SOCIETY OF ACTUARIES   Product Development
Section

Product Matters!

Product Development Section Election Results

Election results bring exciting news of new members that are eager to jump in and contribute. At the same time, it's sad to say good-bye to the retiring members who have willingly volunteered their time over the last year to help in the success of this section. Please join us in saying thanks and good-bye to retiring members Rob Stone (outgoing Chair), Cathy Bierschbach and James Christou.

Looking forward, the new members joining the Product Development Section Council are Mitchell Katcher, Donna Megregian and Lisa Renetzky. The remainder of this article tells you more about each of your new council members. Please don't hesitate to get to know them.

Mitchell Katcher has more than 30 years of experience in the life and annuity industry. He is a principal at Deloitte Consulting LLP with a long and successful background in the life and annuity product development arena, with particular focus on retirement, including variable annuities, income annuities, longevity insurance and retirement income optimization. This includes the pricing, risk mitigation strategies and capital management of these products and guarantees. Mitch has helped companies develop innovative and competitive new products including the first survivorship version of the lifetime guaranteed minimum withdrawal benefit and the unbundling of annuity guarantees for application directly to mutual funds, managed accounts and 401(k)s. Mitch is also spearheading the upgrade of Deloitte's current retirement income packaging and optimization model and Deloitte's Life Loans program.

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Articles Needed for the Next Issue of *Product Matters!*

While all articles are welcome, we would especially like to receive articles on topics that would be of interest to Product Development Section members based outside of the United States.

Please e-mail your articles to Christie Goodrich or Paul Fedchak by April 1, 2010.

Chairperson's Corner

PD Section Rings In The New Year

By John Currier

It is a great honor to be writing this as the new chair of the Product Development Section Council. As product development actuaries, our need for relevant and timely information has never been greater. Our jobs require working knowledge of multiple accounting regimes, capital requirements, the investment landscape, tax policy, consumer attitudes, an understanding of the existing and potential regulatory framework, and the world of distribution—all of which are very dynamic as we begin 2010!

My goal for the coming year is simple—to continue to make sure the Product Development Section is relevant for our Section Council members. This is no small feat in this environment! To ensure we are responsive to your needs, we recently surveyed the entire Section membership to create a focused list of the topics that are of the most interest to the membership. I hope you took the opportunity to tell us what matters to you. The results of that survey will drive content in meeting sessions, Product Matters' articles, webcasts, and the research projects sponsored by the council.

The Professional Interest Sections are the Society's front line to serve the diverse needs of the membership, and the Product Development Council is poised to move that line forward this year. The council is actively planning for the first ever Life and Annuity Symposium in Tampa in May of 2010. This exciting combination of the former Life Spring Meeting and Product Development Symposium creates a unique opportunity to provide broad exposure to a variety of topics, a deeper dive into some of the topics that are most important to you, and intensive learning through the adjacent seminars. This repositioning of the meeting is based on direct feedback from you—we are eager to see the success.

The Council is also beginning work on the Annual Meeting, webcasts for 2010, sponsoring and reviewing research projects, and gathering content for the next Product Matters issue. In addition, we continue our partnership with the SOA staff, other Sections, and the SOA Board.

Our outgoing chair, Rob Stone, has certainly left some big shoes to fill! A heart-felt thanks to Rob for his leadership and service during his term on the Section Council and year as chair. The Council will certainly miss the insight and dedication of the other members rotating off this year, James Christou and Cathy Biersbach. Our new Section Council members—Donna Megregian, Lisa Renetzky, and Mitch Katcher—are already making great contributions. Coupled with the efforts of our returning Council members (Sue Saip, Tom Phillips, Christie Goodrich, Paul Pflieger, and Chris Daniels) and numerous friends, it is clear that 2010 is shaping up to be another successful year.

As much as the Council tries to create value for the nearly 4000 section members, it can only be successful with your support. As part of the recent survey we also asked you if there are topics you would be willing to speak or write about—we need the expertise of the full membership, not just a team of nine, to make sure we are relevant to you. Please let us know where we can count on you—you are the Section, and we need your input to be successful. If you haven't done so already, please make sure that I or any other member of the Section Council, knows both about your specific interests and any expertise that you are willing to share. I can be reached at john.currier@avivausa.com and welcome hearing from you.

Thank you for the opportunity to serve you—I'm looking forward to what promises to be an exciting year! ☐

John Currier, FSA, MAAA, is EVP, chief product officer for Aviva USA. He can be contacted at john.currier@avivausa.com

Mitchell Katcher

Mitch has held several senior positions during his career. At HSBC Insurance North America, Mitch served as executive vice president, Product Development and Marketing. Prior to HSBC, Mitch was senior vice president life and annuity product development of the Phoenix Life Insurance Companies. In his role, he led all life and annuity product development. Prior to Phoenix, Mitch was chief actuary of Sage Life Assurance of America, Inc., where he lead the development of onshore and offshore variable annuity products. Prior to Sage, Mitch has held various other senior positions in which he was involved in statutory, GAAP and other financial actuarial functions. Mitch received a B.S. in Actuarial Science from The College of Insurance (now part of St. John's University) in 1976. He is a Fellow of the Society of Actuaries and a Member of the American Academy of Actuaries.

