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Risky Stories

by David Ingram

In the end, to have an effect on the world, the mathematical risk models need to be translated into stories.

However, that is troublesome because many risk managers and many of those who listen have never heard such stories before. We are all in new territory.

The risk model is an attempt to see the world in a much more realistic way than ever before. We are trying to look not just at a most likely future, slightly conservative future or even a worst-case future, but to look at the shape of all possible futures. Those my age or older may remember the first time that they saw color TV. The color picture looked strange at first and these new stories of risk models will seem strange at first, but it didn't take long for color TVs to look natural, and it will not take that long for stories from risk models to seem natural either.

There are at least three main ways that stories about risk and risk management need to be different from the old black and white financial information. First, risk and risk management cannot be easily described in absolute terms. They will usually be relative to other risks, usually to other similar risks within the company. When you build your first risk model, the risk and return results will be lonely with no basis for comparison within the company. However, the "efficient frontier" model provides a simple, well-known basis for comparison. Markowitz plotted the returns of stocks and risk-free investments, but you will doubtless find it more useful to compare a new product risk return against a stock bond continuum. Once a second product risk return can also be plotted, the risk manager can be off to the races developing the company's own product-efficient frontier. Thereafter, each additional product can be seen to be either "on the frontier" or under it. The most profitable product is often not even on the frontier. When that is seen, the real process of understanding the company risk profits begins.

Second, risk, especially as it is found in long-duration, non-traded instruments such as insurance contracts, is multidimensional. Above I spoke as if the risk return graph was two dimensional. Unfortunately, it is not just two dimensional. To communicate the risk of a long- duration, non-traded instrument, a minimum of at least six values are needed. I will call these six values the "Actuarial Risk Profile" (ARP). A sample ARP looks like this:

	Short Term	Long Term
Expected Return	A	B
Volatility	C	D
Tail Risk	E	F

The short-term measures can be earnings-at-risk type statistics and the long-term measures are often taken at several points in time, when it is recognized that risk changes over time. It is also key to remember that discounting may lead to incorrect evaluations of risk for long-term products, which are not easily traded if they are not in excellent condition. These six numbers should be prepared for each major risk type (credit, market, hazard and operations) before and after adjustment for correlation. The volatility measure can simply be the standard deviation or it can be some other measure that captures the middle of the loss distribution. The tail risk measure can be a VaR or CTE type measure.

This multi-dimensional aspect of risk is problematic when the value of risk management is questioned. That question tries to make you fit risk and risk management into a one-dimensional framework. The value of risk management will only be clear if there is a reduction of

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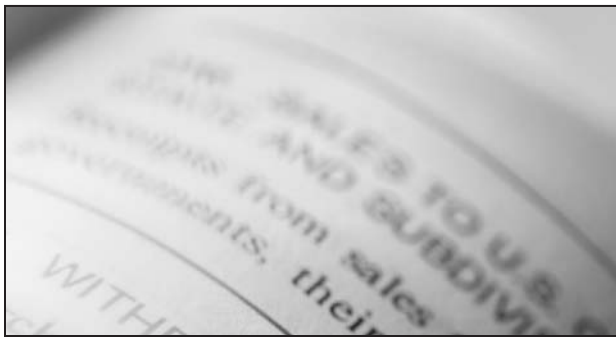
risk for the same return or an increase of return for the same level of risk. More commonly, risk management will mean fine-tuning the risk reward profile, changing both risk and reward to bring a product closer to the efficient frontier. If an organization does not know what they want their risk return profile to look like, risk management would have no more value than a map would have to someone who does not know where they are going.

Third, in communicating risk and risk management, there needs to be an acknowledgement that some unknowns are less certain than others. As Donald Rumsfeld said, "there are known unknowns and unknown unknowns." When the market puts a value on a security, there is usually a charge for expected volatility. This is the charge for the known unknowns. However, if the market perceives that there are any significant "unknown unknowns" then the risk charge can increase dramatically.

When risk profiles are being compared between products, the risk manager should be able to indicate the degree to which the various product risk models underlying the profiles depend on unknown unknowns. Otherwise, there will usually be an unfair comparison between a well-tested existing product and a new product with new benefits operating in a new market where some or all of the assumptions are those unknown unknowns. Ultimately, the risk manager needs to make that distinction to maintain credibility.



So these three things make building the risk and risk management stories more of a challenge. The temptation will be there to simplify by ignoring one or more of these three complications when communicating risk and risk management. However, you will doubtless find that re-introducing one of these elements will be even more difficult later. Better to keep the story a little longer from the start.

In fact, these three ideas could be the basis for a full risk report—Part 1: How does the risk return compare among products? Part 2:—What is the Actuarial Risk Profile of the Product? Lastly, Part 3:—How reliable are the assumptions?

Someday, the risk management profession will need to develop a minimum standard for risk management reports. To be both effective and accurate, these are three basic elements that will need to be included. ✦

PRMIA Provides Credit to SOA Members!

Did you know that PRMIA (Professional Risk Managers' International Association) offers actuaries cross-over exemptions against the Professional Risk Manager (PRM) certification program?

Actuarial fellows and associates are exempted from up to half of the exam modules of the PRM program.

– FSAs are exempt from PRM Exams I and II

– ASAs are exempt from PRM Exam II

The normal requirements are that four exams be passed. PRM exams can be taken on any business day of the year.

For more details about the PRM and to register for the exam, please visit the PRM candidate information Web page at *http://www.prmia.org/certification/candidate_info.html* or contact PRMIA directly at *certification@prmia.org*.

Rising Interest Rates: How Big a Threat?

by Frank Sabatini

For writers of fixed annuities, the impact of rising interest rates largely depends on the speed with which rate hikes are implemented.

Now that the life insurance industry has survived one of the worst bear markets in history, along with the lowest interest rates in decades and another round in the credit cycle, will rising interest rates be the next risk management challenge for life insurers to overcome? Possibly. That depends on a number of factors, some of which are environmental and others that are company-specific.

The recent rise in interest rates—a nearly 2 percent increase from the lowest point as measured using the five-year treasury note—has given the industry some relief from its exposure to an extended period of very low interest rates. But now that the Federal Reserve has embarked on a long-anticipated round of rate increases, insurers are pondering the implications this will have for their business and profitability.

Impact on Annuity Writers

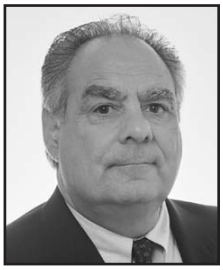
Rising interest rates undoubtedly present the greatest threat to writers of fixed deferred annuities. Deferred annuity crediting rates have been lingering at or slightly above contractual minimums for the past few years. Portfolio rates have declined to the point where some carriers have not been able to achieve their target spreads, resulting in depressed earnings.

To compound the problem, policyholders have come to the realization that the 3 percent minimum guarantee on fixed annuities is a fabulous deal in the current environment, and have therefore, held on to their policies. Some companies have stopped writing new business to avoid selling products with current credited rates that cannot be supported by new investments. Almost all writers have lowered minimum guarantees to 1.5 percent or 2 percent.

Sustained levels of very low interest rates provide sufficient time for portfolio returns to decline further as higher-yielding investments on insurers' books mature and are replaced by investments with significantly lower yields. With the continuation of low rates, the gap between investment returns and minimum guarantees narrows even more. The rate at which this occurs for a particular company depends on its particular circumstances, but the most important factor is the extent to which there is a mismatch between the company's asset and liability durations.

Companies historically have purchased investments that have a longer life than the liabilities the company has acquired. Since longer-term investments often have higher yields, this practice has provided the annuity writer with either a greater profit expectation and/or a more competitive credited rate. However, as interest rates have fallen, the liability duration has become longer as the minimum guarantees have been reached, and policyholders have shown a greater tendency to keep their policies in force.

The historically low levels of interest rates have placed pressures on realized spreads that have been reflected in earnings results in recent years. Low interest rates work toward an insurer's detriment because they cause investments to mature more quickly and portfolio yields to decline more rapidly than liability rate changes, accelerating the spread compression caused by the minimum guarantees. To dampen the impact on spreads, many companies have maintained an intentional mismatch of assets and liabilities through the normal management of the asset portfolio.



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From this perspective, the recent rise in interest rates is actually good news for fixed annuity writers. The rise has produced higher investment yields on new investments without a corresponding increase in credited rates, resulting in improved spreads. The rates that annuity writers are crediting today still represent an attractive alternative to consumers, especially relative to certificates of deposit. Therefore, the rise in rates has benefited annuity writers.

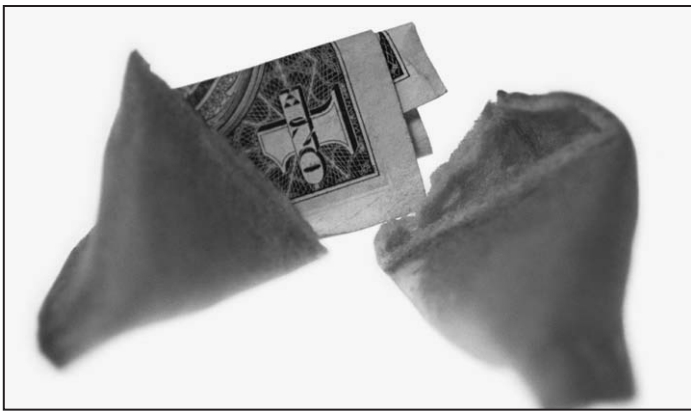
It's Not How High, but How Fast

But what happens when interest rates rise suddenly? This situation last occurred in the late 1970s and early '80s, when interest rates rose quickly and dramatically. What occurred then could happen again, with a similar impact on annuity writers. At that time, the rise in rates outpaced the ability of existing investment portfolios to keep pace with credited rates seeking new deposits and supported by the current higher-yielding investments.

Companies had two choices. They could either subsidize existing credited rates to keep customers from leaving to get the higher returns, or they could suffer the financial consequences of losing the customer, including a loss of spread income and capital losses from having to liquidate existing assets at a loss to fund the departures. Often, the departing customer was funded by the arrival of a new customer, who got the higher crediting rate but was backed by the lower-yielding asset, thus constructively realizing the financial loss.

Back then, of course, we had double-digit interest rates. But it's not the level of rates that matters—it's the relationship between new money and in-force credited rates. Right now, new-money credited rates are close to 4 percent, and in-force policy credited rates are at the 3 percent minimums. This differential provides little incentive for existing policyholders to switch to a new contract, especially when many of them would have to accept a new surrender charge period to make the change. But a rapid rise in new-money rates will quickly change this dynamic.

The fact that significant portions of an insurer's annuity business are outside the surrender-charge period or carry a relatively small penalty for the policyholder would likely create even greater financial pressures for the insurer. Many existing policyholders would have to accept a new surrender-charge period to move to a higher-rate contract, but in cases where existing policyholders incur either no penalty or only a small penalty for withdrawing funds from their contract, there will still be a significant incentive to accept the new contract, unless access to the funds is a consideration.



