimal once the full extent of the risk surrounding the most likely path is taken into account. In general, different policies will exhibit different degrees of robustness with respect to the true underlying structure of the economy.*
>
> *For example, policy A might be judged as best advancing the policymakers' objectives, con-*

ditional on a particular model of the economy, but might also be seen as having relatively severe adverse consequences if the true structure of the economy turns out to be other than the one assumed. On the other hand, policy B might be somewhat less effective in advancing the policy objectives under the assumed baseline model but might be relatively benign in the event that the structure of the economy turns out to differ from the baseline.

One insight that I take from these comments is that you need to consider "what if" your model is wrong. A particular investment or hedging strategy might appear very appealing in one model, but if the strategy is not robust, if it is too sensitive to parameter estimates or model structure, then it is not likely to turn out to be as good as you thought it would be. For example, a strategy involving multiple long and shorts of futures and options contracts to offset interest rate risk and volatility could be quite wrong or ineffective if the hedging ratios or positions are too highly dependent on a covariance matrix that is estimated with error.

In the next few paragraphs Greenspan makes statements suggestive of tail risk analysis that is increasingly used among actuaries.

As this episode illustrates, policy practitioners operating under a risk management paradigm may, at times, be led to undertake actions intended to provide insurance against especially adverse outcomes. Following the Russian debt default in the autumn of 1998, for example, the FOMC eased policy despite our perception that the economy was expanding at a satisfactory pace and that, even without a policy initiative, it was likely to continue doing so. We eased policy because we were concerned about the low-probability risk that the default might trigger events that would severely disrupt domestic and international financial markets, with outsized adverse feedback to the performance of the U.S. economy.

The product of a low-probability event and a potentially severe outcome was judged a more serious threat to economic performance than the higher inflation that might ensue in the more probable scenario.

Such a cost-benefit analysis is an ongoing part of monetary policy decision making and causes us to tip more toward monetary ease when a contractionary event, such as the Russian default, seems especially likely or the costs associated with it seem especially high.

A parallel to the inflation/liquidity crisis dilemma might be short-run GAAP earnings versus longer term statutory solvency facing risk managers choosing to use derivatives in an accounting challenged world.

Perhaps another view is that we get so caught up in the more likely events that we underestimate or ignore the low-probability events that can and do occur. Greenspan further notes that human behavior changes in crisis events, something that should be acknowledged and incorporated into the risk management process.

The 1998 liquidity crisis and the crises associated with the stock market crash of 1987 and the terrorism of September 2001 prompted the type of massive ease that has been the historic mandate of a central bank. Such crises are precipitated by the efforts of market participants to convert illiquid assets into cash. When confronted with uncertainty, especially Knightian uncertainty, human beings invariably attempt to disengage from medium to long-term commitments in favor of safety and liquidity. Because economies, of necessity, are net long—that is, have net real assets—attempts to flee these assets cause prices of equity assets to fall, in some cases dramatically. In the crisis that emerged in the autumn of 1998, pressures extended beyond equity markets. Credit-risk spreads widened materially and investors put a particularly high value on liquidity, as evidenced by the extraordinarily wide yield gaps that emerged between on-the-run and off-the-run U.S. Treasuries.

We typically allow for changing policyholder behavior as gaps between credited rates and market rates expand, but do we also allow for

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changing behavior in crisis situations? It seems that knowing what is in the model, and what is left out, combined with more qualitative thinking is all that can be done and what must be done.

Chairman Greenspan then turns to a discussion relating models to risk management, and the role of policy rules in risk management.

> *The economic world in which we function is best described by a structure whose parameters are continuously changing. The channels of monetary policy, consequently, are changing in tandem. An ongoing challenge for the Federal Reserve—indeed, for any central bank—is to operate in a way that does not depend on a fixed economic structure based on historically average coefficients. We often fit simple models only because we cannot estimate a continuously changing set of parameters without vastly more observations than are currently available to us. Moreover, we recognize that the simple linear functions underlying most of our econometric structures may not hold outside the range in which adequate economic observations exist. For example, it is difficult to have much confidence in the ability of models fit to the data of the moderate inflations of the postwar period to accurately predict what the behavior of the economy would be in an environment of aggregate price deflation.*

Seems like there are a lot of lessons here for risk management in insurance companies and pension plans. We must expect change in estimated parameters and in behavior and in legal environments and so on. Model estimates from a previous era may not fit the current era. Calibration of a model to historical data may inadvertently straitjacket risk management if we do not allow the future to look different from the past.

But if the past is not prologue, what are we to do? Greenspan offers his pragmatic approach.

> *In pursuing a risk management approach to policy, we must confront the fact that only a limited number of risks can be quantified with any confidence. And even these risks are generally quantifiable only if we accept the assumption that the future will, at least in some important respects, resemble the past. Policymakers often have to act, or choose not to act, even though we may not fully understand the full range of possible outcomes, let alone each possible outcome's likelihood. As a result, risk management often involves significant judgment as we evaluate the risks of different events and the probability that our actions will alter those risks.*

So does the future resemble the past? It's a hard question for an economic policymaker. It is perhaps even harder for an individual risk manager because the financial markets depend on the behavior of the economic policymaker too. An investor's world changes if the Federal Reserve changes its behavior, regardless of whether the economic world is fundamentally changed. That is, an investor must consider not only whether the world has changed, but also whether the Federal Reserve's view of the world has changed.

Certainly company executives must make decisions before our models are final or perfected or even ready for prime time. Judgments are part of real life, and must be factored into the risk management process, even if only qualitatively or judgmentally.

Greenspan notes that rule-based behavior has value, but can be overvalued if evaluated in the context of theoretical models rather than actual policy worlds.

> *Some critics have argued that such an approach to policy is too undisciplined—judgmental, seemingly discretionary and difficult to explain. The Federal Reserve, they conclude,*

should attempt to be more formal in its operations by tying its actions solely, or in the weaker paradigm, largely, to the prescriptions of a simple policy rule…. And the prescriptions of formal rules can, in fact, serve as helpful adjuncts to policy, as many of the proponents of these rules have suggested. But at crucial points, like those in our recent policy history—the stock market crash of 1987, the crises of 1997-98, and the events that followed September 2001—simple rules will be inadequate as either descriptions or prescriptions for policy. Moreover, such rules suffer from much of the same fixed-coefficient difficulties we have with our large-scale models.

So many investment houses attempt to model the Fed's behavior, and thereby gain an edge in their investment strategy. It's not clear whether they want the Federal Reserve's behavior to be more transparent—thereby making the forecasting of Federal Reserve behavior easier—or to be even more clouded—thereby making the value of a correct forecast just that much higher.

At any rate, Greenspan appears to feel that rules are good, but meant to be broken. Judgment must rule the day.

To be sure, sensible policymaking can be accomplished only with the aid of a rigorous analytic structure. A rule does provide a benchmark against which to assess emerging developments. However, any rule capable of encompassing every possible contingency would lose a key aspect of its attractiveness: simplicity. On the other hand, no simple rule could possibly describe the policy action to be taken in every contingency and thus provide a satisfactory substitute for an approach based on the principle of risk management.

At this point Greenspan provides some ammunition for those of us who want some discipline in risk management and its associated modeling. In short, we must remember his audience: academic economists, a group that might make an SOA Section Council seem exciting. Greenspan has been saying that models and rules, by themselves, are not the answer. One should not, therefore, conclude that no models and no rules are the answer. Greenspan wants good models and good rules, but also judgment and discretion. Undoubtedly, he feels that he has something to contribute to the risk management process known as monetary policy.

As I indicated earlier, policy has worked off a risk management paradigm in which the risk and cost-benefit analyses depend on forecasts of probabilities developed from large macromodels, numerous sub-models, and judgments based on less mathematically precise regimens. Such judgments, by their nature, are based on bits and pieces of history that cannot formally be associated with an analysis of variance.

Yet, there is information in those bits and pieces. For example, while we have been unable to readily construct a variable that captures the apparent increased degree of flexibility in the United States or the global economy, there has been too much circumstantial evidence of this critically important trend to ignore its existence. Increased flexibility is a likely source of changing structural coefficients.

So, could we say that not only does he rely on data, but his knowledge of how data are produced and collected. From that knowledge he and others at the Federal Reserve use qualitative adjustments to quantitative models and recommendations to arrive at the actual policy that is implemented. He sums up this portion of his talk—that it's not that we're complex, it's that the world is complex.

Our problem is not, as is sometimes alleged, the complexity of our policymaking process, but the far greater complexity of a world economy whose underlying linkages appear to be continuously evolving. Our response to that continuous evolution has been disciplined by the Bayesian type of decision-making in which we have engaged.

Chairman Greenspan continued his remarks on the role of forecasting, inflation targeting and future challenges for policy makers. He closed the presentation with a question and answer period.

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So many investment houses attempt to model the Fed's behavior, and thereby gain an edge in their investment strategy.

Influenza Pandemics: Are We Ready for the Next One? What Actuaries Can Learn From 1918

By Max J. Rudolph

This article summarizes a presentation given at the 2004 ERM Symposium by the author along with David Ingram. Opinions expressed are those of the author and not his employer or any other organization he is affiliated with. It is not a refereed paper and does not substitute for doing your own research on the topic. The author is indebted to the researchers who wrote the books referenced, to SOA librarian Ellen Bull (an underutilized but wonderful resource for actuaries) and to David Ingram, whose interest in the subject and initial research helped to jump-start this project.

Introduction

Tail risk has gotten the actuarial profession's attention. With supposedly 10 Sigma events occurring almost every year and contagion risk consistently underestimated, best estimate assumptions using a single economic scenario are not sufficient. Many practitioners have known this for years, but technology now allows actuaries to model and manage these risks. These models generally use a combination of stochastic and deterministic scenarios. Interest rates and equity returns are often modeled deterministically to address specific risks and stochastically to cover the universe of possibilities. Risks as diverse as earthquakes and anthrax attacks can be similarly modeled.