Donna Megregian

Donna Megregian joined Milliman Inc. in July 2006 as a consultant. In her role, Donna is primarily responsible for life product development focusing on term and return of premium term, universal life with secondary guarantees with experience in pricing whole life and group term. She has been involved in a variety of projects including cash flow testing, illustration testing, appraisals, reinsurance, state filing support, and pricing assumption review. Prior to joining Milliman, Donna held a variety of roles in the product development and pricing of life insurance and annuity products at Lincoln Financial Group, Zurich Life and Conseco. Donna graduated from the Ball State University in 1997 with a B.S. in Actuarial Science. She became a Fellow of the Society of Actuaries (SOA) in 2006. She is a member of the American Academy of Actuaries, and serves on the Illustration Work Group as well as the Nonforfeiture Improvement Work Group. Donna looks forward to serving on the Product Development Section of the SOA.
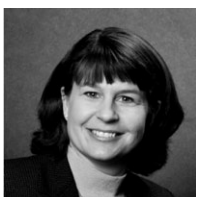
Lisa Renetzky

Lisa Renetzky is vice president, Pricing, responsible for managing the pricing function for RGA's U.S. Mortality Markets Division. In this role, she is responsible for the pricing of traditional reinsurance products to meet client's risk and capital needs. Lisa has been involved with term product development for many years and also has experience working with distribution channels in product development, reinsurance structures and administration capabilities. Other various experiences at RGA have included acquisitions, financial reporting valuation actuary responsibilities, nontraditional pricing, product development and participation in international projects. Lisa is a Fellow of the Society of Actuaries and Member of the American Academy of Actuaries and holds a B.S. degree in mathematics from the University of Notre Dame. She has been a featured speaker at life insurance industry conferences and events. ☐

Will Sales Of A De-Risked VA Product Improve Reserve And Required **Capital Positions Under Principle-Based Approaches?**

By Yuhong Xue

Editors' note: The following article was written prior to the Dec. 31, 2009 implementation of AG43.

Over the past few years variable annuities have enjoyed healthy growth as a viable option for managing retirement because of the attractive guarantees embedded in the products and a rising equity market. During this period, to attract new business, there has been an intense competition to enrich the product features, especially in the riders, with complex financial guarantees. As a result, variable annuities have evolved from guaranteeing just the simple return of premium death benefit to the rich lifetime withdrawal benefit which guarantees a percentage of the initial premium if certain conditions are met. Such rich guaranteed benefits are financially equivalent to complex equity or interest rate derivatives. These riders can create big liabilities with adverse movements in equity and interest rate markets.

In the second half of 2008 and first quarter of 2009, equity markets and interest rates went down precipitously. The financial liabilities of the guaranteed benefits in the variable annuity products shot up, causing tremendous strain on risk-based capital and reserves of the VA writers. In fact, two large insurers took capital from the federal Troubled Asset Relief Program (TARP) partly due to exposures to the VA business.

In the wake of the market turmoil, it became apparent that the current VA products loaded with rich benefit guarantees will not withstand another test such as this one. In the past few months, the majority of the VA writers have already de-risked or are in the process of de-risking their VA offerings, making them less risky and more profitable. Some are even considering scaling back or stopping new sales.

In the mean time, the statutory reserving standard for VA contracts is moving from the current formulaic based approach as specified in Actuarial Guideline 33, 34 and 39 to a principle-based approach known as AG VACARVM (Actuarial Guideline covering the Commissioners' Annuity Reserving Valuation Method for VAs) which was adopted by the National Association of Insurance Commissioners (NAIC) and became known as Actuarial Guideline 43 or AG 43. The effective implementation date is Dec. 31, 2009.

Unlike the current approach, AG 43 requires you to evaluate the financial outcomes under a wide range of economic scenarios taking the whole contract into consideration. Risk offsetting effects between base contract and riders, between different riders, between different scenarios and between timing of occurrence of deficiencies are now possible. This stochastic result is subject to a Standard Scenario floor which is calculated based on a deterministic scenario and a set of prescribed assumptions.

Companies are currently in the process of evaluating how exactly AG 43 will impact reserves and risk based capital (RBC) from their VA in-force block. According to a recent survey published by Towers Perrin, reserves are increasing for some companies and decreasing for others under AG 43 compared to the current standard. On the capital side, despite RBC C3 Phase II—which is based on an approach similar to AG 43—being adopted in 2005, the fact that RBC is defined as Total Asset Requirement (TAR) in excess of statutory reserve means that AG 43 will also impact required capital.