For policies that were issued during the past few years and have significant withdrawal penalties still in effect, the issue is different. When the policyholder has to incur a penalty to receive the higher rate, the rate improvement has to compensate for the penalty fairly quickly to justify the contract change. Bonus-rate products are designed to address this issue for the policyholder, and the sheer existence of these products makes the insurer's exposure to an exchange even greater.

It's difficult to forecast how policyholders and distribution systems will respond as rates rise. However, as the gap between new-money credited rates and existing credited rates widens, the propensity for policyholders to exchange the existing policy will increase. Conventional wisdom, which is not supported by actual historical experience, has been that policyholders will begin to accelerate their movement to higher rates when the gap reaches 2 percent or more. As a result, it is believed that a further rise in interest rates of 1 percent to 2 percent would likely trigger increased lapsation unless credited rates were increased on in-force policies. An even more dramatic rise would accelerate the potential for disintermediation.

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Rising Interest Rates

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Unfortunately, insurers' ability to credit higher rates on in-force policies—and remain profitable—is limited by their returns on existing investments. A rapid rise in rates, e.g., over a 12-month or shorter period, would not allow portfolios to respond. Insurers then would be faced with the choice of subsidizing credited rates or allowing policyholders to leave. In contrast, a more gradual rise over several years could be manageable.

Different Results for Different Companies

The financial impact of a rapid rise in interest rates will be different from company to company, based on a number of company-specific factors, including the insurer's distribution system, balance sheet diversification, product line mix and asset/liability matching approach.

Balance sheet diversification. The financial impact will show up on the balance sheet as reduced earnings from either reduced spreads, as liability credited rates rise faster than portfolio earnings, or as spreads earned on a shrinking base as policyholders leave the company in pursuit of higher credited rates. In reality, the impact will be a combination of both effects. Insurers realize that policyholders will tolerate some gap and will manage in-force policy credits to mitigate departures without having to provide market rates to all existing policyholders.

Distribution system. An insurer's ability to retain existing policyholders is also tied to the distribution system that produced the business for the company. If the producers are independent, the insurer faces increased pressure to maintain in-force credited rates at competitive levels; otherwise, the business is likely to move rapidly. Distribution systems with greater loyalty to the manufacturer are likely to tolerate a higher gap between market rates and in-force credited rates. Therefore, how a company responds to the higher-rate environment will be influenced by the distribution system's likely behavior.

Product line mix. The mix of a company's business will also play a role in determining the severity of the financial impact. Clearly, companies with diversified balance sheets will see a smaller effect. Many other products besides deferred annuities have interest rate sensitivity. Universal life and similar products would be most affected; however, the level of disintermediation with these products could be significantly lower. Other product lines, such as immediate annuities, traditional life insurance, long-term care and disability income, will actually benefit from the rise in rates. Finally, some deferred annuity writers have written market-value-adjusted (MVA) business with fixed-rate guarantees. This product design protects the company from disintermediation, although any ALM mismatch could negatively impact profitability.

Asset/liability matching. As noted above, the level of surrender charge protection also will have an impact on the financial implications of rising rates. In general, companies that have asset/liability mismatches of one year or greater will be more at risk than companies that have accepted a lower spread over the past few years to stay more closely matched.

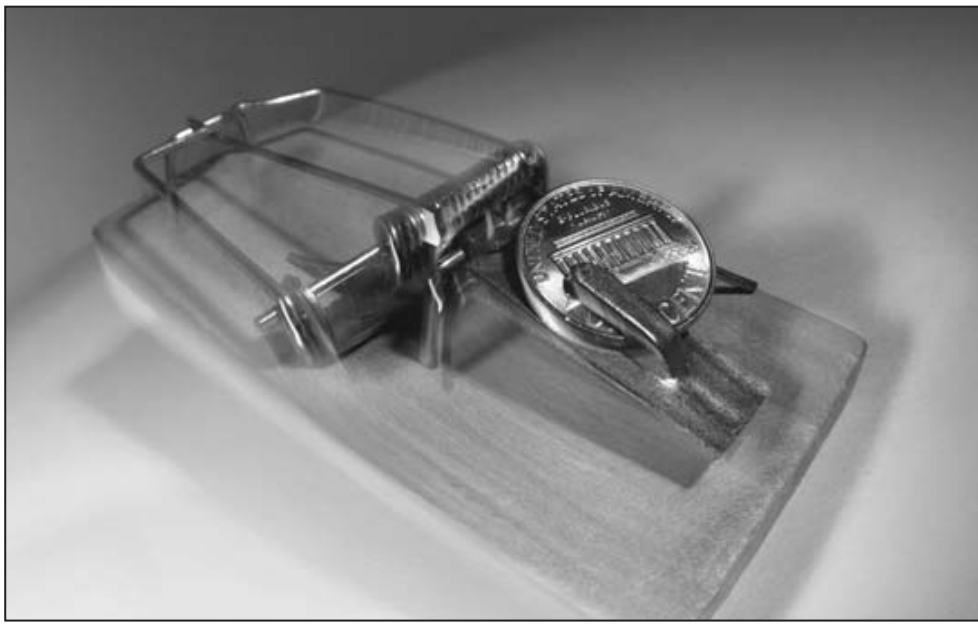
In addition, some companies have implemented risk management programs designed to respond to the rapid-rise scenario by implementing derivatives-based and/or carefully designed strategies to mitigate the effects of a rise in interest rates. How companies have positioned their assets and liabilities prior to an interest rate hike, and the nature of the hedging strategies that are in place, clearly will have an impact on the financial effect they experience once rates begin to rise.

“How companies have positioned their assets and liabilities prior to an interest rate hike, and the nature of the hedging strategies that are in place, clearly will have an impact on the financial effect they experience once rates begin to rise.”

Hoping for the Best ... Fearing the Worst

What should we hope for? A slip back to lower rates or a rapid increase in rates will present the industry with serious challenges. Margins would shrink in either scenario. The best scenario is that interest rates will stay where they are or rise gradually over time.

For those not wanting to risk an acceleration in upward rate movements, now would be a good time to evaluate investment and product management strategies that are designed to mitigate this exposure or respond as it emerges. The companies that are better prepared will produce better earnings in a rising-interest-rate environment. ✦



7702 Announcement

Get your copy of the Society of Actuaries' newest publication and first-ever book on the topic, *Life Insurance and Modified Endowments Under Internal Revenue Code Sections 7702 and 7702*A later this month. This innovative work provides a practical look at the issues surrounding federal income tax treatment of life insurance products, including the in-depth information on the statutory definition of life insurance found in sections 101 (f) and 7702, and the modified endowment rules in 7702A. An essential resource for product designers and those dealing with compliance issues on a daily basis, the book also delivers background and historical information to help readers appreciate the context in which these sections were developed.

Leading experts in the field, actuaries Chris DesRochers, Doug Hertz and Brian King teamed up with attorney John Adney to write a well-balanced book. The result is a text that reflects the actuarial theory, tax policy and political compromises underlying the statutory limitations. Formulas and calculations are provided, along with extensive legal analysis and citations.

To purchase a copy, visit the Bookstore on the SOA Web site—www.soa.org. Just click on Research and Publications.

Risk Management: The Total Return Approach and Beyond

by Thomas S.Y. Ho

Risk management for insurers is quite distinct from that for the trading floors. The main differences arise from the insurer's liabilities. They are in general long dated and illiquid with no secondary markets and some of their risks cannot be replicated or hedged. As a result, the management of the liabilities tends to be based on book value. The management performance metrics are not based in on marking to market value, but on performance over a much longer time horizon. For these reasons, "enhancing the equity" based on marking to market or over a short-term horizon can no longer be used as the performance metric. VaR approach has to be extended to the management of insurance liability before it can be useful; and, to date, managing the VaR risk of the "equity" of an insurer's balance sheet is often not considered relevant in practice.[1]

This paper discusses the risk management approaches of insurers. I will describe some of the current practices of the total return approach. Then I will describe how the total return approach is used in managing risks as a process. Finally, I propose a model that takes future sales into consideration and determines the appropriate fair valuation method of an ongoing business. The methodology enables us to determine the goal of managing the risk on an enterprise level, taking other performance metrics like earnings at risk, into account.

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A. Risk Management Practice for Life Companies: the Total Return Approach

There is no one standard approach to risk management for life companies in practice. Different insurers have their methodologies and procedures in managing risk. On the one hand, there is regulation in place to ensure that insurers comply with the adequacy of their assets in supporting their liabilities. This regulation is called cash-flow testing. Such a risk management approach is confined to managing the solvency risk. How should we manage the economic value of the insurer's assets and liabilities?

The total return approach is a risk management process that can be used to measure, monitor, report and manage the assets and liabilities on an economic basis. The total return approach has been described elsewhere (see Ho, Scheitlin and Tam 1995). I will provide a brief summary here. The total return approach can be used as an extension of the cash-flow testing methods.

The approach can use the liability models developed in the cash-flow testing to determine the cash flow of each product under different scenarios. The main difference between the two analyses, cash-flow testing and total return approach, is the use of present value measures in the total return approach versus the use of cash-flow projections in cash-flow testing. By using the present value concept, the analytical results do not depend on future reinvestment strategies. This is because when assets are fairly priced, future investment strategies (buying or selling the assets) would not affect the portfolio value today. And the present value measure for the assets is the same as the market value of the assets. Therefore, the total return approach can analyze assets and liabilities in one consistent framework. The total return approach has four steps: (a) fair valuation of liabilities, (b) determination of the liability benchmark, (c) determination of the asset benchmarks and (d)

[1] *Portions of this article are taken from "The Risk Management of Insurers" by Thomas S. Y. Ho in the* Journal of Investment Management, *forthcoming.*

establish the return attribution process. We now describe them in turn.

a. Fair valuation of liabilities

Fair valuation of liabilities begins with the determination of a pricing curve. The pricing curve is the time value of money curve that is used to discount the liability cash flows. The curve can be the Treasury curve or the swap curve. The cash flows of the liabilities are discounted by this curve to determine the present value of the cash flows. In the cases where the liabilities have embedded options, we use an arbitrage-free interest rate model to determine the interest rate scenarios and we determine the present value of the cash flows. In essence, the method uses the arbitrage-free valuation approach to determine the fair value of the liabilities. As a result, the liability cash flows are valued relative to those of the capital markets. Assets and liabilities are evaluated in one consistent framework. This method has been discussed extensively in other papers. (Ho 2000; Ho, Scheitlin, Tam 1995; Ho and Lee 2003).

As I mentioned in the previous section, the liabilities have characteristics that are difficult to treat like capital market assets. For example, some liabilities have a time to termination of over 30 years, beyond most of the capital market bonds. In these cases, one approach may be to assume that the yield curve is flat beyond a certain maturity to determine the fair value of these liabilities. Therefore the assumptions of the modeling of liability have to be specified, in general.

b. Liability Benchmark

When the liability is first sold to the policyholder, a constant spread is added to the pricing curve such that the present value of the liability is assured to equal the value of the premium of the liability sold. This spread is the option-adjusted spread of the liability and this spread is called the required option-adjusted spread (see Ho, Scheitlin, and Tam 1995.) The financial model of the liability becomes a representation of the actual liability. In particular, the liability model captures the simulated projected cash flow of the liability under different market scenarios. And the market scenarios are consistent with the observed interest rate levels, the interest rate volatilities and other market parameters.