Mortality risk is generally tested deterministically, with specific concerns stress tested. For life insurance products, stresses of 110 percent of base mortality are commonly used for external projects like asset adequacy testing. Recent discussion has focused on the very real risk of bioterrorism, with geographical concentrations of exposure creating the risk. Hopefully there will never be enough "data points" to fit a distribution for these risks, but some hypotheses can be modeled. Either a dirty bomb or water poisoning are examples that could present a major disruption to a state, province or other geographical region, but it is unlikely that such an event would be either national or worldwide in scope. Even a natural disaster like an eruption of Mt. Rainier or a large earthquake in California would impact a limited region. Only an outbreak of a disease that is both highly contagious and lethal could affect global populations materially. One might think, with today's medical tools and research labs, that such an outbreak could be easily contained. While medical knowledge has improved greatly since then, in 1918 such an outbreak of disease occurred that remains untreatable even today. It was influenza.

This article, while not a formal book review, takes much of its information from three books. All are very readable and provide slightly different perspectives. *America's Forgotten Pandemic*, by Alfred W. Crosby and first published in 1976, follows the story through America's cities as the virus spread and mutated. It was the definitive book on the topic until recently. The second book, *Flu: The Story of the Great Influenza Pandemic of 1918 and the Search for the Virus that Caused it*, by Gina Kolata (science editor for the *New York Times*) and published in 1999, describes the pandemic but also tells a true detective story. Several groups, working independently, raced to isolate the virus that caused this particularly virulent strain of influenza and their stories are told here. The third book was released in 2004 by John M. Barry, titled *The Great Influenza: The Epic Story of the Deadliest Plague in History.* It includes both advances made in the past 30 years as well as some new investigative work that convinced me that this virus originally presented itself in the United States. It will quickly become the standard bearer for this topic and a must read for anyone determined to learn from the mistakes made in the past.

Actuarial Interest

What makes the 1918 influenza pandemic (epidemic is within a country or region, pandemic is worldwide) so interesting to actuaries is the excess mortality curve. While the other epidemics of the 20th century were lethal to the old and most, but not all, caused extra mortality for the very young, only in 1918 did those aged 20-40 experience material excess mortality. When a whole life policy is several years old and the pol-

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icyholder's attained age is high, reserves have built up and the net amount at risk (NAAR) is much smaller than the face amount of the policy (face amount = reserve + net amount at risk). With group life, sold as annual renewable term (ART) to all employees at many firms, the net amount at risk is a large percentage of the face amount. And reinsurers generally provide ART coverage to direct writers. As a profession we spend a lot of time studying tail risk of equity-based and casualty products. However, the greatest tail risk of all for insurers might be a product most life insurers and reinsurers have been happy selling for years as a core product, life insurance.

How it could happen

Several months ago the Extreme Values Subgroup of the SOA's Risk Management Task Force had a contest to describe an extreme event. In my entry I described a college all-star soccer camp held in the Midwest over semester break in late December. One of the campers isn't feeling well, but this camp increases his chance to make the U.S. National Team and it is worth playing even while feeling a little sluggish. The campers sleep in bunk beds set up in a gym. They spend all their time together, making many new friends. After the camp everyone flies back to his home to finish the rest of break, and then returns to their respective universities. No one realizes that all of them are now infected with influenza and contagious. Before anyone knows it an influenza outbreak has occurred. How can society stop this scenario? It can't, and that is what is so scary about influenza.

Pandemic Basics

Every year approximately 30,000 Americans die from the flu. Most are very old or very young, with immune systems that are either not as strong as they once were or as they will become. Many get sick and spend a few days in bed to rest and recover. Few in the prime of life die from it. The general pattern is high morbidity and low mortality. Occasionally, perhaps five times per century, the virus mutates into a form that is either more contagious or experiences higher mortality. About once every century or two it takes a form that history remembers. This last happened in 1918, when 600,000 Americans and up to 100 million people worldwide died, most over the course of less than three months. While history is very likely to repeat itself, and the odds seem to increase over time, the more we know about the last pandemic the better we can deal with the

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U.S. Monetary Policy

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In listening to Chairman Greenspan I found so many insights and applications of his comments to my work that I thought you all might feel the same. In trying to summarize what I take from his comments, here's the Top Ten:

1. Risk management is a conceptual framework.
2. Use your models as tools, as means to an end, not the end.
3. The simpler the better.
4. But the world's complex so even the simplest models might need to be complicated.
5. Robust is better than precise.
6. Rules help, but judgment matters too.
7. Know what you know and know what you don't know and never confuse one with the other.
8. Don't confuse the future with the past.
9. Avoid a big mistake from which you can't recover.
10. Never stop learning.

Now, I'm not going to run out and campaign to be the next Federal Reserve Chairman. But if that's your dream, go for it. ✦

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next one. Unfortunately, when I speak with practicing physicians they have only cursory knowledge of the 1918 outbreak, often referred to as Spanish flu, and seem to assume that today's available technology and drugs make it unlikely to return.

Influenza pandemics repeat periodically. Records are not always accurate, and other diseases are sometimes confused with influenza. Pandemics were recorded in 1510, 1580, 1688, 1693 (all ages were impacted), up to six in the 1700s and at least four in the 1800s. The 1889-91 pandemic was especially strong and the most notable in the past three centuries except for 1918, which also returned in less virulent form in 1919-20.

Influenza can be very contagious. In the air after being exhaled, it can infect someone else up to a day later. On a hard surface it can remain potent for two days. Door knobs and remote controls become inadvertent killers. The only effective measures, even today, are isolation and quarantine. Doctors and nurses put their lives at risk when taking care of these patients and, to their credit, very few shirked their duties in 1918. Keep in mind that many of the top medical professionals had been called to duty for the war effort and there was a shortage of qualified practitioners at the time. This fact wasn't helped when national nursing organizations refused to support curriculums to develop practical nurses. Only recently has the medical profession developed knowledge about this particular virus and is starting to understand what made it so lethal. In 1918 they knew little more than when plague spread centuries earlier about how to treat it.

“Only recently has the medical profession developed knowledge about this particular virus and is starting to understand what made it so lethal.”

Are influenza pandemics like earthquake risk that increases with time since the last one, or is pandemic probability completely random with the likelihood just as high in the year following the most recent outbreak? Since antibodies created in one pandemic give some protection against the next one, it seems more like earthquake risk, building over time. As the last major pandemic happened over 80 years ago, it is appropriate to allocate resources to better understand influenza today.

Waves

The 1918 flu was active for several years, but mutated its form over time and created several “waves” that each traveled across most of the globe. The first wave in spring 1918 was very contagious, especially for young and healthy adults, but not very lethal, and was given little notice outside of the U.S. military camps where it thrived. It required few contacts with others to spread and took only four months to cover the globe. Africa, South America and Canada were initially spared. Those who were victims of the first wave showed resistance to later mutations of the virus, although little preparation anticipated future waves.

Author John M. Barry has traced the origins of the first wave to Haskell County, Kansas. This small farming community in southwest Kansas was missed in earlier research as a starting point for the pandemic because of an incorrectly published date of the local epidemic. Barry's research of local newspapers allowed him to track each of the outbreaks from this local epidemic, advancing to what is now Ft. Riley in Kansas, then on to other military bases and beyond.

The second deadly wave occurred in the late summer and fall of 1918. Since the “hosts” either died quickly or recovered with antibodies to fight off future contacts with the disease, in a given city the flu arrived, flourished and was gone. In cities this took six to eight weeks, while in military camps the overcrowding compressed it to three to four weeks. Within a region, the virus appeared to grow weaker over time. If a community could delay its arrival or slow the contact rate just a bit it had a material impact. As an example of the intertwined histories of the war and pandemic, the Armistice Day celebrations recognizing the end of hostilities in November 1918 touched off a second wave of the flu in many cities.

U.S. troops in Europe had half the rate of death from influenza as those in the United States. It is likely that they were exposed to the first wave and had developed some immunity. While the deaths in the western world were staggering, those in other parts of the world that had not previously been exposed to influenza were horrific.

It is estimated that 20 million deaths occurred in India alone.

The third wave started in December 1918 and had mutated such that schoolchildren were most impacted.

Life in 1918—Dominated by World War I

The times surrounding 1918 were dominated by World War I, once thought to be the war to end all wars. Influenza likely impacted this concept, but I'll get back to that later. After the United States entered the war and troops started to travel across the Atlantic Ocean to the front lines, the country quickly mobilized. This transition was helped by laws to improve morale. In effect, you could not criticize the federal government run by Woodrow Wilson. Media fell in line, supporting "our boys" and the Liberty Loan bond drives that pressured all citizens to buy government bonds to pay for the war effort (war funding was outside the regular budget at the time and required funding from other sources). Meetings, rallies and door-to-door solicitations raised money for the war effort while unknowingly spreading the virus. Any negative event was downplayed or ignored. Information regarding the influenza epidemic was suppressed, causing concerns to be downplayed and the media to lose the trust of their customers. The virus moved very quickly. With an economy shifted to war production, there was limited lasting impact on the economy. Since the virus hit both sides it does not appear to have impacted the outcome of the war, although the fall elections in the United States were very close and Congress was divided evenly between parties.

The name "Spanish flu" seems to result from the lack of information reported by media in countries involved in the war. Spain, as a neutral party, had a relatively free press and reported the impact. Other countries reported the impact in Spain even as they ignored their own outbreak.