Yuhong (Jason) Xue, FSA, MAA, is an officer of Retirement Solutions at the Guardian Life Insurance of America in New York, NY. He can be reached at yuhong_xue@glic.com.

CONTINUED ON **PAGE 6**

Perhaps a more interesting question is what kind of reserve and capital impact AG 43 has on new business, especially in the context of the de-risked products. Should companies scale back or stop new sales—even for a less risky product—in light of the new reserving standard? Or should companies sustain or even increase sales levels given some of the potential benefits that the new standard brings?

The author argues that given the "right" product mix of an in-force block and a complimentary less-risky new product, companies' statutory reserve and RBC positions can at least avoid additional stress, and possibly even benefit from, new business sales—even in "bad" economic conditions under AG 43—due to the various risk offsetting effects in the stochastic calculation. The author will illustrate his point through a specific example which will be discussed in detail in a later section.

Risk offsetting effects in AG 43 and RBC C3 phase II

As mentioned previously, statutory reserves for VAs are currently governed by AG 33, 34 and 39. AG 33 reserves merely represent features in the base contracts, ignoring the riders in the calculation. AG 34 only computes the additional liability in excess of AG 33 reserves due to the death benefit guarantees, and AG 39 reflects only the living benefit riders. This is a bifurcated approach where the base contract and the different types of riders are considered separately. However, in the AG 43 new reserving standard, the base contracts and the riders are considered together.

Briefly, AG 43 has two components: the stochastic piece and the standard scenario floor. In the stochastic calculation, you are required to project the scenario Greatest Present Value of Accumulated Deficiencies (GPVAD) for each of many stochastic scenarios representing a wide range of economic conditions. The scenario GPVAD is the greatest of all deficiencies, in terms of present value, over all projected time periods and aggregating all contracts. The average of the worst 30 percent of the GPVADs is the so-called Conditional Tail Expectation (CTE) 70. This CTE 70 is compared to a standard scenario reserve and the greater of the two is the final AG 43 reserve. The standard scenario reserve is the sum of

a Basic Adjusted Reserve (BAR) and Accumulated Net Revenue (ANR). The BAR is similar to the AG 33 calculation with different treatment of rider charges and partial withdrawals. The ANR is defined somewhat similarly to GPVAD, but projected using a prescribed deterministic scenario and prescribed assumptions.

Now that the whole contract is projected together under AG 43, some risk offsetting effects can be observed in the stochastic calculation:
1. When combining the base contract with riders
   - In addition to the rider charges, the M&E fees, admin charges, and revenue sharing income from the base contracts can help offset the claims generated from the riders during a down market. The base contract is often priced with a profit while the riders are priced to break even. In a down market, the profit from the base contract is used to pay rider claims.
2. When combining different riders
   - If you were to calculate a GPVAD for each rider type for a given scenario, the periods at which the GPVADs occur are different for different rider types. For example, GPVAD occurs much earlier for DB riders than for WB riders. This means when combining the DB and WB riders, the GPVAD of the combined is less than the sum of the individual GPVADs of DB and WB for a particular scenario.
   - Secondly, a bad scenario, one which produces large GPVAD, for one rider is not necessarily a bad scenario for other riders. The worst 30 percent of the GPVADs of the WB riders are not necessarily the worst 30 percent scenarios for the DB riders. Therefore, CTE 70 of the combined is less than the CTE 70s of the riders individually.
3. When combining different years of issues and new business
   - When business is sold continuously throughout a volatile market, some policies are in the money while others are out of the money. The profits accumulated from the policies which are out of the money can be used to pay claims from the policies that are in the money in a bad scenario.

These risk offsetting effects will be illustrated in the example in the next section.

Similar to AG 43, RBC C3 phase II also defines the Total Asset Requirement (TAR) to be the bigger of a stochastic component and standard scenario component. The key differences in the stochastic part include CTE level (CTE70 vs. CTE90), tax treatment for cash flows, different rules for recognizing non-contractually guaranteed net revenue sharing, and discount rates. In addition, the standard scenario of RBC allows aggregation of different contracts while that of AG 43 is a seriatim calculation, no aggregation is allowed.

Given the conservative nature in the standard scenario of AG 43, the relevance of this floor can depend on many factors. This discussion only focuses on the stochastic component of AG 43 and RBC C3 phase II. Therefore, it is not applicable for companies where both the standard scenario amounts of AG 43 and RBC are dominant.