Using the liability model, we then decompose the liability to basic building blocks. For example, we can represent the liability as a portfolio of cash flows with options. These options can be caps and floors. Or they can be swaptions. Such a decomposition may allow management to manage the derivatives separately from the cash flows. This decomposition has been explained in Ho and Chen (1996). For example, Wallace (2000) describes the construction of the liability benchmark in the management of a block of business, which can be decomposed into a portfolio of cash flows and a portfolio of interest rate derivatives.

The liability benchmark captures the salient features of the liabilities in terms of their capital market risks. As a result, the method provides a systematic way to separate the market risks and the product risks, like mortality risk. The separation of these two types of risks enables us to use the capital market instruments to manage the capital market risks embedded in the liabilities and to use actuarial methods to manage the product risks. In sum, the liability benchmark may be a liability financial model or a set of financial models represented by specific cash flows and market derivatives like caps and floors. This liability benchmark replicates the liability in their projected cash flows under a broad range of scenarios. The effectiveness of the liability benchmark depends of on its ability to capture the liability cash flows under stochastic scenarios.

An insurance company may have multiple products and product segments. Therefore, the insurers may have multiple liability benchmarks. These benchmarks have to be revised periodically since the actual liabilities' characteristics may change over time and the bench-

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“In sum, the liability benchmark may be a liability financial model or a set of financial models represented by specific cash flows and market derivatives like caps and floors.”

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marks may become less accurate in replicating the behavior of the liabilities. This revision should be conducted when the liabilities undergo significant changes.

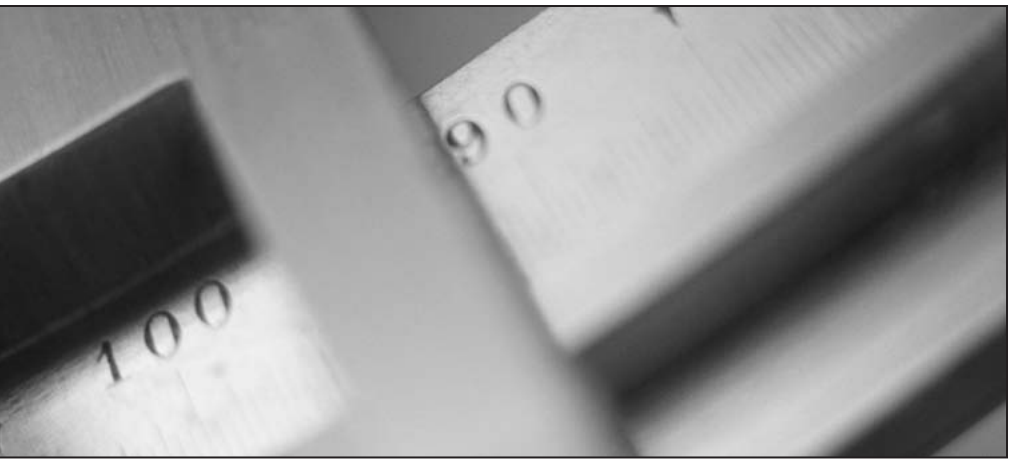
c. Asset Benchmarks

The asset benchmarks are derived from the liability benchmark. There are two types of asset benchmarks: an asset portfolio benchmark and a sector benchmark. The procedure to determine the asset benchmarks for a particular liability benchmark may follow three steps: (1) specify the investment guidelines, (2) construct the asset benchmark, (3) and construct the sector benchmarks.

1. Investment Guidelines

The procedure begins with the senior management laying out some specific guidelines about the appropriate risk that the company is willing to take. These guidelines may reflect the preferences of management and the constraints imposed on the company from outside constituents. A typical guideline may address the four characteristics of an asset portfolio.

Interest rate risk exposure limits can be set by stating the maximum allowable duration mismatch, or key rate duration mismatch, between the liability benchmark and the portfolio benchmark. Further, there may be a maximum exposure of negatively convex assets that may be allowed in the benchmark.



Credit risk exposure limits may be set by the maximum allowable percentage of assets that are categorized as high-yield assets. There can also be a minimum percentage of assets that are rated as "A" and above.

Liquidity in the asset portfolio is assured by the maximum allowable percentage of assets that are considered less liquid (or one could state them as illiquid assets). Assets that fall in this category, for example, are private placement bonds and commercial mortgages.

The senior management of some companies may also place overall broad guidelines on asset allocation—in the form of maximum or minimum allocation to certain specified classes of asset sectors.

Several other factors also affect the overall guidelines. For example, the insurance companies may incorporate the rating agencies' measures of risk, mimic the asset allocation of peer group companies, and take the desired level of capital of the company into account.

2. The Asset Benchmark

The asset benchmark consists of several sector benchmarks (which are described as follows) with appropriate weights to each asset class (which is often referred to as the asset allocation). It represents the mix of asset classes and their weights that will meet the desired needs of the liabilities while catering to the restrictions imposed by the investment guidelines.

The design takes into account the liquidity needs, the duration (or key rate durations) and convexity profile, the interest crediting strategy, minimum guarantees, required spread over the crediting rates and other product features. All of these attributes are not always identifiable

through the liability benchmarks. Therefore, it is important that the design incorporates senior management's perspective on the allowable risk that the company is willing to take. The risk is defined to include the model risks as well as the market, credit and product risks.

The portfolio managers then add specificity to the benchmark by reviewing the requirement/behavior of the liabilities, the desired minimum spread and the guidelines specified by the senior management.

The process of refining the benchmark balances the asset allocation and the duration distribution of the assets within each asset class. The latter defines the duration of the benchmark and consequentially the targeted duration mismatch between the assets and the liabilities.

Therefore, the asset benchmark is an asset portfolio that satisfies all the constraints determined from the analysis of the liability benchmark, the investment guideline and the asset portfolio management preferences.

3. The Sector Benchmark

The sector benchmark is specific to an asset sector or class of an asset (like investment-grade domestic corporate bonds, collateralized mortgage-backed securities, high-yield securities and asset-backed securities). The portfolio manager of each market sector manages the portfolio using the sector benchmark to measure the relative risks and returns of the portfolio. The manager's performances are then analyzed based on the sector benchmarks.

Thus far, we have described an asset benchmark that replicates the characteristics of the liability benchmark. However, if the asset and liability management process does not require immunizing the market risks, then the asset benchmark can be constructed with mismatching asset and liability market risks. For example, some life insurers use a mean variance framework to determine their strategic asset portfolio positions. Other insurers use the distribution of the present value of the cash flows of assets net of liabilities to determine their optimal asset portfolio.

d. Return attribution

Return attribution is concerned with calculating the total returns of the assets and the liabilities and determining the components of the returns. The purpose of breaking down the returns into its components is to detect the sources of the risks and attribute the returns to decisions made in the asset and liability management process. In identifying the impact of the decisions on the insurer's asset and liability combined total return, we have developed a procedure with a feedback effect to the management process.

The return attributions can be calculated as follows. Over a certain time horizon, say one month, we can determine the portfolio total return and the liability total return. The total return of an asset follows the conventional definition, and that is the change in the unrealized profit and loss plus the cash flow (dividends, coupons and actual gain/loss from the disposition of the assets) to the insurer's portfolio over that period. The liability total return is defined analogously. It is defined as the change in the fair value of the liability plus the cash outflows of the liability over the holding period.

Both the total returns of the assets or the liabilities can be decomposed into the basic components. These components are the risk-free returns, the option-adjusted spreads, the key rate duration returns, transactions and cheap/rich changes. Specifically, the total return of the asset portfolio is given by:

$$\Delta r_A = (r + OAS)\Delta t - \sum krd_A(i)\Delta r(i) + e_A$$

And the liability portfolio total return is given by

$$\Delta r_L = (r + ROAS)\Delta t - \sum krd_L(i)\Delta r(i) + e_L$$

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> **In identifying the impact of the decisions on the insurer's asset and liability combined total return, we have developed a procedure with a feedback effect for the management process.**

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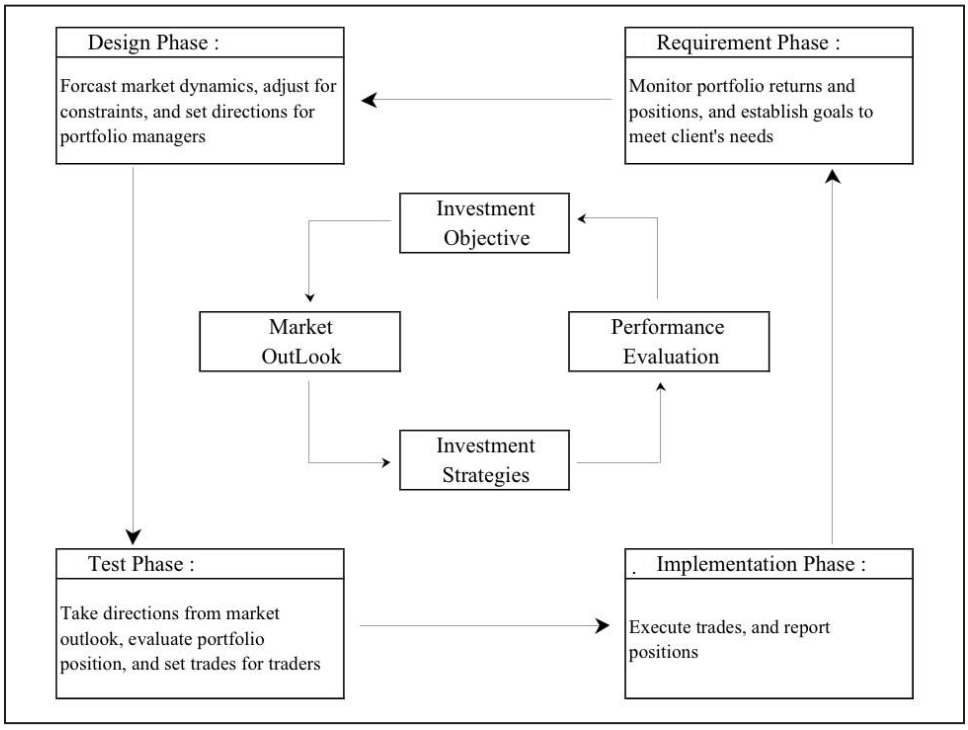
where r is the risk-free rate. OAS is the option-adjusted spread of the asset portfolio. ROAS is the required returns of the liability portfolio. $krd_A(i)$ and $krd_L(i)$ are the key rate durations of the assets and the liabilities respectively. $\Delta r(i)$ is the shift of the ith key rate relative to the forward yield curve. Finally, e_A and e_L are the residuals of the asset total returns and the liability total returns equations respectively. There may be other basic components depending on the asset and liability types. For example, there may be factors explaining the convexity effect and the product risks. For clarity of exposition, I only describe some of the components here. Details are provided in Ho, Scheitlin and Tam (1995).