American medicine had progressed rapidly in the early years of the 20th century and, for the first time, had become as capable as the research facilities in Europe. In Europe, researchers were busy trying to combat gas attacks from the war and did not have resources available. As it turned out, the medical profession was helpless beyond common sense techniques of hydration and rest, which made public policy even more important. The lack of honest information allowed fear to run rampant. Some family members refused to enter homes where simple care would have saved the patient. The army's surgeon general, William Gorgas, warned of a high pneumonia risk in the military because of overcrowding, especially in the winter when heat became a luxury. He suggested a 10- to 14-day quarantine of troops arriving in Europe, shorter than Canada's 28-day isolation period. He was ignored. Even when quarantines were set up by the U.S. military, officers were often exempt. Unfortunately for the doughboys, the influenza virus can't read the bars on their shoulders. An incomplete quarantine is little better than no quarantine at all.

As war production ramped up, workers descended on cities. Crowding became worse in these cities, with shift workers often sharing rooms (and beds) with workers from other shifts.

Historical Perspective

Politics played several roles in the 1918 flu pandemic. No major player in world politics died. This is one reason why the pandemic escapes many history books of the era and is likely caused by the nature of the mortality curve. While normal influenza outbreaks cause excess mortality primarily at very young and very old ages, in 1918 the primary group afflicted was aged 20-40. Few people have distinguished themselves enough by this young age to merit inclusion in a history book. We know, because he survived and accomplished much later in life, that Franklin Roosevelt, as assistant secretary of the Navy, became very sick with flu during a trip to Europe. Had he died we would not know this today. Who knows how many future world leaders were lost? Several members of the Paris Peace Conference delegations died. The most notable American death was Willard Straight. When he died he received three columns on the front page of the *New York Times*. Both President Woodrow Wilson and General John Pershing became sick.

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The other role of politics did little to minimize the pandemic's impact. President Wilson never mentioned influenza publicly; not once. While 600,000 Americans died at home from the virus, he focused on the war effort and ignored the war against disease being fought by the civilian population. It is interesting to note that he tried to keep the United States out of the conflict, but once America entered he seemed to become obsessed by it.

Woodrow Wilson arrived at the Paris Peace Conference driven by strong principles. He was reportedly so frustrated with the negotiators, particularly those from France, that he was ready to leave the negotiating table and return to America when he became ill. While there is still some debate on the matter (some think he had a stroke), his symptoms were consistent with influenza. After this time, future President Herbert Hoover, also in Paris, thought his mind lost "resiliency." Wilson suddenly had new and strange ideas. For example, he thought there were French spies in his residence. He suddenly abandoned principles he had previously insisted upon and yielded to France on everything of significance. Four months later President Wilson suffered a major debilitating stroke. Many think that the seeds of World War II were planted in the treaty that ended World War I. Would history have turned out differently if Wilson had not encountered flu in early 1919? We will never know.

Other reasons for the lack of historical perspective include the passage of time and the fact that flu is common, with a person rarely dying from it. I think a separate reason is bringing this devastating event back into the forefront—research into the cause is starting to be successful. In the 1920s much research was attempted, and side benefits included penicillin and genetics, but the solution never came. The scientists were not able to identify what made so many so sick in 1918.

Although sanitation had improved enough so that large cities like London could support their own population without immigration from the countryside for the first time, epidemics were not rare in the early 20th century. As recently as 1911 a measles epidemic had broken out in the U.S. Army that killed 5 percent of those who caught it. Various forms of plague had also broken out since 1900 around the globe. The entry of the United States into war drove leading scientists of the day to predict that travel and crowded conditions would lead to some form of epidemic. Their goal was for this war to be the first where more died from battles than from disease by lowering the number of disease-related deaths. Little did they know that war conditions, especially troop ships, would accelerate the pandemic.

Funeral homes and cemeteries were quickly overrun, even as life insurance agents were placing ads encouraging business (apparently improperly aligned incentives are not a new phenomenon). Fear and sickness caused many of the people who normally performed these burials to stop or run away. Often there was no one left to pay the funeral bills, and wood for coffins became scarce. Women of "society" often took over when the government proved ineffective. Volunteers too quickly abandoned the task. Families had to dig their own graves and police often had to collect the bodies using wagons reminiscent of plague.

In some families everyone was wiped out. Large numbers of orphans and single-parent families were created in late 1918. Although the impact on servicemen is well documented, young women were also heavily impacted. Pregnant women proved especially vulnerable. Some thought it might be the end of the world based on biblical references in Revelations to a deathly pale horse.

Reactions

Since medical researchers at the time had not identified the virus and how tiny it was, many cities passed laws requiring that masks be worn when out in public. They did not help. As long as the masks were replaced frequently there was no harm done, but the masks themselves started to breed germs when moist for long periods. Not surprisingly, the supply of masks ran low, creating shortages and encouraging people to wear them for longer periods. Another rumor had it that chewing tobacco decreased your odds of contracting influenza.

> **While originally thought to be purely a human disease, influenza actually passes back and forth between humans and several species of animals.**

In late September 1918, the surgeon general provided advice to avoid influenza. It included general common sense suggestions like avoiding needless crowding and washing your hands, but also to chew your food and avoid tight fitting clothes.

Victor Vaughan, head of the Army's Division of Communicable Diseases, said "If the epidemic continues its mathematical rate of acceleration, civilization could easily disappear…from the face of the earth within a matter of a few more weeks."

The draft was canceled in the United States—not to reduce the impact of influenza, but because influenza had so impacted the military camps that no training for deployment could occur. It was the right thing to do, but for the wrong reason. Many lives were likely saved nonetheless.

Children are often a good barometer of the nation's pulse, taking a serious subject and putting it in their terms. A jump rope verse heard across the country reflects this.

I had a little bird
And its name was Enza.
I opened the window
And in-flew-Enza.

The Virus

Pigs, ducks and humans

While originally thought to be purely a human disease, influenza actually passes back and forth between humans and several species of animals. Each one reacts differently to a specific strain of the virus. Since farmers are in regular contact with pigs and birds (primarily ducks and chickens), they are one of the conduits between human and animal influenza. Another is markets where live animals are sold. It is thought that if an animal (or human?) catches both human and animal flu at the same time that it mutates into something that can be more lethal to one or the other species. The 1918 swine flu was new to the species, has been present ever since and was initially deadly to pigs. It was recently shown to have originated as an avian, or bird, flu, adding to the confusion. The virus strain itself is mild to pigs but, as happened in 1918, in combination with B. influenzae as a secondary invader it becomes highly lethal. Antibodies from humans have been used to protect pigs from the virus. An old wives tale that just might be true is that an outbreak of flu among horses often is a leading indicator of human flu epidemic.

Several recent influenza outbreaks have originated in China. Live animal markets have been involved in many of these epidemics, but farmers also live in a high-risk environment. For example, farmers in China use ducks to grow rice. When the fields are flooded, the ducks eat insects and weeds while leaving the rice alone. The ducks are removed while the rice grows, returning to clean the fields after the harvest. Having served their purpose, the domesticated ducks are then slaughtered for dinner. These farmers also raise pigs. This combination of swine, birds and humans has historically believed to have been the source of the worst influenza outbreaks. The viruses are able to combine between species and sometimes create a lethal cocktail.

Medical Basics

While this paper is not being prepared for a medical journal, some basic information will provide background.

Influenza consists of eight genes made of ribonucleic acid (RNA). Other viruses in this family include HIV and coronaviruses (SARS and many colds). Viruses have no means to replicate themselves. They use their genes to subvert and direct host cells. Influenza moves in and out of these cells using sharp protein shards, hiding from the immune system while in the cell. The virus requires a specific enzyme found in humans only in the lungs. Birds are the natural and original homes for influenza, existing in their gastrointestinal tract. It is often found in their droppings. While a human can catch avian flu from birds directly when exposed to massive amounts of bird droppings, it can't spread to other humans because the binding process between virus and host cell differs between species. The virus must first adapt to humans, using an intermediary animal like

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pigs. When deoxyribonucleic acid (DNA) copies itself, it works very hard to do so correctly. There are redundancies to make sure the copy is correct. When RNA copies itself, very few copies are exact because no redundancies are built in. Because the influenza virus is a segmented genome, the genes can reassort themselves, allowing the virus to move between species. It is much easier for RNA to mutate and find a form that helps it to survive than it is for DNA to do so. This "mutant swarm" process makes it inevitable that new forms of the influenza virus will emerge. It is very hard to create a vaccine, trying to hit a moving target as the virus mutates. In addition, influenza mutates very quickly to become drug resistant, often within days. While not meaning to detract from the seriousness of AIDS, the cumulative total deaths from HIV is lower than those recorded by the 1918 influenza virus. Since research is continuing on both and they are similar, perhaps joint efforts will help control both viruses.

The virus contains two proteins: hemagglutinin (H) that helps flu to enter cells and neuraminidase (N) that helps flu escape from the cell. As these proteins mutate, they are identified by shape (each shape is identified by number). H1N1 identifies the 1918 Spanish flu, along with epidemics that occurred in 1976, 1977, 1986 and 1988. Other epidemics included 1956 (Asian flu—H2N2), 1968 and 1993 (Hong Kong flu—H3N2), 1995 (H7N7), 1997 (Chicken flu—H5N1) and 1999 (H9N2). The influenza virus is unique in that, as a new virus takes hold, it seems to drive old forms of the virus to extinction. There are 15 known shapes of hemagglutinin and nine of neuraminidase.

The 1997 virus generated another concern. Influenza vaccine is grown in eggs, and this particular one was so strong that it killed the eggs. It took a year to overcome the problem. In a pandemic you don't have a year.