Illustrative Example

For illustration purposes, the author constructed an in-force block of VA business with $100 million in account value as of Dec. 31, 2008. Many of the contracts have Guaranteed Minimum Death Benefit (GMDB) riders. Only a small proportion has Guaranteed Minimum Income Benefit (GMIB) riders. The business is projected one year forward to the end of 2009. Only contracts with lifetime Guaranteed Minimum Withdrawal Benefit (GMWB) riders are sold as new business during the year 2009. The projection is done under three market conditions and two new business volumes. The stochastic component of AG 43 and RBC C3 phase II are then calculated and analyzed.

Here are the six cases. The market decline is as of Dec. 31, 2009 compared to the Dec. 31, 2008 level.

New business volume	$20 million of GMWB sales	$40 million of GMWB sales
Market return 0%	Case 1	Case 4
Market return (10%)	Case 2	Case 5
Market return (20%)	Case 3	Case 6

The above will provide a picture of reserve and capital levels at the end of 2009. Would this picture change in a multi-year scenario where new business is sold continu-

ously? For this, the author also projected the in-force and new business for five years and studied the reserve and capital positions at the end of the five-year period. The following two cases are used for this purpose:

	Case 7	Case 8
	$20 million of GMWB sales every year	$40 million of GMWB sales every year
Market return	(10%), (10%),0%,10%,10%	(10%), (10%),0%,10%,10%

Assumptions in the Example

In-force business assumptions

The in-force block consists of contracts with GMDB and GMIB riders:

Rider Type	Account Value (millions)	Guarantee Balance (millions)
Annual Ratchet GMDB (Dollar-for-Dollar)	26	33
Annual Ratchet GMDB (Pro Rata)	38	44
GMDB 3% roll-up	12	16
Return of Premium GMDB (ROP)	10	13
GMIB 5% roll-up (10 years wait period)	14	19
Total	100	125

Policies in this VA block were issued throughout the past 10 years. Accompanying base contracts are a mixture of B and L shares with equal amounts. Fund selection is limited to major index funds. Here are some additional statistics on this block:

Policy Count:	1,790
Average Size:	$56,000
Average In-The-Moneyness (ITM):	25%
Average Attained Age:	61
Gender Ratio:	50:50
Equity vs. Bond fund selection:	70:30

New business assumptions

The new business contracts with lifetime GMWB riders are a mixture of two types of rider designs: the plain GMWB has no additional bonus except for an annual ratchet for delaying withdrawals. The bonus GMWB design will credit an additional 6 percent compound to the GMWB balance for each additional year of withdrawal delay until year 15.

The above GMWB riders are priced in the interest rate and equity environment of the first quarter of 2009 when the 30-year swap rate hovered around 3 percent. They are priced to break even using risk neutral techniques. The rider charge for the plain design is 75 bps and 140 bps for the bonus design. The lifetime withdrawal benefit ranges from 3 percent to 6 percent depending on the age at which withdrawals starts. This level of rider charge and benefit is comparable to the de-risked products currently sold in the VA market.

Here are some additional statistics on the assumed new business:

Base contract B vs. L share:	50:50
Single vs. Joint:	50:50
Male vs. Female:	50:50
Plain vs. Bonus GMWB:	20:80
Average issue age:	60
Age distribution:	Older people tend to buy the plain design and younger people tend to buy the bonus design
Average size:	$90,000
Equity vs. Bond fund selection:	70:30

Modeling assumptions

A cash flow projection model is created for calculating the stochastic CTE levels as defined in AG 43 and RBC C3 phase II. The assumptions follow the guidelines or regulations. The margins required by AG 43 are assumed to be already built in the various assumptions.

Economic scenarios

One thousand scenarios are generated for equity returns and interest rates. The equity model is a two-regime switching model with correlations between equity indices and the interest rates. The interest rate model is lognormal with mean reversion to a long term mean.

The scenarios are based on parameters derived from historical market data and are calibrated to the calibration points published by the Academy.

Fees and expenses

M&E fees	150 bps
Surrender charges	8% grade to 0% depending on schedule of B or L
Net revenue sharing	30 bps (all are assumed to be guaranteed)
Per policy maintenance expense	$120
Asset based maintenance expense	50 bps
Trail commissions	1%

Policyholder behavior assumptions

The base lapse rate is assumed to be 4 percent within the surrender charge period and 10 percent beyond it. There is also a shock lapse of 20 percent or 30 percent at the end of the surrender charge period for B and L share respectively. A dynamic lapse formula is acting to reduce the base lapse rates when guarantees are in the money.

For policies with lifetime GMWB riders, the author adopted a cohort approach when it comes to withdrawal delay assumptions. Generally the assumption is that the policyholders are rational and efficient, they will choose to start withdrawing the full amount allowable by the contract at a time that is most beneficial to them financially. The author also assumed that a small cohort of policyholders will start withdrawing at a less optimal time due to other considerations.

Utilization of the GMIB benefits is also assumed to be dynamic based on in-the-moneyness of the guarantee.