Product risks are priced by the margins, which are the spreads that are part of the required option-adjusted spreads. And each product risk will be measured from historical experience. Therefore, while the asset benchmark has not incorporated the product risks explicitly, it has taken the margins for the product risks into account. The margins can then be compared with the experience of the product risks to determine the risk and return tradeoff in the pricing of the products.

Figure 1: An Investment Process



An investment cycle describes the process for making investments. There are four "phases of the investment cycle" that will oversee the milestones: the requirement phase, design phase, test phase and implementation phase. Each phase will provide the checks and balances for the following phase. The boxes for investment objective, market outlook, investment strategies and performance evaluation are indicating that they are actions to take one phase to another phase.

B. Beyond the Total Return Approach: Risk Management as a Process

The returns attribution process is becoming more important in asset management. The process relates separate departments requiring the departments to coordinate. Stabbert (1995) describes how such a coordination can be organized. Typically, return attribution, based on total return approach, is not commonly found in liability management. The lack of use of return attribution method in liability management may be explained by the slow adoption of fair value approach to analyze the liabilities. With the recent emphasis on fair value accounting to insurance companies, the return attribution approach may be adopted in the risk management practice in the future.

Risk management considers asset and liability management as a process. In this process, we then can measure the risks and the performance of each phase, and a risk/return trade-off analysis is conducted for each phase of the process. A more detailed description of an investment cycle can be found in Ho (1995) where the management of the organization is discussed.

We can construct asset and liability management as a cycle. It should be clearly organized in

order to monitor each business unit's responsibilities to determine the: asset and liability management objective, market outlook, investment strategies, product management and performance evaluation. There are four "phases of the asset and management cycle" that oversee the process: the requirement phase, design phase, test phase and implementation phase (see Figure 1). Each phase provides the direction for the following phase. The requirement phase establishes the goals to meet the client's needs. This in turn dictates the objective. The design phase sets strategies for portfolio managers, which formulates the market outlook from the investment objective. The test phase uses the market outlook to formulate investment strategies. The implementation phase executes the investment strategies that result in trades and portfolio performances, which completes the investment cycle.

Each phase can be managed separately to assure that each phase's performance ties back to the asset and liability management objectives, a process similar to quality assurance management. For example, we can decompose the risk of the process into the risks of the phases of the cycle so that each risk can be measured separately. In measuring the risk of an investment cycle, risk managers can manage all the phases of the asset and liability process.

Risk managers can implement a more complex investment cycle that will include the design phase of all the proposed business strategies to monitor and adjust the business cycle. The business cycle would enable risk managers to provide risk exposures, risk sources, risk limits and policies, etc. Implementing risk management within a business control cycle would benefit the senior management when it comes to making decisions to optimize the shareholders' value, using all the measures that impact the balance sheet's risk and profitability.

The risk management of investment using a process described above illustrates how enterprise management can be implemented by modeling the business processes of the enterprise. Now we can relate this asset and liability management process to the firm's organization.

The insurer has five departments, which are senior management, ALM Committee, portfolio management, line business and risk management. The responsibilities of each department are given as follows:

(1) Senior management is responsible for the operations of the insurer and setting the insurer's performance targets; senior management includes the management committee that represents the stakeholders' interests.
(2) ALM is responsible for determining the asset and liability structure. For the purpose of this paper, asset and liability management also coordinates with risk management.
(3) The Portfolio management is responsible for investments. Investments include asset allocation, sector rotation and securities evaluation and trading. For most insurers, portfolio management is separated into trading and other functions. The proposed methodology can be used for drilling down to such disaggregated levels.
(4) Line business is responsible for the sale of products.

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(5) Risk management, as mentioned above, is responsible for the management of the process.

The model can be used in a multi-period context. To simplify the explanation, we will present the model as a one-period model. The period refers to the reporting period, which may be one month or three months in length. The model will be used on a prospective basis when it is used for risk management. At the same time, we will also use the model on a retrospective basis when it is used for performance measures.

The model can be used on a retrospective basis for measuring the performance of each department in the process of the commercial banking business. This is accomplished by setting up asset benchmark returns (r_A^*) and liability benchmark returns (r_L^*). The benchmark returns are the returns of portfolios (loans or deposits) based on the average performance determined by senior management. For the assets, this is often accomplished by using some broad-based market index, tilted to reflect the desired risk exposure of that asset and liability management view. Similarly, the liability benchmarks are determined by the liability modeling without assuming significant superiority in knowledge and information of the line of business. The performance of the ALM department depends on the views that the ALM department takes and how their views are reflected by the benchmarks that they establish for each reporting period. Therefore, their performance is measured by the difference of the returns of the asset and liability benchmarks. Specifically, we have:

$$y(ALM)=r_A^* A-r_L^* L$$

where A is the asset value, L is the liability value and $y(ALM)$ is the performance measure. r_L^* and r_A^* are the returns of the liability and asset benchmarks respectively.

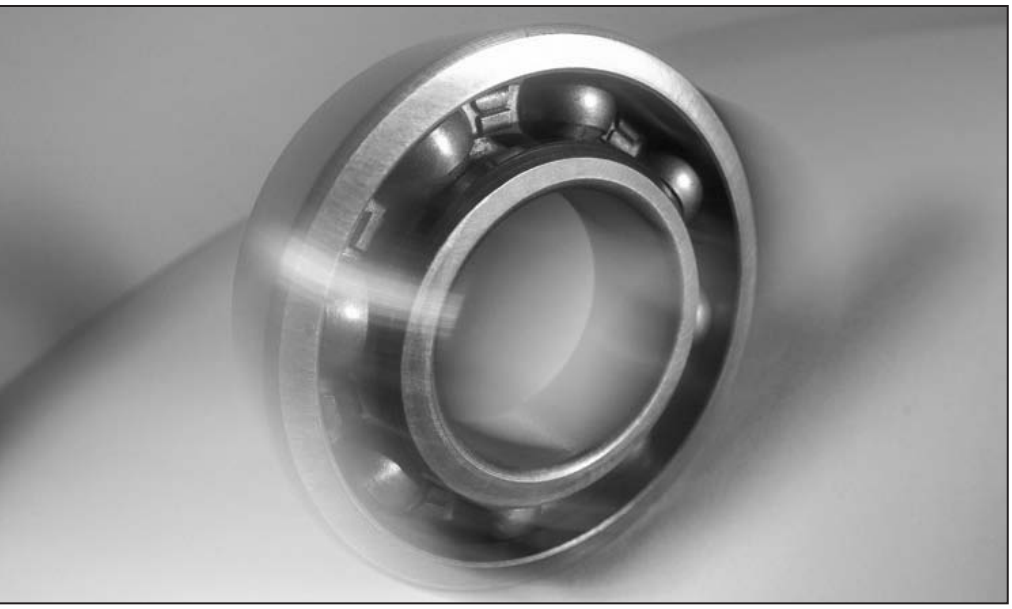
The performance of the portfolio management, $y(PM)$, is measured by the expected return of the asset portfolio net the expected returns of the benchmark on a prospective basis. For return attribution on a retrospective basis, the performance would be the realized returns of the assets r_A net the realized returns of the asset benchmark r_A. Specifically, we have:

$$y(PM)=r_A^* A-r_A^* A$$

The performance of the line business ($y(LB)$) is measured by the profits they generate from the new sales and their management of the liabilities in their performance against the benchmarks:

$$y(LB)=pv+r_L^* L-r_L L$$

where p is the profit margin and v is the sales volume.



We can now specify the corporate performance measure by noting that:

$$y=y(ALM)+y(PM)+y(LB)-FC$$

where FC is the overhead costs of the management of the business. The senior management's role is to ensure that the income y will enhance the shareholders' value by managing the process and ensuring that the net income y meets the shareholders' expectations.

It is important to note that this paper proposes a set of performance measures. It does not suggest that management compensations should be directly related to these measures, even though these measures can be part of the inputs. It also does not propose a management system to deal with human resource issues. It focuses on the process-engineering aspect of the risk transformation and control of an insurance company.

While performances in general are additive, risks are not. Indeed, not only are risks diversifiable so that they are not additive, but risks are often cross-hedged across different business lines. Therefore, risk attribution must take these issues into account to assure coherence in the analysis.

C. Beyond the Total Return Approach: The Corporate Model Approach

The total return approach focuses on managing the risks of the economic value of the in-force business. Using benchmarks in our risk management processes can assist us in managing our business, but these approaches have their limitations.

First, to manage the risk of our shareholders' value, we need to relate our models to the values of the businesses, identifying the sources of risks to our shareholders, and not only to the in-force business. There is no direct relationship between managing the total returns of the assets and liabilities to the shareholders' value.

Second, many products do not fall into the usual genre of a spread product where the total return approach is effective. These products may have significant product risk with lapse or renewal risks, more akin to a going concern business. For example, long-term health care insurance in life insurance is more like the general insurance where the potential product liability is significant and difficult to estimate.

The model that brings the two approaches together in one consistent framework is called the fair value corporate model. The corporate model is described in more detail in Ho and Lee (2004). In the corporate model approach, we determine all the assets and liabilities by arbitrage-free relative valuation models. We calibrate all the assets and liabilities to the observed securities prices.

The extension of the approach is based on incorporating the following features of modeling:

1. We specify the models of new sales. From these models, we can determine the free cash flow generated by the product sales and the asset and liability management. The present value of the free cash flow is then related to the market capitalization via relative valuation approaches.
2. We relate the economic value to the GAAP financial statements. Therefore, earnings at risk can be calculated.
3. We determine the appropriate discount rate of the business in such a way the valuation is consistent with the total return approach.
4. We determine optimal risk management to maximize the market capitalization of the insurer subject to market constraints, like the rating agencies' measure of credit risks and the stock analysts' demand on performance metrics.