The similarities to the 1918 virus created the swine flu scare in 1976, where the United States encouraged immunizations for all. Unfortunately, the vaccine proved to have some negative side effects. Luckily the influenza outbreak did not occur. This highlights a very difficult issue for public policy makers. They use the prior year's flu, especially those mutations that appear in the spring, to make the next year's vaccine. If they successfully reduce a pandemic's impact they are open to criticism for crying wolf. Resources and time are both limited, so they have to focus their efforts. Stockpiling vaccine doesn't work because the virus mutates quickly, making such efforts fruitless.

Moisture appears to play a part in the influenza story, as it appears to die quickly in high humidity. One story I heard referred to the 1988 Kansas basketball team, led by Danny Manning and coached by Larry Brown. Apparently flu was going around campus and Coach Brown had his players sit in a humid environment every day to breathe in the moisture and kill any flu virus. While you still have to play the game, that team won the NCAA tournament as a number six seed.

Symptoms

There are stories of people that appeared to faint, collapse and die during the pandemic. Soon-to-be patients would leave for work, seemingly healthy, and die the same day. In one to two hours a person could become prostrate with fever up to 105 degrees, general weakness and severe headaches. Their eyes would burn and their ears would ache, with blood coming from ears and eye sockets. So much pressure would build up that blood would sometimes spurt several feet from a patient's nose. Severe aches in their muscles, joints, backs and heads made them feel as if they had been beaten all over by a club. Kidneys, liver, adrenal glands and testes all were impacted. Nurses reported that air pockets beneath the skin caused patients to crackle like a bowl of Rice Krispies when they were rolled over.

When autopsies were completed, the heart had often been impacted. There was often an inflamed pericardium, the sac around the heart, and the heart muscle itself was flabby.

Doctors will tell you that there is no such thing as intestinal flu, but many of the cases in 1918 packaged together influenza and dysentery. This is likely a case of the influenza weakening the immune system in a way that encouraged opportunistic secondary diseases to take hold.

“Doctors will tell you that there is no such thing as intestinal flu, but many of the cases in 1918 packaged together influenza and dysentery. This is likely a case of the influenza weakening the immune system in a way that encouraged opportunistic secondary diseases to take hold.”

Acute Respiratory Distress Syndrome (ARDS) was not identified as a specific sickness until after 1918, although the doctors of the time would be very familiar with it because of its common occurrence among influenza deaths. It is caused by an extreme stress on the lungs. This can be caused by near drowning, smoke inhalation, inhaling toxic fumes (or poison gas) or influenzal viral pneumonia. The immune system burns the insides of the lungs, followed by secondary invaders that attack the weakened defense systems. Someone diagnosed with ARDS today has a 40-60 percent chance of survival. Without intensive care units, this rate dwindles to near zero. There were no ICUs in 1918. The army found what is now called ARDS in half the autopsy cases it reviewed from 1918. As the virus mutated it became less prevalent and was rarely found in the comparable 1919 autopsies.

As a comparison, bacterial pneumonia following influenza has 7 percent mortality rate. Antibiotics are used to treat these infections. Over 35 percent of pneumococcal infections are resistant to the antibiotic of choice. For staphylococcus aureus bacterium, which is very resistant to antibiotics, the death rate is over 40 percent.

Lasting Effects

The 1918 influenza strain appears to have left residual effects on many who recovered, leaving them tired and susceptible to heart and neurological problems. Many who had flu died early in 1919 of secondary causes and were not recorded as flu deaths.

The influenza virus is hosted in the human body by the lungs. Yet the virus also appears to have impacted the neurological system, causing paralysis and mental illness. Hysteria, melancholia, delirium and insanity with suicidal intent were not uncommon. Some of this was temporary. A study that followed influenza patients that suffered from schizophrenia showed that most recovered completely within five years.

There appears to be a link to the brain as well, with those infected having a higher rate of Parkinson's disease a decade later.

Worst Case—Death

Many of the worst cases resulted in what was essentially drowning. As the lungs filled with reddish fluid, less oxygen was transported to the extremities. Nurses could tell which patients were not going to make it by looking at their feet. If they were black it was as if a death sentence had been given. Faces turned a dark brownish purple and patients coughed up blood while gasping for breath.

Research

Over the years much research time and effort was devoted to Pfeiffer's bacillus, a bacterium often present with influenza as a secondary invader. In some locations it was found in nearly all of the cases and was thought to be the cause of influenza. This is partly because of the stature of the scientist who discovered the correlation, Richard Pfeiffer of Germany. Many researchers were so sure of themselves that, if no influenza bacilli were found, then the disease present could not be identified as influenza. But this was a bacterium, and the true cause of all influenza is known today to be a virus.

While little success was achieved in discovering the source of the virus, lots of good research was performed and some important discoveries were made. Penicillin was found to kill bacteria, and Oswald Avery made the key observation that DNA carried genetic information when he determined how a weak pneumococcus could be made strong by adding a capsule around its structure.

Several individuals worked for many years to isolate samples of the virus. Since the Civil War, standard autopsy procedure for military doctors has been to take thumbnail samples of tissue, soak it in formaldehyde and store it in paraffin wax. The Armed Forces Institute of Pathology then stores these samples. Several of these samples survived from 1918, and Dr. Jeffrey Taubenberger painstakingly dissected them until he had sequenced the genome. Dr. Taubenberger continues to be a principal researcher of this topic. Dr. Johan Hultin, while studying at the University of Iowa, also became involved in the issue. The Swedish-born scientist made trips to Alaska to find bodies buried in the permafrost

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where the virus might have been frozen. Eventually the science caught up and he was able to bring back small samples to study. Several other researchers have been involved as well, but these two have been more focused on saving lives than personal glory.

The mystery that still stymies scientists today is the 1918 strain's lethality. What made so many people die from this influenza and not from another one? Once this is identified, vaccines and other methods can be used to lessen its impact. Since flu shots create antibodies in a person, does getting an annual flu shot help to protect you from the next pandemic? It is currently thought that a mild flu earlier than the pandemic of 1889 provided those older than 40 with some immunity to the 1918 virus.

Similar Topics Today

SARS

Severe Acute Respiratory Syndrome (SARS) first appeared in late 2002 in China. It was not reported to the World Health Organization (WHO) for several months, which allowed it to get a foothold and spread through international travel. While it is more lethal than influenza, it is less dangerous. It requires close contact to spread. It also lives primarily in the upper respiratory tract, so is spread via coughs and sneezes up to a week after symptoms develop. This makes it much easier to isolate and quarantine. Nevertheless, the ease of its spread to Toronto shows how important it is to react quickly to any outbreak.

Bioterrorism

It is difficult to read about influenza in today's environment and not think about the possibility of terrorists discovering the secrets of influenza before "the good guys" do. There are many historical cases of bioterrorism, mostly involving hurling infected animals over the wall of a town. In recent times the Japanese spread bubonic plague in China during World War II, in 1984 an Oregon cult infected salad bars in a restaurant with salmonella, in 1995 a cult group released the nerve gas sarin on commuter trains in Tokyo, and in 2001 anthrax was spread through the mail in the United States. Smallpox was used against Native Americans, both accidentally and on purpose (millions of Native Americans lived along the Mississippi River until a messenger carrying news of the Spanish arrival also carried smallpox). The risks today are anthrax, plague, smallpox and botulinum toxin. All can be countered with either antibiotics or antitoxin. Poison gas has been used more frequently, notably in World War I and more recently in Iraq.

Actuarial Involvement

The Numbers

The resulting mortality curve for 1918 looked like a W, with some additional deaths at early ages and little excess mortality at older ages. The unusual characteristic of this pandemic was the high number of deaths among those in the prime of life. Other flu outbreaks have had fewer than 10 percent of the deaths at ages 16-40. In 1918 over half the deaths occurred in this age range, with ages 21-30 the worst hit.

Specific industries that featured overcrowding and moist conditions were particularly susceptible. In 1918 Met Life reported that 6.21 percent of all insured coal miners and 3.26 percent of all insured industrial workers died. Overall estimates of worldwide deaths have ranged from 20-100 million, with the higher numbers now considered more credible. The high end of the range translates into 5 percent of the world's population dead from influenza within about three months. Based on population increases, today as many as 350 million would die. Population morbidity was less than 30 percent, which is toward the high end but still within a normal range for influenza. Slightly higher percentages were found in the military, likely caused by the overcrowded conditions. In the army, one in 67 died over a 10-week period starting in mid-September 1918.

In the United States, the consensus is that 25 percent of the population became infected with influenza and, of these, 2.5 percent died. This resulted in .06 percent of the population dying from the virus (.25 * .025 = .00625). This left 600,000 Americans dead and reduced the ex-

pected lifetime (taking the probability of surviving 1918 for each attained age and multiplying the results) from 51 to 39. More Americans died from the 1918 influenza pandemic than from all 20th century combat deaths. Up to 10 percent of the world's young adults died. One can only imagine the impact these lost lives could have had, for better or worse, during their lifetimes. Could World War II been prevented, or did a brilliant German soldier die that would have changed the outcome of the war? We will never know.

Looking at U.S. population trends shortly before 1918, the average annual increase was about 1.4 million (average of 1915-1917). In 1918 the population decreased by about 60,000. One could conclude that excess mortality from all causes was 1.5 million (an alternative could be fewer children being born—this was not the case in 1918 but did reduce in 1919). War deaths are listed as over 50,000 in battle and over 60,000 other deaths, which would include those caused by influenza. It appears that a strong argument can be made that the 600,000 deaths from flu estimate in the United States is low, especially since the number also includes deaths from 1919 and 1920 when a less virulent form of influenza created later waves.