There is also a 2 percent partial withdrawal assumed for non-GMWB contracts.

Other assumptions
Mortality is 80 percent of the annuity 2000 table. The short rates specific to the economic scenario are used as discount rates. And finally, no dynamic hedging strategy is modeled.

Analysis of Results

As a reminder, on Dec. 31, 2008, we started with a block of $100 million in account value that consists of policies with GMDB and GMIB riders. The guarantees are 25 percent in-the-money. We assumed $20 million or $40 million of new sales in 2009, all are policies with GMWB riders. We projected the in-force and new business to the end of 2009 under three market returns, flat 0 percent, down 10 percent and down 20 percent. Finally, we calcu-lated CTE 70 and CTE 90 by projecting cash flows of the whole business as of Dec. 31, 2009 under 1000 economic scenarios. The average of the worst 30 percent of the pre-tax GPVADs is the pre-tax CTE 70. The average of the worst 10 percent of the post-tax GPVADs is the post-tax CTE 90.

The results are shown in the tables below. The negative values indicate deficiencies. The stochastic component of AG43 is the starting asset plus the absolute value of CTE 70. And the Total Asset Requirement (TAR) as defined in RBC C3 phase II is the starting asset plus the absolute value of CTE 90. In the following discussions, whenever CTE 70 or 90 is mentioned, it is referring to its absolute value.

Case	In-force Business (millions of Account Value)	New Business sales (millions of Premium)	Equity Market Return	Time Horizon (Years)	CTE 70 Pre-tax IF+NB (000s)	CTE 70 Pre-tax IF+NB (000s)	CTE 70 Pre-tax NB+NB (000s)
1	100	20	0%	1	(44)	(69)	(66)
2	100	20	(10)%	1	(72)	(202)	(85)
3	100	20	(20)%	1	(366)	(325)	(124)
4	100	40	0%	1	(96)	(69)	(133)
5	100	40	(10)%	1	(138)	(202)	(170)
6	100	40	(20)%	1	(392)	(325)	(249)

Case	In-force Business (millions of Account Value)	New Business Sales (millions of Premium)	Equity Market Return	Time Horizon (Years)	CTE 90 Post-tax IF+NB (000s)	CTE 90 Post-tax IF Only (000s)	CTE 90 Post-tax NB Only (000s)
1	100	20	0%	1	(122)	(129)	(187)
2	100	20	(10)%	1	(195)	(295)	(240)
3	100	20	(20)%	1	(495)	(396)	(351)
4	100	40	0%	1	(270)	(129)	(375)
5	100	40	(10)%	1	(390)	(295)	(480)
6	100	40	(20)%	1	(764)	(396)	(702)

The following graph illustrates CTE 70 values for market returns at a flat 0 percent, down 10 percent and down 20 percent, corresponding to the cases 1, 2 and 3 above. We assumed $20 million of new sales for the three cases.

The graph reveals a surprising result: when the market is flat or down 10 percent, the CTE 70 of the whole block (solid line) is less than the CTE 70 of the in-force (dotted line) or new business (wiggle line) individually. When the market is down 20 percent, the CTE 70 of the whole block is larger than that of the in-force or new business individually, but it is still much less than the sum of the two. This is also true for the CTE 70s and CTE 90s in the other cases.
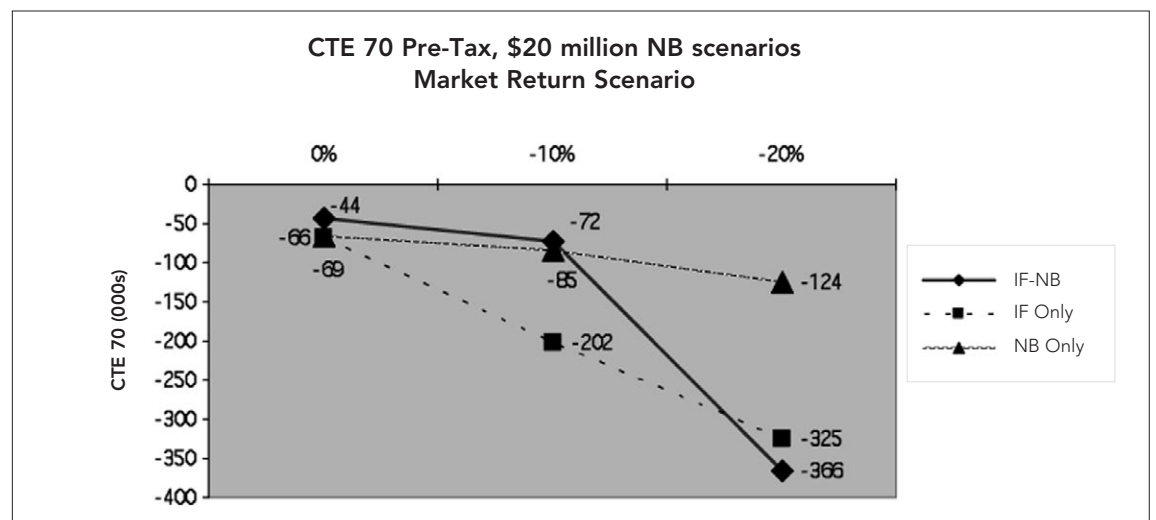
> " … sales of a de-risked GMWB rider can actually improve companies' overall reserve and capital positions due to the risk offsetting features embedded in AG 43 and RBC C3 Phase II. "