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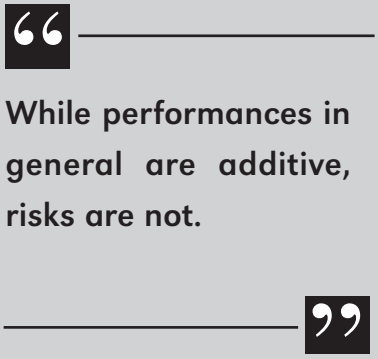

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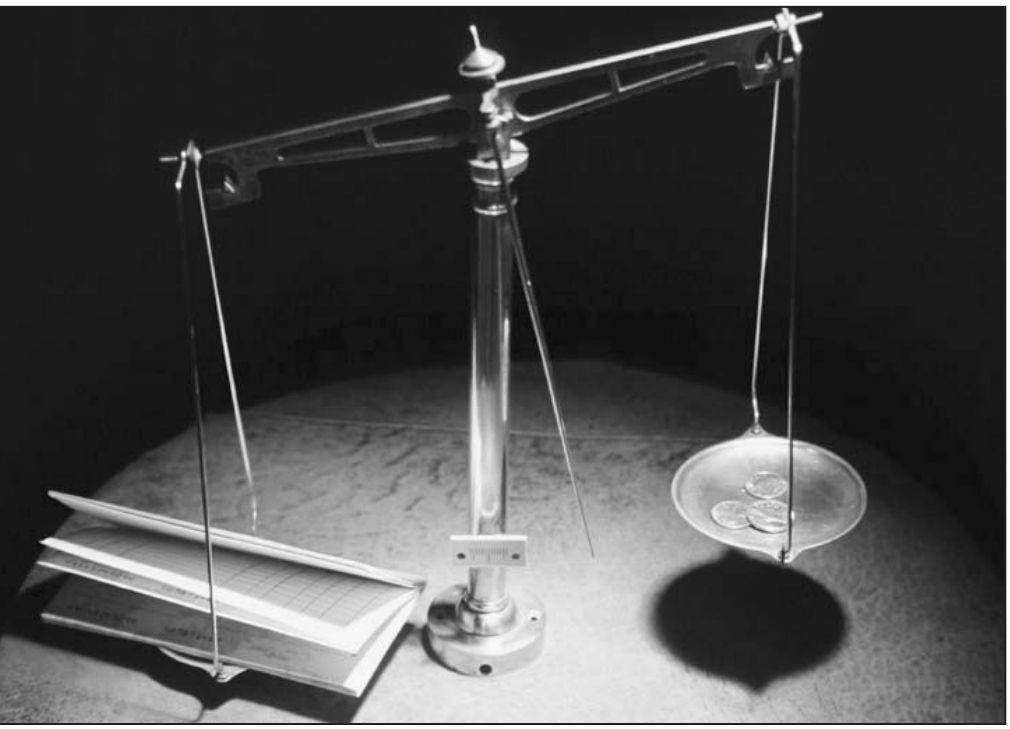
D. Conclusions

While all insurance companies are engaged in selling insurance products, they differ significantly in their approaches to managing their assets and liabilities and in managing their risks. Indeed, asset liability management and risk management in practice is quite fragmented within the industry. The methods used depend on the product within the company or depend on the business units. The approach is clearly different between one company and another.

We have shown that the life insurance company's risk management practice focuses on in-force business. They seek to manage the assets and the liabilities on their balance sheets. The fragmentation confines us in the usefulness of the asset/liability and the risk management processes. As a result, an insurer's risk management practice may be limited to determine whether a product's risk can be appropriately managed or a business unit satisfies a solvency test, but we cannot determine how each business unit should be optimally managed. Methodologies have been proposed to answer these questions.



I propose a general approach, which is to incorporate the future projected sales and the valuation of the firm in the financial modeling of the insurance company. Under a more integrated framework, we could deal with risk management in a broader context. Specifically, I propose using a corporate model that uses the arbitrage-free approach in valuing the assets and liabilities and incorporates the future sales of the products to develop a going concern approach to determine the free cash flows of the insurer. We then relate the risk management impact on the assets and liabilities to the market capitalization of the insurer and the impact of the firm's financial statements. In doing so, we can relate risk management to many performance metrics of the firm, like earnings at risk. Given this relationship, we can then develop a consistent methodology to determine the optimal risk management.

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  Health Solvency—Trevor Pollitt
CRO (Juan Kelly)
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All groups are open to additional volunteers. No experience necessary.

Risk Management Seminar Visits Six Asian Cities

by David Ingram

Editor's note: Reprinted with permission from *Asia Insurance Review*

"You are always at the mercy of your dumbest competitor," George Tang warned the crowd at the Joint Regional seminar on Risk Management in Kuala Lumpur. In fact, George actually said that six times to five additional audiences in Taipei, Hong Kong, Shanghai, Seoul and Tokyo. George is an actuary at the MassMutual Mercuries Life Insurance Company in Taipei. He addressed many of the practical issues for risk managers practicing in Asia, pointing out that risk management goes beyond ALM to encompass operations, products, financials, investments, legal and market (sales) conduct.

The most popular part of George's presentation in each and every city was when he addressed Asian cultural issues that impede risk management effectiveness. Common behaviors such as reticence to say a direct "no" and the propensity to avoid controversial topics are often in direct conflict with effective risk management. George suggested strategies to overcome these problems such as presenting solutions along with problems and seeking personal opinions in private meetings.

Kuala Lumpur was the starting point for the traveling seminar. The seminar was jointly sponsored by the Faculty and Institute of Actuaries, the Society of Actuaries China Regional Committee and the Institute of Actuaries of Australia as well as local actuarial bodies in each city. The audience topped 100 in KL as it did in every city and the seminar was held in the shadow of the Petronas towers. Interest in KL was high since insurance companies in both Malaysia and Singapore are being challenged by their regulators and sometimes also by bank owners or partners to implement bank-style risk management.

"You are not alone. Insurers in many countries are suffering," said Steve Miles, a Tillinghast consultant from Singapore. Steve talked about strategies for a low interest rate environment. He described how regulators were taking completely different approaches to the problems caused by low interest rates in Japan, China and Singapore.

In Japan, regulators played for time, hoping that rates would rise, by bending solvency rules, manipulating interest rates and providing subsidies or preferred loans. Since interest rates failed to rise, those actions encouraged unhealthy competition and ultimately increased the cost to the taxpayer of bailing out the most troubled companies.

In China, regulators have permitted relatively weak reserving levels, allowing companies to cover shortfalls from unprofitable in-force business with future margins from profitable new business. The Singapore regulators have gone the route of developing a risk-based capital requirement. This requirement will encourage companies to look more at reducing the risk inherent in product structures.

Taiwan was the second stop on the tour. There the need for good risk management practices is becoming evident with the emergence of significant negative interest spread in the in-force business. ALM practices are being developed in many companies with the usual concern of how to match when the available assets are too short and/or too low earning. Regulators have recently changed the regulations on par business, in hopes that more companies will sell those products with significant margins that can cushion against future risks, but true par business has yet to become popular in Taiwan, and it remains to be seen whether it will be widely accepted as an alternative to non-participating and unit-linked/variable products. We left Taiwan as a typhoon was approaching. It fol-

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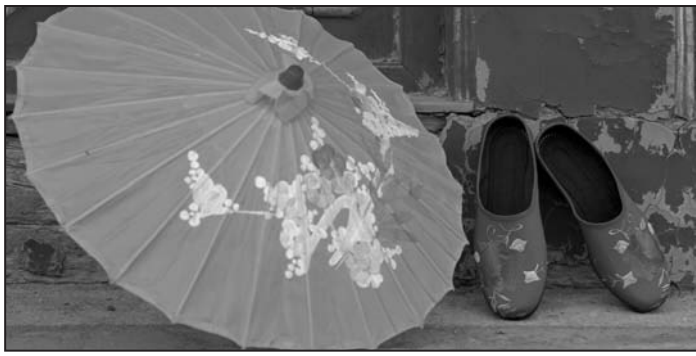
lowed us for most of the rest of the tour, but we kept one city ahead at all times.

Neil Parmenter, or Pong Ming Dur as he liked to introduce himself, the current president of the Society of Actuaries kicked off the seminar in each city with a talk about the importance of Asia to the SOA. Asian actuaries account for a large portion of the growth of the SOA over the past 10 years and the membership of the SOA in Asia continues to have strong growth. Neil also told of the importance of risk management to the future of the actuarial profession and the work that the SOA and the Casualty Actuarial Society are doing to help to position actuaries to be the first called for chief risk officer positions.

In Hong Kong, we saw the nightly laser light show and spoke to a very diverse crowd of aspiring and current risk managers. People from all over the world are working in the insurance industry in Hong Kong. Hong Kong has a large contingent of international companies, many of whom have brought risk management practices from their parent companies to Hong Kong. Risk management practice and regulation in Hong Kong are among the strongest in Asia but there is room for improvement and seminar attendees were looking for help to identify their next risk management development step.

"Market consistent embedded value is not a replacement for embedded value, but an enhancement" said Mark Saunders, managing principal and head of Tillinghast in Asia. As Mark explained, MCEV helps you obtain a robust measure of risk, bringing the concepts of modern finance theory into the valuation and risk assessment of insurance companies. Those concepts include: (1) risks that can be diversified away do not command a risk premium; (2) systemic risks can be replicated with a portfolio of traded assets; (3) two portfolios with the same cash flows have the same value; and (4) the value of a company is more (or less) than the sum of its discrete parts. With MCEV an explicit allowance is made for the cost of policy guarantees and policyholder options in assessing the value of the insurance company and/or line of business. In the MCEV calculation, the appropriate risk discount rate should be based on the real risks. Even though MCEV is not yet widely accepted, Mark recommended that it should be used to give additional insights into the business so that alternative perspectives can be understood and that sensitivity testing is essential. Mark concluded that MCEV helps you be better informed. The better informed you are, the better placed you are to succeed.



Following Mark's session we had the liveliest round of questions and answers yet. The Hong Kong attendees were clearly interested in these enhanced techniques and were up-to-speed on the issues as EV determination is common practice for Hong Kong insurers.

We landed in Shanghai and the entire group of speakers and our invaluable coordinator, Pat Kum of the Actuaries Office in Hong Kong brought us directly to Zhou Zhuang, a traditional Chinese water village with canals running throughout the town and picturesque footbridges. A packed hall heard our seminar the next day and a presentation the following day from a locally based actuary, Terrence Cummings of AIA, on the topic of annuity longevity concerns. Many students and recent graduates were in the audience who are all hoping to put their recent risk management learnings to good use. Insurance industry focus in Shanghai has been on growth, not risk management however. The regulations and underdeveloped capital markets currently restrict investment options significantly. This will change in time and more sophisticated risk management should become possible in future.

"Many insurance companies are struggling to close the gap between the design and planning stages and the actual execution and integration of their ERM programs," said Robert Fok, PWC Director of Actuarial Services in Hong Kong. Robert spoke about a recent survey of global risk management practices. The survey report-

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ed the responses of 44 companies in Asia, Europe, North America, Australia and Africa. Most companies have several key components of ERM in place such as enterprise-wide risk identification, risk assessment, risk response and controls and monitoring. However the survey found that ERM is not yet aligned with strategic planning. ERM is not fully integrated across companies and there is often an absence of clear standards for risk taking. In total, only 8 percent of the companies polled felt that their ERM system was fully in place and operating effectively.

> **“The savvy corporate leader uses risk management as both a sword and a shield ...”**

City number five was Seoul. By this time we were waking up not knowing where we were and dreaming that we were being asked to do each other’s presentations. Risk management is a hot topic in Korea. Events following the “Asian currency” crisis of 1998 seem to have driven home the importance of ALM to Korean insurance companies. Most would like to develop sophisticated ALM programs but are stymied by the lack of long-term assets in the Korean financial markets. The Korean regulator has been working on a requirement that companies adopt a full-scale risk management program, phased in over several years. Companies are beginning to implement ERM and find themselves with questions about how it is being done in other areas of the world.

“Many life insurance products have the characteristics of highly complex financial derivatives,” Paul Headey stated. Paul is the head of the Milliman Hong Kong office. His presentation discussed ways of hedging insurance product options and the impact such strategies could have on product development. Since there are few if any traded financial instruments that can be used to replicate insurance product options, the delta hedging process is often used. With delta hedging, the sensitivity of the insurance contract to changes in the marketplace is matched by securities with the same sensitivity. Frequent rebalancing is usually necessary to keep a delta-hedging program effective. In some cases insurance companies can purchase a static hedge contract customized by a bank for their risks. Rolling hedges are used for currency exposures that last beyond the horizon of any FX contracts. Insurance risks usually have fatter tails or extreme situation loss characteristics than most market traded instruments. Risk managers were urged by Paul to be careful when modeling risks, and that they should start simple and refine their models as they learn.