Remote Areas

Areas not readily accessible and without domesticated farm animals were especially vulnerable since many had not previously been exposed to milder forms of influenza. The visiting postman wiped out some Alaskan villages, delivering flu along with the mail. In Tahiti over 10 percent of the population died within a month of a ship's docking with flu aboard. Samoa provided an interesting case study. In Western Samoa, 20 percent died after a boat docked with flu. In American Samoa, the governor quarantined boats with the flu and there was limited impact. The locals still sing a tribute song to the governor for his strong and prompt action. Native Americans were also susceptible, with 2 percent mortality. In Russia and Iran it is estimated that 7 percent died. In India it was 5 percent. Funerals in India use cremation and return ashes of the deceased to the rivers. When they ran out of firewood, corpses soon clogged the rivers.

Models

This paper is based on a presentation given in April 2004 at the Enterprise Risk Management Symposium. Dave Ingram also presented at a session titled "Pandemic History and Financial Implications: Focus on Flu Epidemics." Dave's focus was to present a simple teaching model that he developed while working on SARS. Such a model can help someone cut through the hysteria and understand where an outbreak may be heading. Parameterizing and modeling an emerging epidemic allows the modeler to provide a leading indicator of the epidemic's strength while it is still early enough to put measures in place that reduce the impact.

Dave trued up his model to the 1918 U.S. pandemic using the following parameters: population 100 million, contact rate 12 per day, transmission efficiency (probability of infection per contact) 2.5 percent, recovery rate 25 percent per day and mortality .64 percent per day. This is consistent with the 25 percent morbidity and 2.5 percent mortality data described earlier that resulted in a reported 600,000 U.S. deaths. With a population at year-end 2002 of 289 million, proportionate results would be 1.8 million deaths today in the United States. It is easy to think of adjustments to the contact rate based on today's global industrialized society that would quickly increase these results even if mortality resulting from secondary infections were reduced. Adding inoculations to the model and reducing the contact rate even slightly has a major impact on the results. Dave's model can also be adjusted to include an initial number of infected persons in case the epidemic has already started.

The Centers for Disease Control and Prevention (CDCP) has built a model to project a pandemic in the United States. It uses an average of the 1918, 1957 and 1968 outbreaks. While these numbers are large, if they were to use only the 1918 statistics the deaths would be four times as great as those modeled and the shape of the excess mortality curve will not match that of 1918. Users of this model should be careful to understand its limitations.

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“The Centers for Disease Control and Prevention (CDCP) has built a model to project a pandemic in the United States. It uses an average of the 1918, 1957 and 1968 outbreaks.”

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Insurers

Actuaries had their hands full in 1918. For those policies where the attained age was older and the policy had been in force for several years, reserves had built up and the net amount at risk was lower. For younger policyholders, where little reserve had been set up, the hit was harder. About three quarters of the companies either omitted or reduced their dividend.

As a result of the 1918 pandemic, the Committee on Statistical Study of the Influenza Epidemic created an opportunity to show what statistics and their methods could do for preventive medicine. Insurers also began funding research on the flu. Insurance applications picked up, not surprisingly, as there were many examples where life insurance would have helped families cope with their losses. Underwriters were aware of the heart based after effects of this flu and included this in their analysis.

During a June 1919 American Institute of Actuaries conference, the dynamics of the time were discussed. In addition to the mortality increased by the influenza pandemic, the war also took its toll. There were other repercussions from the war effort. Some added to mortality, some encouraged a healthy lifestyle. They included dietary improvements in the general population as they planted "war gardens", a switch from wool to cotton based clothing (higher mortality assumed from the change, not because one was better than the other), landlords cutback of coal during the pandemic to "support" the war effort, lengthened work hours and higher accidents caused by skilled workers entering the armed forces.

Before the end of 1918, President of the Actuarial Society of America Henry Moir estimated that the pandemic had cost 400,000 American lives having an average age of 33. The average age at death prior to 1918 had been 55-60. He estimated that 25 years were lost per victim and a total of 10 million person years were lost to mankind.

Fast-forward to today, where many individual policies and most group life insurance are designed using annual renewable term features. Many reserves are ½ cx for these policies, a statutory accounting convention that treats each policy year as an independent event. In addition, reinsurance is often designed using ART. A company might determine that it can survive 5 percent excess mortality due to offsetting in-benefit annuity mortality, but what if (like in 1918 when older ages did not experience higher mortality) the offset did not appear? And what about the counterparty risk of the reinsurer? What if the reinsurer pays 50 cents of every $1 it owes the direct writer? Even these reduced payments could be delayed, especially if a bankruptcy results for the reinsurer. My opinion is that the life insurance industry will survive the next pandemic only if there is wide spread securitization of term policies. At least life reinsurers and companies with large ART concentrations should strongly consider this option.

"As a result of the 1918 pandemic, the Committee on Statistical Study of the Influenza Epidemic created an opportunity to show what statistics and their methods could do for preventive medicine. Insurers also began funding research on the flu."

Summary

Why the next pandemic may be mild

There are several reasons why the next influenza pandemic may not be as serious as occurred in 1918.

- Today's health teams have developed Intensive Care Units and other means of caring for patients that are much advanced from 1918. Many deaths at that time were from secondary invaders that can be better treated today. An example is bacterial pneumonia, which can be treated with antibiotics.

- There was a World War going on at the time, with nearly all regions of the world impacted. This made countries unwilling to impose travel quarantines.
- Germ theory has advanced to where the next virus can more easily be analyzed.
- Antiviral drugs are now available.
- International cooperation has improved dramatically, partly because of the 1918 pandemic. Countries, cities and towns created new departments of health, including the U.S. National Institute of Health. The World Health Organization (WHO) coordinates surveillance of mutations to adjust each year's vaccine.
- Many emergency hospitals created in 1918 were converted into permanent ones.

Why the next pandemic may be worse

There are also several reasons why the next influenza pandemic may be more serious than occurred in 1918.

- Travel—it is the primary concern. It is so easy to travel internationally that any contagious virus would appear to hit everywhere at once. A quarantine of one region would likely come too late, as it did with SARS. It took only two weeks for the influenza virus to travel from Boston to Seattle in 1918. This virus would have covered 90 percent of the earth in that time period today.
- Time—it has been a long time since the last major influenza pandemic and few are still alive with antibodies in their system.
- Medical advances have not yet identified the virus completely and don't know why it was so lethal, let alone how to counteract it. Within the next few years, additional research may turn this into a reason the next pandemic will be mild. Offsetting this is the ability of the virus to quickly mutate to a drug-resistant strain.
- ICUs will quickly be overrun with patients. Many hospitals have downsized as they privatized and are not capable of supporting the needs of 30 percent of the population simultaneously. There will be a shortage of beds when they are needed most.
- Many bacteria are building resistance to currently available antibiotics, making secondary infections more dangerous.
- Regional conflicts throughout the world are constantly flaring up. Some could expand.
- Influenza is showing signs of building resistance to antiviral drugs.
- More countries do not participate with the WHO than do, so coverage of future influenza mutations is not complete.
- Politics and the courts—try to imagine telling everyone that they can't leave a state. The courts would be flooded with cases to allow freedom of travel and might have to allow it if laws are not enacted in advance to allow and enforce a quarantine. The quick challenges to the Patriot Act provisions are good examples where the proper balance is a debatable question among reasonable people.
- More people live in urban areas. This means there are more contacts per person per day. On the flip side, there is also greater probability of previous exposure to a similar virus that provides partial protection.
- There will be a greater impact on the economy, as relatively more people less than 40 have key positions in the information-based global economy. The financial markets are also likely to react quickly to an outbreak.
- A population exists today with compromised immune systems. Those with HIV, being treated with radiation/chemotherapy and transplant recipients will all be susceptible to influenza and its secondary invaders.

In May 1919, the Actuarial Society of America published, in *Transactions* (Vol. XX, Part 1 No. 61), a paper by James D. Craig and Louis I. Dublin titled, "The Influenza Epidemic of 1918. "Their lead paragraph included a statement that could be made today, and I will include it here. "With the recent development of hygiene and sanitation as marked as it is, the world felt safe against the possibilities of any new conflagration from influenza. But the experience of the last two years has demonstrated that we are not so far advanced in our knowledge of this disease, of its cause and of the methods of its control as we thought we were. Epidemics may still occur with sufficient virulence to test the resources and stability not only of life insurance companies but also of civilization itself." Will history repeat itself?

Overall, if the scientists can develop countermeasures that can be quickly implemented this will be a great weapon in the battle against an influenza pandemic. If not, public policy will drive the results. Closing down public meeting places like schools and shopping malls, limiting contact with others and temporary telecommuting will all help.

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Influenza Pandemics

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What can we do to protect our families?

This is a tough question, and one that I have thought a lot about over the past year as I researched this topic. Until Dr. Taubenberger and his extended team solve the riddle of why this particular strain of influenza was so virulent and develop the tools to create countermeasures quickly, there is little beyond common sense. Getting a flu shot every year will help, even if just to ease identification of similar viruses like SARS. I have to wonder if flu shots might have antibodies that will also help protect from future, similar, strains. Perhaps something that seems odd today, like getting a transfusion from someone who lived through earlier mutations of influenza, will be found to add the proper antibodies. The most difficult challenge will be political. It is difficult to determine as an outbreak is occurring how bad it will be. Will our leaders have the nerve to quarantine large segments of the population in a democracy? And even if they have the nerve, will the courts allow it to happen (Tom Clancy's fictional work *Executive Orders* addresses the quarantine issue when the Ebola virus is released.) As the models show, reducing the contact rate even slightly has a major impact on how bad a pandemic will become.