This indicates, given the in-force block and certain market conditions, sales of a de-risked GMWB rider can actually improve companies' overall reserve and capital positions due to the risk offsetting features embedded in AG 43 and RBC C3 Phase II. Even under adverse market conditions, the risk offsetting effects can soften the impact on reserves and capital of new business sales.
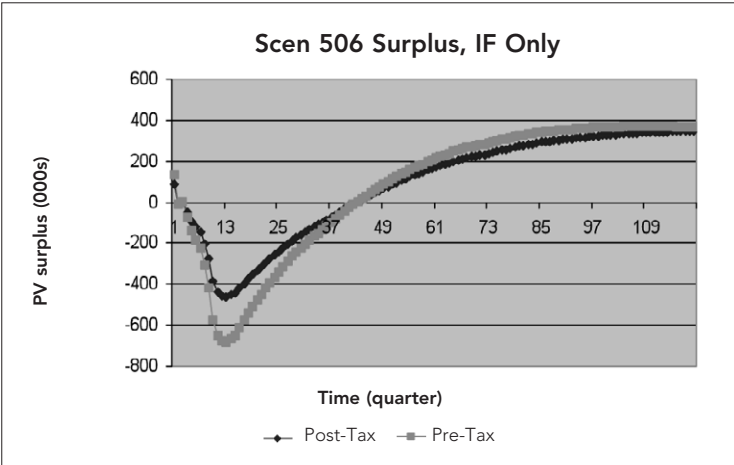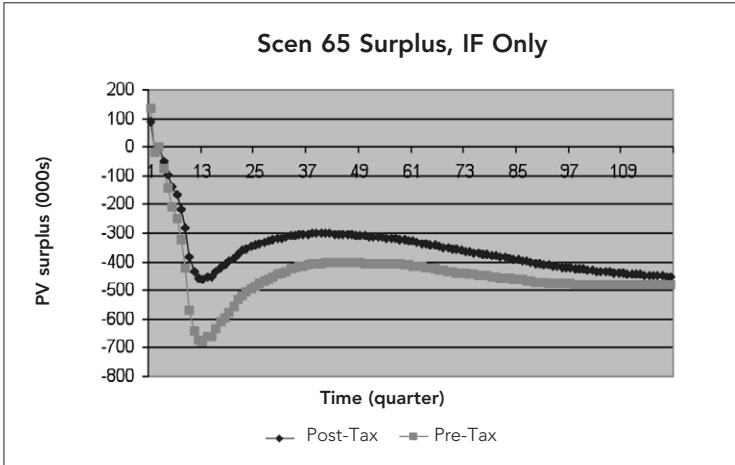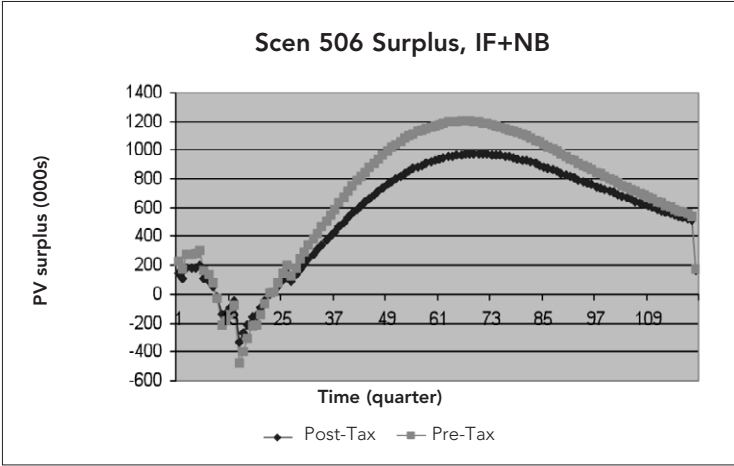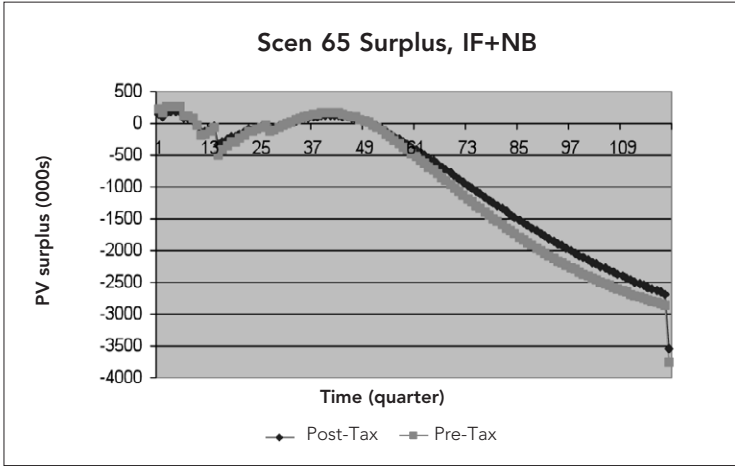
To understand the risk offsetting effects, let's study the stochastic results of a particular run: the case of $20 million of new sales while the market is down 10 percent. Let's examine two scenarios out of the 1000: scenario 65, a bad scenario with low or negative market returns; and scenario 506, a rather benign scenario where market performance is slightly weak. The graphs on page 11 plot the present value (PV) of surpluses in all 120 quarters or 30 years of the projection under the two scenarios. The GPVAD of that scenario is the lowest of the PV of surpluses. The graph shows the PV of surpluses for the whole block, the in-force business, and new business separately.