Tokyo provided a very warm—well, actually a very hot—welcome to our final stop on our seminar. Japanese companies have been practicing many of the aspects of risk management for several years, but are still developing their capabilities to fully quantify their risks. The audience presented many challenging questions to the speakers as participants were clearly hoping to go away with knowledge that they could immediately use and they wanted to make sure that they fully understood the presentations.

“The savvy corporate leader uses risk management as both a sword and a shield,” was a quote from John Hunkin that Dave Ingram used to open his presentation. Dave is a Milliman consultant in New York City. As head of the SOA Risk Management Section, Dave has seen the risk management operations of many North American companies. Key to the success of an ERM program is the development of a risk management culture. He presented a set of 12 risk management best practices as a sample of one way that a risk management culture can be defined in a company.

1. Board and senior management are responsible for risk management.
2. Senior management understands all firm activities and understands the basis of the risk management system.
3. Authority and responsibility are clearly defined and risk measurement and management are independent from risk taking functions.
4. All material risks are identified and measured; exposures are aggregated and

management attends to the largest exposures.
5. There are risk limits for all material risks and a system for enforcing the limits that is part of an internal control system.
6. The firm has staff with sufficient expertise to perform the risk management functions and adequate systems support.
7. Risk surplus is allocated to business units and products and used for capital budgeting purposes.
8. Stress testing is a part of the risk management process.
9. New products and ventures trigger consideration of potential risks and new risk management procedures.
10. Financial reporting allows management to view the risk-adjusted returns of business units, products and activities.
11. Product pricing and rate setting reflects the risk adjusted return.
12. The firm has a process for quickly resolving identified risk management weaknesses.

Dave urged each audience member to develop their own list of risk management best practices, taking into account their company culture, capabilities and goals.

Suddenly, the sixth seminar was over and we swore never to give those presentations again. No sooner was I back to New York than I was asked to give my best practices presentation in the fall in Nebraska. Well, it was a hit all over Asia, why not Nebraska? These seminars really did permanently enlarge my world. Hopefully we did the same for our audiences. ✦

Book Review

Risk Management by Michel Crouhy, Dan Galai, Robert Mark

by Fred Tavan

This book is a 'must-read' for any serious student of risk management. It provides a comprehensive introduction to the subject. Presented within the framework of a financial institution, it covers the design and operation of a risk management system, the technical modeling within the system, and the interaction between internal oversight and external regulatory requirements. The mathematical models and methodology of risk management are presented rigorously, and they are integrated with the empirical evidence on their application.

This book covers the entire field of risk management from policies to methodologies, as well as data and technological infrastructure.

The reader can learn about using different VaR approaches to measure and manage market and credit risk. Approaches other than VaR are also detailed. Pros and cons of each approach are summarized for quick reference. RAROC concepts are described and provide a good starting point for a student's education in this area. Operational risk management is covered in a practical way and a framework is described for operational risk assessment.

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Guaranteed Annuity Options or a Fine Mess

by Mary R. Hardy

1. INTRODUCTION

The actuarial profession in the UK is under unprecedented external scrutiny currently. The serious financial difficulties faced by Equitable Life (UK), the oldest mutual insurer in England, led to the government commissioning an investigation by a senior law lord. The result is the recently published *Penrose Report*. As a consequence of criticisms of the profession in the *Penrose Report*, the government then asked a senior economist, Sir Derek Morris, recently retired chairman of the competition commission to review the way the UK profession sets standards and monitors performance. Although the word 'crisis' is not being publicly bandied about, there is a lot of discomfort around Staple Inn, the headquarters of the Institute of Actuaries.

The solvency problems, which brought Equitable Life (UK) to close its doors to new business, and which nearly broke several other companies, arose from an obscure rider to some insured defined contribution pension contracts issued in the 1970s and '80s. The rider was an annuitization guarantee, called the guaranteed annuity option (GAO), and the risk management challenges that this option created are the topic of this article.

The most significant contributions to the discussion of risk management of these options are Wilkie et al (2003), Ballotta and Haberman (2003) and Boyle and Hardy (2003), where more details about the results in the next couple of sections can be found.

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2. THE GAO

The GAO was attached to with-profit and unit-linked, single-premium and annual-premium contracts. Although most of the contracts affected were with-profit, we will look at a single premium unit-linked version here, as it is more transparent and therefore easier to describe and model than the with-profit version. A unit-linked contract is very similar to a variable annuity contract in the United States, or a segregated fund contract in Canada; premiums (after deduction for expenses) are invested in a fund similar to a mutual fund, with certain guarantees on death and possibly maturity.

Suppose the policyholder's fund at maturity is denoted $F(n)$. The GAO rider guaranteed an annuity rate g such that that the pension after annuitization would be no less than $F(n)/g$. Typically, for a 65-year-old male, $g = 9$. Now, without this guarantee, the pension would depend on the annuity value $\ddot{a}_{65}^{(12)}$ at maturity, which would obviously vary with interest rates, as well as being updated from time-to-time to allow for improvements in mortality. For a cost-neutral annuitization, the amount of pension would be $F(n) / a_{65}^{(12)}$.

So, if $a_{65}^{(12)}(t)$ is the market value of the unit annuity at time t, then the payoff of the option at maturity at time n, say, is

$$\max\left(\frac{F(n)}{g} - \frac{F(n)}{a_{65}^{(12)}(n)},\ 0\right) a_{65}^{(12)}(n)$$

Now, $F(n)$ is the accumulated fund; if the original premium is P, and letting S_t denote the market value of the investment fund at t, then

$$F(n) = P\,\frac{S_n}{S_0}$$

So that the payoff formula can be rearranged to:

$$P\,\frac{S_n}{S_0}\quad \max\left(\frac{a_{65}^{(12)}(n) - g}{g},\ 0\right)$$

This is a quanto interest rate option. A quanto option is one that is measured in units different

from standard cash units; in this case the payoff is in units of the final fund value. The option itself depends on mortality and interest. We will focus on the equity and interest rate risk, though the cost of mortality improvement has also proved a significant nondiversifiable risk factor.

We can see the experience of the option cost over the last 25 years in Figure 1. This gives the cost of the option per $100 maturity proceeds at retirement for a male age 65 using an up to date mortality table (PMA92(C20)). In the mid-'90s, actuaries began to be aware of the potential liability, and in the late '90s, the true cost of falling interest rates became evident. The figure does not show the cost of the spectacular equity returns in the 1990s.

3. VALUING THE OPTION

3.1 Using Jamshidian's formula for options on coupon bonds

Given that several companies have substantial GAO liability risk, there has been some discussion of how to manage the risk now that it is better understood. Many companies have used reinsurance through banks. The modern actuarial approach to risk management might be to project the liabilities under P-measure, and use a discounted tail measure as a capital requirement. This approach is explored in Wilkie, Waters and Yang (2003). Pelsser (2003) discusses the use of swaptions, though this only manages the interest rate risk, not the equity or mortality parts of the liability.

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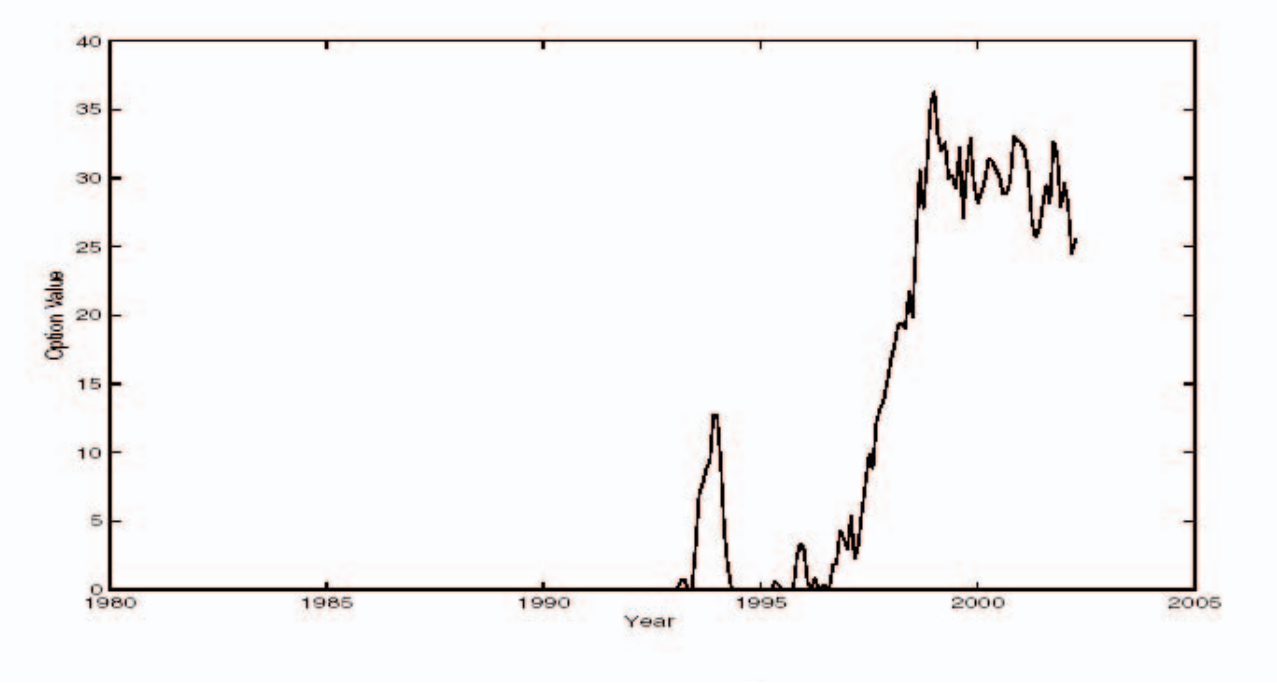
Figure 1: Emerging GAO Cost Per $100 Maturity Proceeds



Guaranteed Annuity Options

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From an option pricing viewpoint, the GAO is easier to price than to hedge. We will demonstrate an approach to pricing here.

Assume annual pension payments in arrear, and letting $D(t, T)$ be the price at t of a pure discount bond maturing at T, then we have

$$a_{65}(n) = \sum_{j=1}^{\omega-65} {}_jp_{65}\, D(n, n+j)$$

Using $D(t, n)$ as numeraire means that for any option payoff at n, say, the value at $t < n$ is

$$V(t) = D(t,n) E_Q [V(n) \mid \mathcal{F}_t]$$

Q here represents the forward measure.