> **History often repeats itself, and influenza pandemics are no exception. The key to dealing with them is for politicians to treat them seriously and not just hope they will go away.**

Risk to the Life Insurance Industry

According to the 2003 ACLI Life Insurers Fact Book, which cites data from 2002, the total net amount at risk in the life insurance industry is $15.5 trillion and statutory surplus is $198 billion. Surplus as a ratio of NAAR is 1.28 percent. Excess mortality, beyond conservative statutory based assumptions of 1.28 percent would bankrupt the industry if it were just one company. This, of course, does not include life insurance benefits designed into a product like a variable annuity. The 1918 pandemic reportedly killed .6 percent of the population and had limited excess mortality at high ages. There appears to have been underreporting of this cause of death in 1918 even in the United States, let alone elsewhere in the world. Even so, the estimate is 5 percent dead worldwide, much higher than in the United States. There are a number of reasons that likely account for this anomaly. Sanitation matters greatly when secondary diseases attack. So does poverty, since it leads to overcrowding.

Each year companies report results such as asset adequacy tests (U.S. regulators) and dynamic capital adequacy tests (OSFI in Canada). These require deterministic scenarios, and most companies include at least one based on higher mortality for life business. Companies should consider the risk to their block if the 1918 influenza pandemic recurs. Even with U.S. data, which is lower than most of the world, the risk to insurers writing mainly group life or other ART-based products is high. Insurers should also stress their counterparty risk. What if the reinsurer pays less than 100 percent and/or the payments are delayed? Can the insurer survive?

This naturally occurring catastrophic risk seems logical to be considered for a government backstop, much as the man-made terrorism payback coverage. Without it, the industry will not survive the next influenza pandemic in its present form. Another possible solution would be to tap into the financial markets. Securitization of mortality risk into a financial instrument, similar to catastrophe bonds, would spread the risk across a diverse group of investors that could absorb a large loss occasionally, if paid for taking the risk in the other years.

History often repeats itself, and influenza pandemics are no exception. The key to dealing with them is for politicians to treat them seriously and not just hope they will go away. Any reductions in contact rate can have major benefits for a region. It likely will take at least one more major outbreak for scientists to get their hands around this disease, but in the future lies hope of treatment and vaccine. In the meantime actuaries should consider various scenarios and determine the expected impact of each. Only through analysis can you determine the interactions between product lines to various levels of mortality and shapes of the mortality curve. It's time to do that analysis. ✦

Getting to Know CTE

By David Ingram

The risk measure conditional tail expectation (CTE) has been getting more and more attention for measuring risk in any situation with non-normal distribution of losses. Canadian and U.S. insurance regulators have adopted CTE as a standard for regulatory capital measurement. Academics have lauded CTE as a "coherent" statistic. Those outside the insurance industry call it "Tail VaR" or "expected tail loss" (ETL). Actuaries, who have always been suspicious or even hostile to the usage of value at risk (VaR) as a risk measurement standard, have readily embraced CTE.

This article presents the observations of some random investigation into the nature of CTE. There are still many questions that need to be asked and answered before we can say that we are completely familiar with the nature and characteristics of CTE. There are six questions that will be discussed:

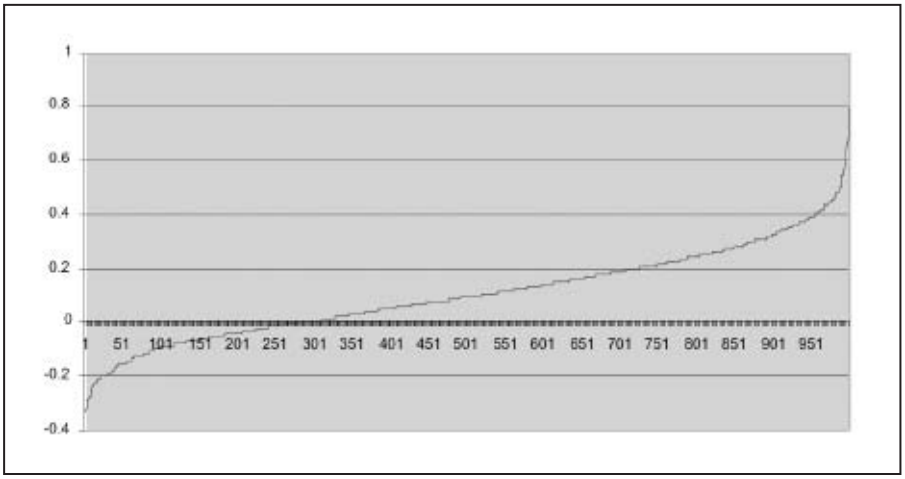
- How does CTE compare to VaR?
- How sensitive is CTE to the number of scenarios used?
- Is CTE consistent with existing RBC factors?
- What is the impact of time period used for calculating CTE?
- How does CTE measure the difference between regime switching and single regime lognormal scenarios?

These observations are all tied to examples. Since insurance products are very complex, it is difficult to see whether the results of any one test would apply to any other situation. Therefore, the examples used here will all be based on simple random values, rather than to calculations based on the random values. The random values are developed as stock returns that would be used as inputs to calculations about a stock-linked product. These discussions will not resolve any issues about CTE calculations for insurance products, but through some sort of rough transitive property, can form a part of a starting point for investigations into the ultimate nature of this new tool.

1. CTE vs. VaR

Without getting into the mathematics of coherence, a simple picture can show the appeal of CTE as opposed to VaR. CTE is defined as the probability weighted loss above a certain probability level, while VaR is the loss at a certain probability level. One definition of CTE is that it is the average of all VaR values for probabilities above a specified level. Generally VaR is used by banks and most often it is used to measure risk over a very short (less than one month) time frame. CTE is becoming the standard for insurance company risk measurement, especially regarding risk capital and is most often used to measure risk over multi-year time frames that are needed to view insurance risks. The following two charts show the distribution of values for stochastic tests of two products. Product A has a normal distribution of gains and losses, while the distribution of gains and losses for Product B are not as predictable.

Chart 1—Distribution of Gains and Losses



For Product A (Chart 1) and any other product with a normal distribution of gains and losses there is a regular predictable relationship between CTE and VaR. Using one measure or the other does not necessarily add any information.

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Getting to Know CTE

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For Product B (Chart 2), VaR and CTE can sometimes show drastically different stories. The VaR for Product B on the graph above is a near zero value. There is a small loss compared to the expected gain, but not much. The tail of the profit distribution starts to drop-off somewhere above the 95th percentile. A CTE calculation includes the impact of that drop-off, wherever it starts. A VaR measure will only reflect the drop off if it is occurring at the percentage chosen for the VaR measure.

Above, we noted that there is a predictable relationship between VaR and CTE for a normally distributed gain/loss distribution. In fact, Chart 3 shows the values of 95VaR and CTE90 as a percentage of mean for various normal distributions are both linear relationships, with the 95VaR equal to the mean less 164.56 percent of the standard deviation and the CTE90 equal to the mean less 176.3 percent of the standard deviation. Looking at the graph in Chart 3, first notice that VaR and CTE are both positive when the standard deviation is less than about 65 percent of the mean. The modified CTE used for U.S. NAIC risk-based capital would use zero for any positive values and would therefore produce small negative values a little further to the left on the chart.

Chart 2—Embedded Value

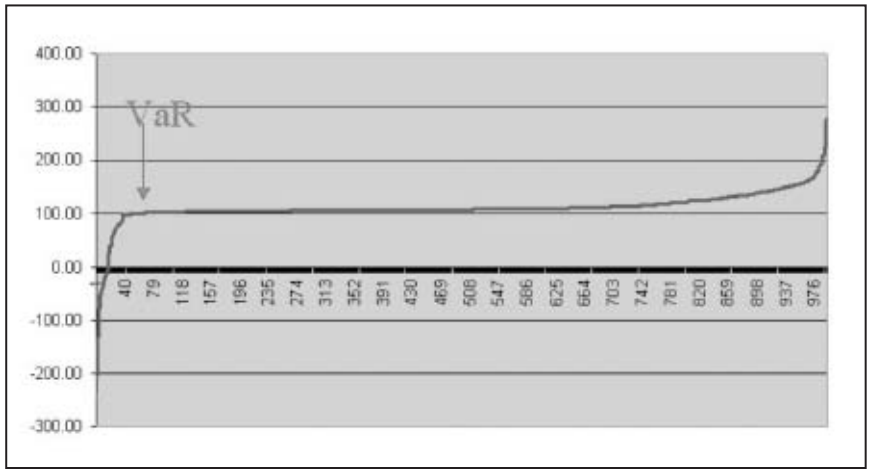
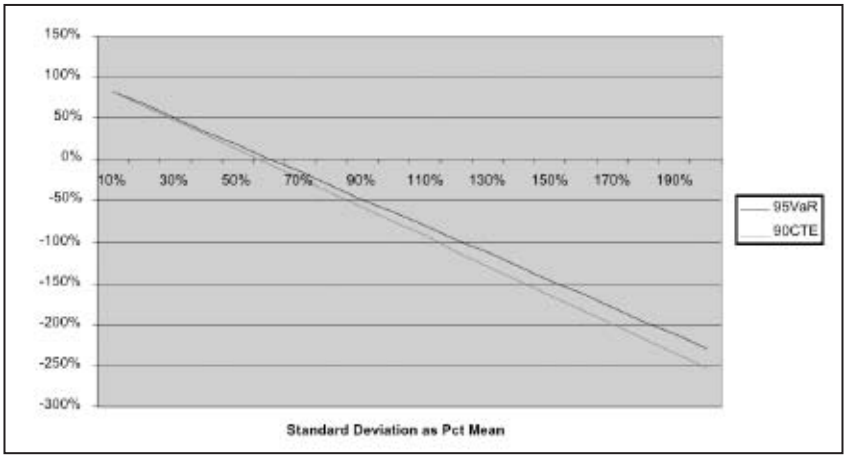


Chart 3—Normal Distribution



The conclusion here is that VaR and CTE are not necessarily significantly different if gains and losses are normally distributed. However, if gains and losses do not conform to a formulaic distribution, the difference is unpredictable. In those situations, CTE can provide significantly different information from VaR.