One of the risk offsetting effects is the fact that for different rider types, the GPVADs occur at different times in a given scenario. Take scenario 506 for example, the GPVAD of the in-force (GMDB and GMIB riders) occurs around quarter 13 while the GPVAD of new business (GMWB riders) occurs at quarter 120, the last projection period. When combining the whole block, the surplus at quarter 13 for the new business helps the deficiency of the in-force at that time. As a result, the GPVAD of the whole block still occurs at quarter 13, but is not as severe due to the surplus of the new business. Even in a bad scenario, scenario 65, the GPVAD of whole block is not a simple sum of the GPVADs of the in-force and new business because they do not occur at the same time.

CTE 70 Pre-Tax, $20 million NB scenarios
Market Return Scenario

Scen 65 Surplus, IF+NB

PV surplus (000s) vs Time (quarter)

Post-Tax — Pre-Tax

Scen 506 Surplus, IF+NB

PV surplus (000s) vs Time (quarter)

Post-Tax — Pre-Tax

Scen 65 Surplus, IF Only

PV surplus (000s) vs Time (quarter)

Post-Tax — Pre-Tax

Scen 506 Surplus, IF Only

PV surplus (000s) vs Time (quarter)

Post-Tax — Pre-Tax

Scen 65 Surplus, NB Only

PV surplus (000s) vs Time (quarter)

Post-Tax — Pre-Tax

Scen 506 Surplus, NB Only

PV surplus (000s) vs Time (quarter)

Post-Tax — Pre-Tax

Another phenomenon acting to offset risk is that a bad scenario for one type of rider is not necessarily bad for another. Take a look at scenario 506 again, it created a big GPVAD for the in-force full of DB and IB riders. But it generates a benign result for the new business with WB riders.

Is the impact on capital and reserves still benign in a multi-year scenario where new business is sold continuously for a few years? Case 7 and 8 are designed to answer this question. The author projected the in-force and $20 million and $40 million of new business each year respectively for five years in a down and up market scenario. The pre-tax CTE 70 and post-tax CTE 90 at the end of five years for the two cases are listed below.

In both cases, the pre-tax CTE 70s are less than half a percent of the starting asset and post-tax CTE 90s are less than one percent of the starting asset. The impact on statutory reserves and RBC is still very manageable.

Conclusion

The recent market turmoil has highlighted just how much volatility the variable annuity business can bring to companies' overall statutory reserve and risk-based capital positions. To manage the risk, a new generation of de-risked VA products has been introduced to the market place. At the same time, AG 43, a new principle-based statutory reserving standard, will be implemented at the end of 2009. The impact of AG 43 on companies' overall reserve and required capital needs to be understood very carefully especially in the context of the de-risked products.

The author has shown through an illustrative example that due to the risk offsetting effects embedded in the stochastic calculations of AG 43 and RBC C3 Phase II, sales of the de-risked VA products can sometimes reduce the total reserve and capital requirements in relatively normal market conditions. Even in a bad market, the risk offsetting benefits can make the new business sales less burdensome on capital and statutory reserves.

Under AG 43, companies have to decide whether to segment and how to segment the VA business for valuation purposes. Having a good understanding of the risk offsetting effects of stochastic calculations can guide this decision.