The payoff of the GAO at maturity, assuming survival, is

$$V(n) = P \frac{S_n}{S_0} \quad \max \left(\frac{a_{65}^{(12)}(n) - g}{g} \ , \ 0 \right)$$

Assume $P = S_0$, for simplicity. The guarantee applies only to lives who survive to annuitize. The value at t of the payoff for a life age $x < 65$, $x+(n-t) = 65$, allowing for survival is then

$$G(t) = {}_{65-x}p_x\, D(t,n)\, E_Q \left[S_n \frac{(a_{65}(n) - g)^+}{g} \,\middle|\, \mathcal{F}_t \right]$$

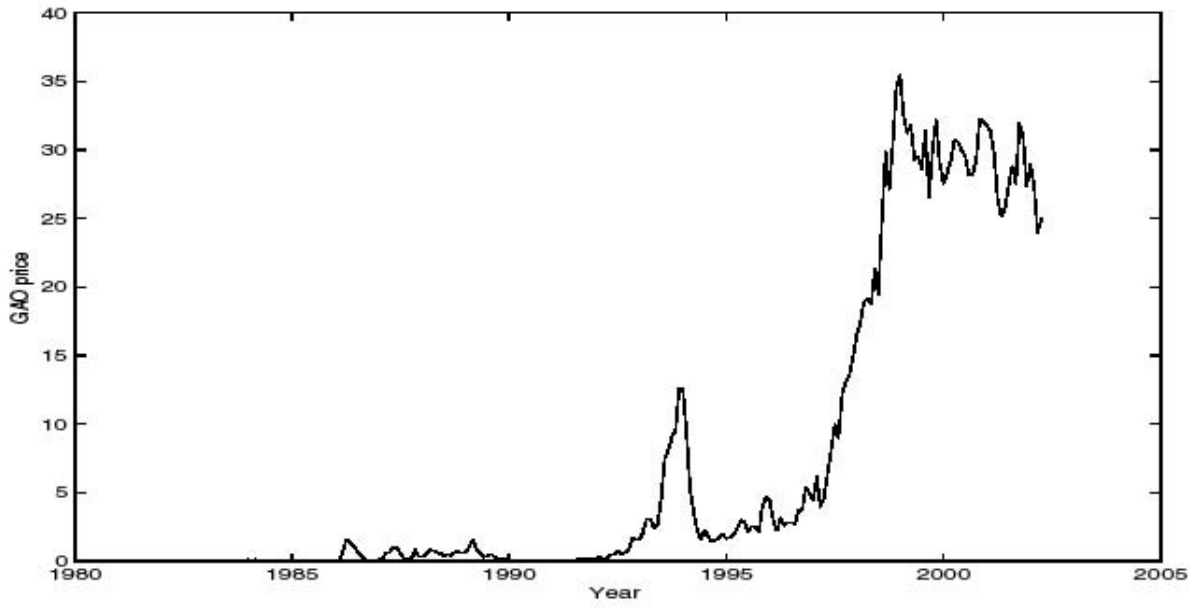
If we assume further that S_t is independent of $D(t, T)$—that is, that interest rates and stocks are independent, then we can simplify further. Recall that under the Q-measure, the discounted value at $t < T$ *of* S_T must be S_t, so:

$$G(t) = {}_{65-x}p_x\, D(t,n)\, E_Q[S_n]\, E_Q \left[\frac{(a_{65}(n) - g)^+}{g} \,\middle|\, \mathcal{F}_t \right]$$

$$= {}_{65-x}p_x\, S_t\, E_Q \left[\frac{(a_{65}(n) - g)^+}{g} \,\middle|\, \mathcal{F}_t \right]$$

So, we have effectively eliminated the quanto problem, and we are left with an (undiscounted) interest rate option. In Boyle and Hardy (2003) the annuity is treated as a coupon bond, and we use Jamshidian's formula for valuing options on coupon bonds in terms of options on pure discount bonds (Jamshidian 1989). In order to apply this, we use the Hull-White (or

Figure 2: GAO Option Value, 10-years to Maturity, % of Fund



extended Vasicek) single-factor interest rate model. The interest rate model is fitted to the term structure at the valuation date. In Figure 2 we show the resulting option prices for a contract valued at the dates given on the x-axis, assuming a life age 55, that is, assuming 10 years to maturity. At the more recent dates the values are very similar to Figure 1 as they should be. The option is deep in the money, and because the graph is shown in units of the fund S_t, the cost is unaffected by discounting[1]. Notice though, that the option price gives some slightly earlier warning that the option might cost money.

Although we have an option price, we don't really have a hedge. It is well known in the area of interest rate options that single-factor models don't give very good hedges. While they might adequately model the Q-measure distribution of losses at maturity, they do not adequately model the Q-measure process over the term of the contract. An accurate representation of the process is required for the dynamic hedge. For the dynamics of the interest rate process to be sufficiently accurate a model with at least two stochastic factors is required, but modelling such a complex option with a two-factor model would be very difficult.

However, we can indicate roughly what the hedge looks like by using a much simpler model for interest rates.

3.2 Using a lognormal assumption for $a_{65}(t)$

There is substantial autocorrelation in the values for $a_{65}(t)$. Nevertheless, in order to give an indication of what the hedge might look like, we assume that $a_{65}(t)$ follows a lognormal process; we also continue to assume that the annuity is independent of equity performance. Note that I am not advocating this approach! I am just using it to illustrate what this hedge might look like. With different assumptions the hedge would look broadly similar.

With these assumptions we can express the option value as

$$G(t) = {}_{65\text{-}x}p_x\, D(t,n)\, E_Q[S_n]\, E_Q\left[\frac{(a_{65}(n)-g)^+}{g}\middle|\mathcal{F}_t\right]$$

$$= \frac{S_t}{g}\,\frac{{}_{n\text{-}t}p_x}{D(t,n)}\, E_Q\left[D(t,n)\,(a_{65}(t)-g)^+\,\middle|\mathcal{F}_t\right]$$

and now the expectation term is a simple option on the risky asset $a_{65}(t)$. The resulting option cost is

$$G(t) = {}_{65\text{-}x}p_x\, S_t\left\{\frac{a_{65}(t)}{g}\,\Phi(d_1) - \Phi(d_2)\right\}$$

where

$$d_1 = \frac{\log(a_{65}(t)) - \log g + \sigma_a^2\,(n-t)/2}{\sigma_a\sqrt{n-t}},$$

$$d_2 = d_1 - \sigma_a\sqrt{n-t}$$

and σ_a is the volatility of $a_{65}(t)$.

We can hedge this in three parts: an annuity part invested in $a_{65}(t)$, H_t^a, say, a bond part in a pure discount bond maturing when the policyholder reaches age 65, H_t^b, and an equity part invested in the same assets as the premium, H_t^s. Each part is determined, as usual, by differentiating the bond price with respect to the different assets.

The result is

$$H_t^a = {}_{65\text{-}x}p_x\,\frac{S_t}{g}\;a_{65}(t)\;\Phi(d_1)$$

$$H_t^b = -H_t^a$$

$$H_t^S = {}_{65\text{-}x}p_x\;S_t\left\{\frac{a_{65}(t)}{g}\,\Phi(d_1) - \Phi(d_2)\right\}$$

continued on page 26 ▸

[1] *We know that the undiscounted value of a deep in-the-money option is more or less the current moneyness.*

Guaranteed Annuity Options

◗ continued from page 25

Which just says that we take the entire option value and put it in the equity fund, and in addition short sell some bonds maturing at the retirement age, and use the proceeds to buy the annuity asset. Even when the option value is relatively small, the positions taken in the bond and annuity might be substantial. For example, assume $\sigma_a = .025$, $g = 9$, and consider a life age 45 with 20 years to retirement. If the long-term rate of interest is around 10 percent (as it was in the early '80s), then the option price is low, at around 0.2 percent of the initial premium. However, the annuity hedge amounts to around 5 percent of the premium, much more substantial, and the sensitivity to changes in the annuity value is more apparent.

“Perhaps the first lesson from the GAO story is that insurers need to be very careful about all financial guarantees, and that (almost) no guarantee is really cost-free.”

4. SOME THOUGHTS

Even though with some simplifying assumptions, the ongoing challenge of hedging is very difficult. Perhaps the first lesson from the GAO story is that insurers need to be very careful about all financial guarantees, and that (almost) no guarantee is really cost-free. Some insurers were so casual about these guarantees that they did not even record which policies carried the option and which did not. They may have believed that they could mitigate the cost of the guarantees by adjusting the with-profit bonus (dividend) when the policyholder exercised the option—giving with the right hand and taking away with the left. The high court found that approach was not an acceptable interpretation of the concept of a guarantee.

The second lesson might be to emphasize the importance of financial mathematics—the mathematics of financial guarantees—in actuarial education. Under the current plans for the 2005 SOA education redesign, only risk management and investment specialists will learn financial mathematics. But the optimal risk management for GAOs would have been not to offer them in the first place (however fascinating they might be to financial engineers). A deep understanding of the nature of financial guarantees is critical at all stages—product development, marketing, valuation and risk management. Every life insurance actuary needs to be comfortable with the characteristics of financial guarantees and how these are managed. Therefore, every life insurance actuary needs to have a good grasp of modern financial mathematics. We must ensure that actuarial education provides what is necessary.

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2005 Enterprise Risk Management Symposium

Building on the tremendous success of the last two years, the Society of Actuaries, Casualty Actuarial Society, Georgia State University's risk management department and Professional Risk Managers' International Association are partnering again to announce the 2005 Enterprise Risk Management Symposium. This world-class professional education event will focus on risk management issues applicable to the entire spectrum of the risk profession, making this event appeal to any professional practicing or seeking to practice in this emerging discipline.

In spite of its tender age, this symposium immediately received great attention from the risk management community after its launch in 2003. It has consistently brought together some of the best and the brightest minds in ERM, who, over the course of event, have been able to successfully network and deliberate on a variety of critical issues in enterprise-wide risk management.

The following are expected general themes for the 2005 ERM sessions. The intent is to address various areas of practice and various industries —from financial services to energy and corporate, and beyond, allowing for cross-pollination of the best risk management practices across various economic sectors. Both practical and conceptual presentations are going to be encouraged.

- Correlation and integration of risks across an organization
- Creation of value through ERM
- ERM risk reporting formats
- ERM—theoretical foundation
- Translating risk monitoring and measurement into decision-making
- ERM frameworks
- Risk capital and management
- Operational risk measurement

Please mark your calendars!

The 2005 ERM Symposium is scheduled for May 2-3 and will be held at the Sheraton in downtown Chicago.

There will also be a separately bookable, limited-attendance ERM Essentials Workshop on May 1, targeted at senior management. Senior managers interested in establishing effective ERM frameworks within their companies will benefit from attending the workshop, taking a step-by-step look into the art and science behind ERM and utilizing the opportunity for personalized interaction with the ERM expert panelists.

A separate stand-alone dedicated Web site is being created for the symposium. It is expected to be launched in October-November. In the meantime, you can view the 2004 ERM Symposium program at *http://www.casact.org/coneduc/erm/2004/*. ✦

2004 Bowles Symposium: Extreme Value Seminar

by Steve Craighead

Our seminar at the Bowles Symposium was so packed with intense mathematical formulae and discussions of complicated material that you might feel as if you just took a 10-week graduate course in three hours!