2. Tails and Number of Scenarios

At this point, we will switch from looking at a general loss distribution to a specific real model situation. The latest CTE discussions are revolving around variable products and guarantees in those products. As mentioned earlier, products and modeling results vary widely. However, significant insight into the workings of CTE can be observed from looking at the CTE of a simple portfolio of common stocks. The portfolio returns can be generated using several different scenario generation methods and the impact on CTE displayed.

The AAA committee report on C3 Phase II RBC suggests that a regime switching lognormal (RS2LN) model adequately captures the desired characteristics for the proposed CTE calculations. We are going to start with a lognormally distributed set of returns for a stock portfolio and eventually compare that to a RS2LN set of scenarios. For both sets, we will calibrate the models so that the mean is 11.9 percent and the standard deviation is 17.2 percent overall.

For the lognormal model, by stating those values, the parameterization is complete. There are only two parameters, mean and standard deviation. The ratio of standard deviation to mean is 1.45 percent and we would expect CTE90 for normally distributed losses to come in at 155 percent of the mean or an absolute value of 18.45 percent based on calculations behind the graph above. In fact, for our set of 1,000 scenarios, we get a CTE90 of 18.35 percent, which is 154 percent of the mean return.

For 20 sets of 1,000 lognormal scenarios, the CTE90 averaged 18.40 percent. In addition, we found that the CTE90 has range of 18.33 percent to 18.50 percent and that there is a 96 percent correlation between the CTE90 and the worst value of the 1,000 scenarios. That is a small cause for concern, since the worst value is probably the least dependable statistic of the entire set (Chart 4).

The ratio of the largest and smallest CTE values is less than 101 percent. That would suggest that the CTE90 calculation for 1,000 scenarios may be sufficiently reliable.

To look for a smaller number of scenarios that may be reliable, we took the same set of random values and divided it into 40 sets of 500 scenarios. The CTE90 results get much more diverse: (Chart 5)

The range of highest to lowest CTE value is 126 percent for these 40 sets of random returns. It would seem that the empirical evidence supports the idea that 1000 scenarios may be adequate, while 500 scenarios is not. The finding that there was high correlation between worst scenario and CTE90 value suggests that a user of CTE should examine the worst scenario to make sure that it is not causing an exaggeration of CTE value due to an extreme outlier in an insufficiently large scenario set.

3. Comparison to C1(CS)

The RBC requirements for life insurance companies already contain a component for common stocks. That amount is 22.5 percent for a fully diversified portfolio that qualifies for the lowest level of RBC based on the beta of the portfolio. If we calculate from the 20 sets of 1,000 random scenarios, the present value of the CTE90 result on year out, we get a result that ranges from 22.13 to 22.29. That looks to be very consistent with the 22.5 percent requirement that already exists.

That question and answer allow us to begin to understand the drastic difference between the risk of an investment holding like a common stock portfolio and an insurance product.

Chart 4—CTE90 for 1000 Scenarios

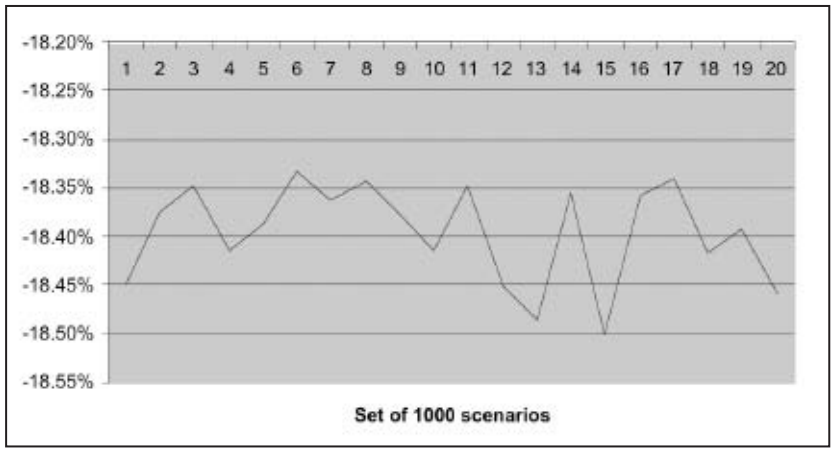
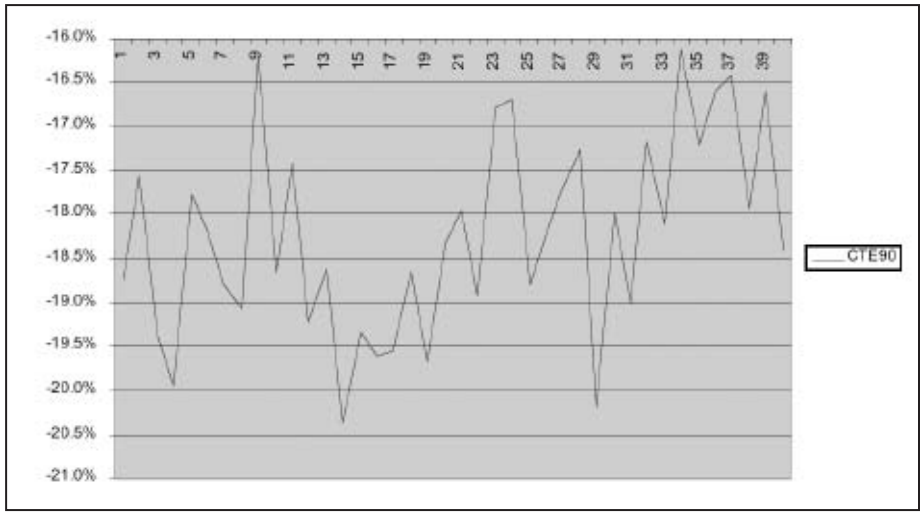


Chart 5—CTE90 for 500 Scenario Sets



4. Modified CTE and Holding Period

When the CTE concept is applied to calculate C3 RBC, there are three differences from any of the above discussion. First, the calculation is projected over multiple years. For that purpose, we will use our 20 sets of 1,000 scenarios to now represent 1,000 scenarios of 20 years.

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Second, for RBC purposes, when calculating the CTE, a present value is calculated for each possible future period under each multi-year scenario and the worst present value is chosen. Finally, in calculating the CTE for any one year, scenarios, which would otherwise become a part of the average, are set to zero first if they are not in a loss position. In this section we will show the impact of each of those modifications to CTE related to our simple test case of a common stock portfolio.

First, let us look at the impact of extending the calculation to multiple years. The RBC for common stocks is equivalent to the CTE90 for a one-year holding period for our common stock model. One year is an appropriate standard for this comparison because there is no commitment on the part of an insurance company to hold stocks for any future period. Variable annuity products and the guaranteed benefits that are the concern of the C3 Phase II proposals do involve long-term commitments. For this example, we will use our stock model as if there were a long-term commitment to remain in the stock market. Most people have seen material during the 1990s bull market that emphasized the favorable impact of diversification over time. That material showed that risk decreases over time for a buy and hold stock investment strategy. However, the mechanics of the CTE measure produce the opposite effect. With CTE as the risk measure, risk appears to go up over time for several years, and then declines (Chart 6).

Why does that happen? While the cumulative standard deviation of returns gets smaller and smaller over time because there are ultimately up scenarios that moderate the down scenarios, the CTE gets worse because the make-up of the CTE90 is continually changing with each passing year. As the random scenarios generate new outliers each and every year, the scenarios that were moderated with the passage of time get pushed out of the CTE by these new outliers.

Chart 6—S&P 500 Normal Scenarios

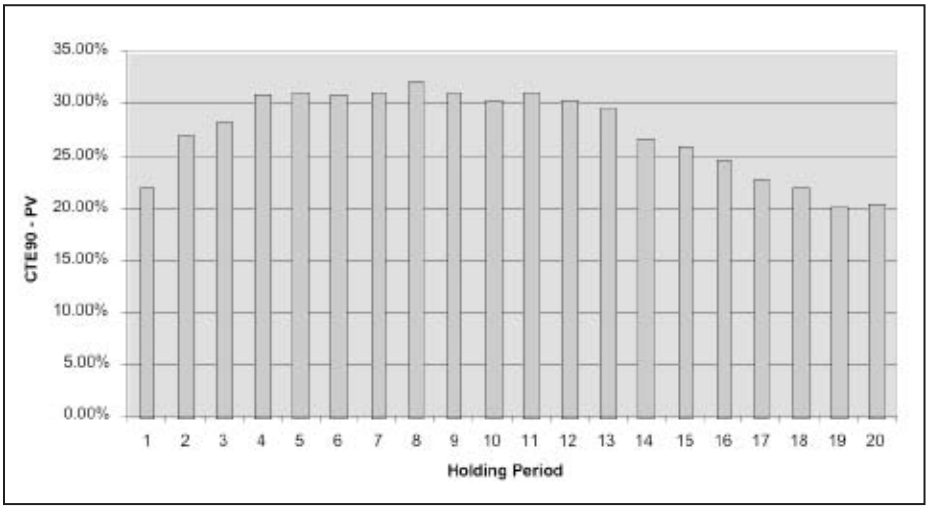

Table 3

Number of total years in worst 100	Worst 100 at 20 years	Next 100 Scenarios
0		32
1	5	10
2	4	14
3	3	6
4	6	1
5	2	7
6	5	3
7	4	7
8	5	4
9	6	4
10	5	2
11	9	5
12	3	2
13	5	0
14	9	0
15	5	2
16	5	1
17	3	0
18	6	0
19	7	0
20	3	0
	100	100

Table 3 shows that there are only three scenarios that were a part of the CTE90 for all 20 years and that five scenarios crept in only in the final year. In addition, the table shows that 68 of the next 100 scenarios ranked by final value of the stock fund, were a part of the CTE90 value for as many as 16 of the 20 years.