However, in those three hours we covered the fundamentals of the use of extreme value theory in risk management. Here we discussed domains of attraction (this describes whether a statistical distribution has a light, medium or heavy tail). We examined various distributions that one would fit to model these domains of attraction such as Fréchet, Weibull, Gumbel and generalized extreme value distributions. We examined ideas of conditional tail expectation (CTE) (just think of this as an average of claims over a threshold). This discussion also included methods to estimate the required number of scenarios for different levels of CTEs. We covered many other topics as well, that are related to understanding and modeling risks.

Dr. H. N. Nagaraja, a world expert in extreme value statistics who is from Ohio State University, was the primary speaker. His presentation was excellent (notwithstanding the complexity). His paper is one of my favorite references as I create new applications using extreme value statistical techniques at my company.

I made two contributions. First, I punctuated Dr. Nagaraja's presentation with brief exposés of insurance applications of the current topic under discussion. Second, I demonstrated a spreadsheet that I have used over the past 12 years to implement some of the extreme value statistical techniques that Dr. Nagaraja presented.

This sheet is fairly simple. First the user inputs the data he or she wishes to examine (starting in cell C22 of the sheet). When the user processes the sheet, it provides two results. The first is that it gives the domain of attraction (remember this is how much area is in one tail of a distribution) as reported in cell C17[1]. The second result is that it allows the user to input a list of various extreme percentiles (such as 0.01 percent) starting in cell H22 and it will extrapolate the user's data to estimate these percentiles. This extrapolation is done either by a kernel method[2] or resampling[3]. A kernel method is where one fits a specific statistical distribution (the kernel) locally over a small subset of the data. This process creates something very similar to a moving weighted average of the data. The size of the local subset used is determined by a distance called a bandwidth. For the actuaries that have used graduation, this is very similar to the ideas used in the Whittaker-Henderson graduation method. Resampling is where one uses their data over and over (resampling) to determine specific statistical values, in this case the extreme percentiles.

The user chooses which kernel by entering a "1" in either cells C4, C5 or C6, which are normal, lognormal or Pareto. Note: Lognormal is most frequently the best kernel.

If the user wants to use resampling, enter a "1" in the resampling cell C7.

Note: The options of fitting the Fréchet, Weibull and Gumbel distributions are not currently active in the spreadsheet.

Next the user should specify how many elements are in the data in cell C12. The sheet does not set an express limit on the number of

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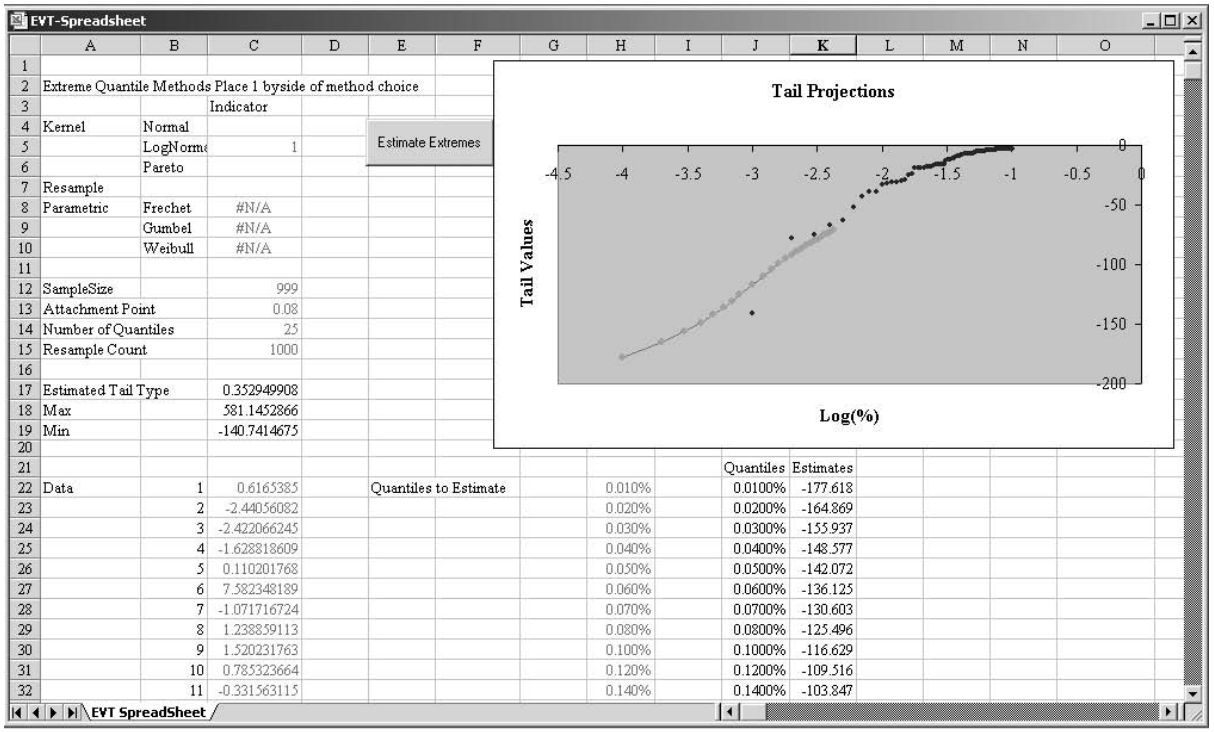
[1] The algorithm is described in the article "The Selection of the Domain of Attraction of an Extreme Value Distribution from a Set of Data," by Castillo, E., Galambos, J., and Sarabia, J. M. This is a chapter in *Lecture Notes in Statistics Vol. 51: Extreme Value Theory* edited by J. Husler and R. Reiss and published by Springer-Verlag.

[2] Dan Heyer, FCAS, introduced me to the use of kernel methods in extreme value estimations in reinsurance.

[3] This method was introduced by D. Zetterman, in the article "A Semi-parametric Bootstrap Technique for Simulating Extreme Order Statistics." This is an article in the June 1993 *Journal of the American Statistical Association* (Vol. 88, No. 422, pp. 477-485).

elements that you can input, however, you many need to revise the diagnostic graph to reflect more than 999 elements.



In cell C13, the user inputs where they believe that the tail of the distribution begins. I have stolen a reinsurance term here and call this the attachment point. This is entered as a percent. Frequently this is a lower percent, which is contained within the data provided. Most frequently reinsurance companies use 1 percent or 2 percent. If you set this value too high, your extrapolations may be too conservative.

In cell C14, enter the number of extreme percentiles that you wish to extrapolate. Recall these were input starting in cell H22.

If you are using resampling, cell C15 is where you specify how many scenarios that you wish processed.

When ready, you execute by pressing the estimate extremes button. Three things then occur.

The first result is that the estimated tail type is updated. If the value is greater than 2, the tail is light. If the value is between 0.5 and 2, the tail has medium weight. If it's below 0.5, the tail is heavy.

The second result is that the extrapolated estimates are placed in cell K22 and below.

The third result is that the diagnostic graph is updated. This is a graph of the 10 percent left tail (in black dots) with the extreme percentiles (purple dots with a blue line) superimposed. The x-axis is the log of the percent.

By playing with your choice of the kernel or resampling, you can examine your own data.

I have used extreme value theory in determining the riskiness of a product. This is indicated if the Estimated Tail Type is less than 0.5.

Other areas where the extrapolation was critical were insolvency analysis and capital needs. Most of our computer financial models are highly accurate, but extremely slow to process. Here I have used extrapolation to obtain extreme percentiles that otherwise may take days or months to obtain from an existing model. The model could also be used to estimate extreme claims, if one would subtract the claim amounts from a very large number. This converts a right tail problem into a left tail problem. By then mapping the threshold by the same method and estimating many extreme percentiles, one can then average these and determine a mean claims over a threshold.

Both Dr. Nagaraja's excellent reference paper and my spreadsheet are available on the CAS 2004 Bowles Symposium Web page (look for Track E) at *http://www.casact.org/coneduc/erm/2004/handouts/* . My spreadsheet is also available on the Risk Management Task Force Extreme Value Subcommittee Web page: *http://rmtf.soa.org/rmtf_evm.html*. Any future updates of my worksheet will be placed on the latter Web site. ✦

Risk Management Sessions at SOA Annual Meeting

The Risk Management Section sponsored the following sessions at the 2004 Annual Meeting in New York:

RM 14 PD—Integrating and Aggregating Risks

Moderator: Frank Sabatini (Ernst & Young)
Panel: Frank Sabatini and Ugur Koyluoglu (Mercer Oliver Wyman)
Summary: Implementing risk integration and aggregation provides a powerful view of enterprise risk and the benefits of diversification on the total company risk exposure. The panelists discussed approaches for measuring risk across risk elements on a consistent basis and discussed the methods for aggregating results and measuring diversification.

RM 27 PD—Quantitative Methods Used in Managing Credit Risk

Moderator: Tony Dardis (Tillinghast)
Panel: Peter Davis (Ernst & Young), Ugur Koyluoglu (Mercer Oliver Wyman) and Rishi Kapur (Swiss Re Financial Services)
Summary: Panel members shared their experiences in credit risk management and described some of the main quantitative methods used. Topics included procedures for evaluating an individual credit risk and techniques for portfolio credit risk management.

RM TS 60—Enterprise Risk Management (ERM) Tools and Analytics

Moderator: Hubert Mueller (Tillinghast)
Instructors: Samir Shah (Tillinghast) and Fred Tavan (Canada Life)
Summary: A teaching session was held to discuss ERM tools and analytics. Instructors discussed industry approaches and best practices for measuring, monitoring and managing financial and operational risks. ERM tools and analytics discussed included quantitative risk metrics, heat maps, risk scorecards and economic surplus charges.

RM 91 OF—Chief Risk Officer (CRO) Forum

Moderator: Helene Pouliot (Tillinghast)
Panel: Don Mango (ERC) and Grant Hardy, executive vice president and CRO for RBC Insurance.
Summary: One of the elements of an effective risk management process is building an effective strategy for managing risk and creating a risk management culture. A panel of CROs discussed the challenges of gaining and maintaining management support, creating a risk management culture and building an effective risk management process.

RM 106 SM—Risk Management Section Hot Breakfast

Moderator: David Ingram (Milliman)
Summary: The meeting focused on the actuary's role in leading risk management activities, and section members were encouraged to express their views on section priorities and activities.

RM 121 PD—Catastrophic Risk in a Post 9/11 Environment

Moderator: Joseph Kolodney
Summary: Panelists offered insight into specific catastrophic risks, methods used to analyze and quantify the risks, available reinsurance solutions to manage the risk and pricing assumptions that have led to significant cost increases in post-9/11 reinsurance. ✦

Articles Needed for Risk Management

Your help and participation is needed and welcomed. All articles will include a byline to give you full credit for your effort. If you would like to submit an article, please contact Ken Seng Tan, editor, *kstan@uwaterloo.ca*.

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

Publication Date	***Submission Deadline***
March 2005	January 3, 2005
July 2005	May 2, 2005

Preferred Format

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

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

If you must submit articles in another manner, please call Joe Adduci, (847) 706-3548, at the Society of Actuaries for help.

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Thank you for your help.

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