Second, we look at the impact of choosing the worst present value (Chart 7). The worst present value rule takes the forces that we mention above and maximizes their impact. Under this rule, the really extreme scenarios dominate no matter whether they are followed by better scenarios or not.

Finally, with the lowest PV adjustment, at least in this example, the need for the no-negative values adjustment is not needed. There are 344 scenarios to choose from in determining the one-year CTE and since no negative value is ever lost, that stable grows to over 600 possible negative values over the 20 years. That means that over 600 of the scenarios show that the stock portfolio is underwater at some time in the 20 years. That is not a statistic that the mutual fund and brokerage industry would have been excited to share when they were talking about how well stocks do when held for the long run (Chart 8).

In fact, if the no-negative adjustment is applied without the lowest PV adjustment, then there is an impact. With our scenario sets, there are less than 100 negative scenarios for holding periods of over 15 years.

This example shows that, as measured by CTE, there is negligible time diversification in this stock portfolio. With the modifications to CTE that are imposed on its use for RBC, extensions to holding period are measured to add significant risk.

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Chart 7—S&P 500 Normal Scenarios

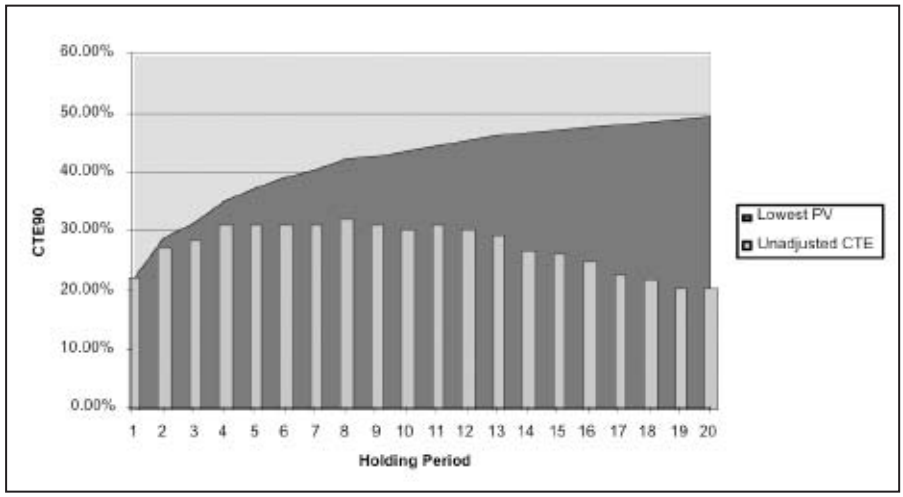


Chart 8—S&P 500 Normal Scenarios

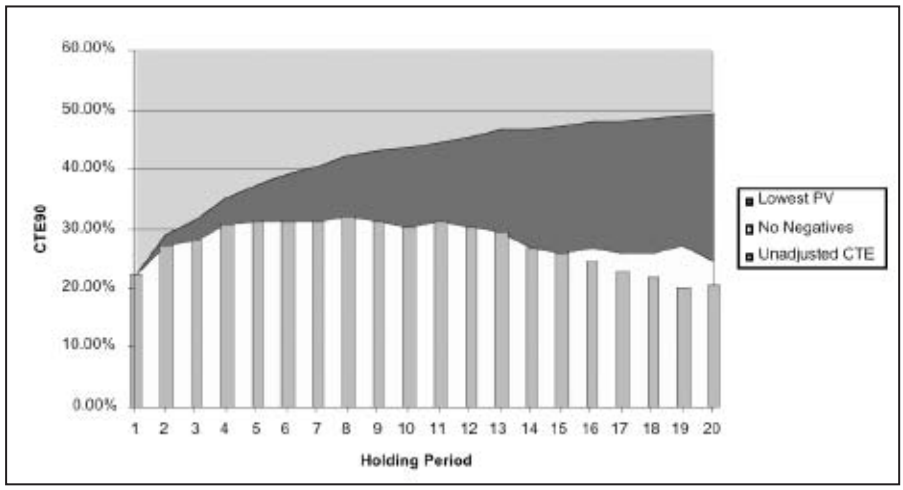
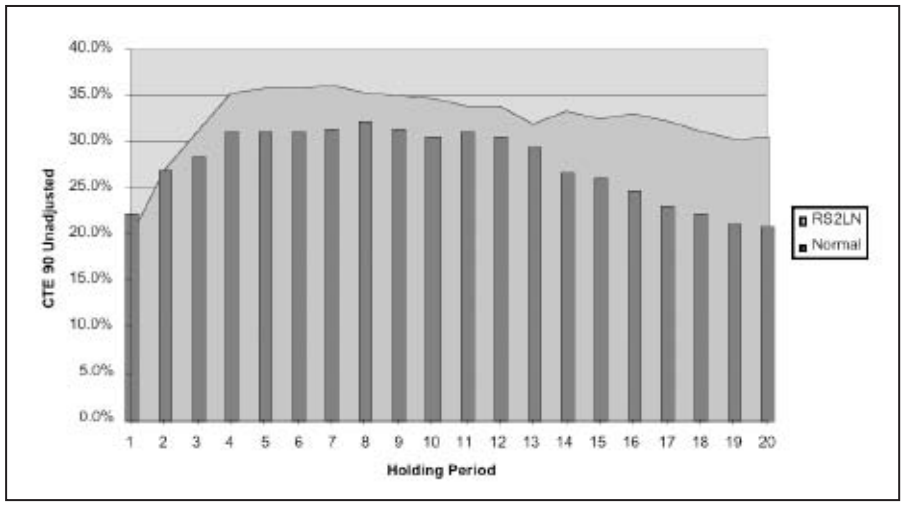


Chart 9—S&P 500 1000 Scenarios



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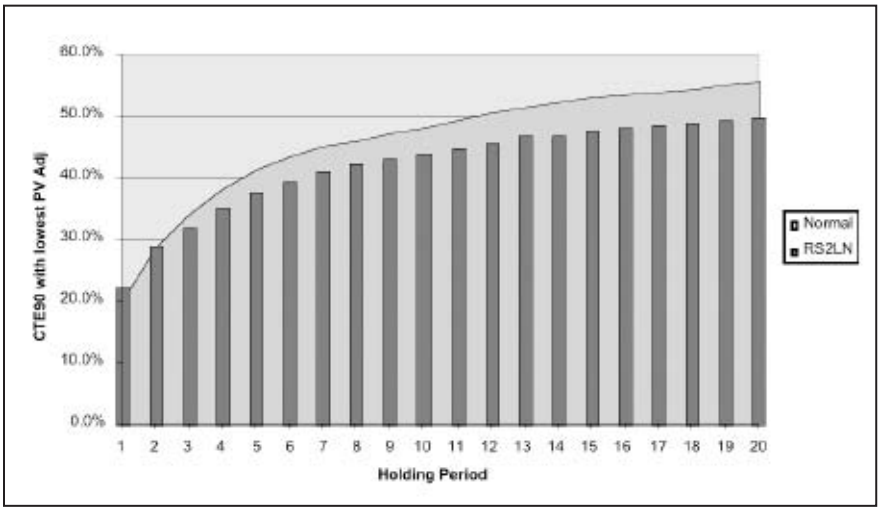
5. Regime Switching vs. Single Lognormal Scenarios and CTE

Now that we are good friends with CTE and its characteristics, we will look at the impact of different scenario generators. A regime-switching lognormal scenario generator (RS2LN) has been mentioned as a method that is sufficiently robust for the C3 Phase II calculations.

We created a set of RS2LN scenarios starting with the parameters in Mary Hardy's paper in the April 2001 *North American Actuarial Journal*. Over 20 years and 1,000 scenarios, the mean is 11.9 percent and the standard deviation is 17.5 percent. If we go back to our normal set of scenarios, we found that the one-year CTE on the return was -18.45 percent. In fact, our scenarios have a CTE90 for a one-year return of -19.98 percent. That means that the tail for these scenarios is somewhat more robust than the tail for normal scenarios.

Chart 10—S&P 500 1000 Scenarios



That more robust tail should and does translate into a somewhat larger CTE figure (Chart 9).

The difference is less severe after the adjustment for lowest PV. The 20-year holding period unadjusted RS2LN value is 45 percent higher than the normal value while the lowest PV value is only 12 percent higher (Chart 10). In fact, Chart 10 shows such a regular relationship between RS2LN and lognormal, that the extra effort does not seem to add any information. A slightly higher CTE (92 or 93) would give the same result under the lognormal scenarios as the CTE90 under RS2LN.

6. Conclusion

This examination of CTE has been performed butterfly fashion. I have skipped around looking at whatever caught my interest. If you are going to use CTE as a primary risk measure, then you should perform these tests and others to assure yourself that you understand why the CTE performs as it does. In this analysis, you should not get overwhelmed by the sheer volume of numbers that are involved. Even thousands and thousands of scenario results will eventually succumb to rigorous analysis.

Once mastered, CTE can be a very useful tool beyond its required use for RBC. As shown above, CTE is consistent with historical risk measures such as the C1 requirement for common stocks. CTE can also be used as a general risk measure and as criteria for replication (See "Why Write Variable Products When You Can Put the Money Directly into the Stock Market," Ingram & Silverman, *Risk & Rewards*, October 2003). ✦

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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.

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