The author is aware, however, that despite trying to design the products and assumptions as generic as possible, the above conclusion is influenced by the product features, business mix, economic scenarios and various other assumptions assumed for the in-force and new business. Variations in these factors may lead to a different result. ☐

Case	In-force Business (millions of Account Value)	New Business Sales (millions of Premium)	Equity Market Return	Time Horizon (Years)	CTE 70 pre-tax IF+NB (000s)	CTE 90 post-tax IF+NB (000s)
7	100	20 million per year	(10%),(10%),0%, 10%,10%	5	(345)	(976)
8	100	40 million per year	(10%),(10%),0%, 10%,10%	5	(649)	(1,838)

New SOA Life And Annuity Symposium

by Mike Boot

2010 is a new decade and thus is time for a new direction. The SOA has taken the best of two meetings—the Product Development Symposium and the Life Spring Meeting—and combined them to create an event of greater value. The Symposium will be held in Tampa, Florida on May 17-19 and will now be known as the Life and Annuity Symposium with the tag line "New Decade, New Direction." This new symposium features two full days of offerings, extended session lengths, in-depth coverage of important topics, more networking opportunities and an optional third day with seminars.

This change came only after careful consideration of the input of many SOA members. The Life Spring and Product Development meetings were not fully achieving their attendance goals and that impacted attendee satisfaction. After every SOA meeting there is an overall evaluation form given to all attendees, and we receive important feedback from about one-third of the attendees in this manner. From those evaluations it was very clear that attendees usually liked the content of the concurrent sessions, but wanted more networking opportunities, wanted more in-depth content rather than just high-level overviews, and wanted a meeting longer than 1 ½ days.

The SOA then surveyed anyone who attended the Product Development Symposium or the Life Spring Meeting in either 2008 or 2009. This survey was answered by over 400 SOA members. The top three cited reasons to attend a specific SOA meeting were (in order): 1. Session Content, 2. Event Location, 3. Continuing Education Credits. The ideal timing for this type of meeting was suggested to be May or June with a preferred location in the Midwest, Northeast, or Southeast. When given three different options about the future of these meetings, the overwhelming response was to combine the Product Development Symposium and the Life Spring Meeting in an enhanced and longer meeting, instead of the other options of keeping the Product Development Symposium and the Life Spring Meeting separate or eliminating the Life Spring Meeting altogether.

It is important for Product Development Section members to note that the SOA is very clear that, in the new Life and Annuity Symposium, we do not want to lose the rich, deep content that has been associated with the Product Development Symposium. The past Chairs of the Product Development Symposium are engaged as team leaders of this new meeting. The following tracks have been used to help plan the new meeting: Management and Professionalism, led by Paula Hodges; Financial, led by Terry Long; Risk, led by Andy Dalton; Product, led by Kevin Howard and Rob Stone.

All indications are this will be a vibrant new meeting with content for those in the life insurance sector. We invite you to join us in Tampa for this inaugural event. Get full details and register at www.soa.org. Just click on Event Calendar. ☐

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Conditional **Stochastic Pricing**

By Feng Sun

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Last year's financial market crisis resulted in significant declines in equity values. As a result, Variable Annuity (VA) writers and their organizations are under stress test. Most companies realized that their guarantee riders within VA were underpriced. They decided to reduce risks and/or increase the rider charges.[1]

So, what went wrong with current VA guarantee pricing? Stochastic methodology has prevailed in variable annuity pricing, especially for VA with living and/or death benefit guarantee riders. The stress scenarios had been tested in the pricing model. What would actuaries do differently this time? Would simply updating assumptions such as higher volatilities of assets returns and rerunning the pricing model do the job? The author believes there is more that needs to be done. One lesson learned from this experience is that capital swing caused the chaos. Companies need to step back and rethink stochastic pricing methodology.

Conditional Stochastic Pricing Methodology

Conditional stochastic pricing methodology believes that the projected profitability is contingent on the solvency or ratings of insurers. If the company solvency or ratings are under pressure, the profitability along these paths needs to be investigated or reconsidered.

Let us start with a casino math example. Gary, a gambler, has a simple, but well-known strategy to play in a casino. He walks away when he wins; he doubles his previous bet and continues to play if he loses. This strategy would guarantee Gary to win if he has enough money (assuming the casino has no up limits on bets, and the odds of winning are slightly less favorable than 50/50). Unfortunately, in reality Gary walks away with nothing in most instances because Gary does not have enough money to stay in the game, whereas, the house has enough chips (same as money in casino) and shifts to play with Gary.

From a statistical point of view, insurers, like the casino, also play with odds, but with good faith. They can design and price products with odds being in their favor. However, insurance businesses are regulated. Similar to gambling, the casino should have enough cash to backup the chips in house; insurers need to meet a list of requirements to stay in business. One of them is minimum assets requirement or capital requirement. For a VA guarantee writer in the United States, the C3

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[1] Variable Annuity Providers Face Tough Decisions in the Midst of the Financial Crisis, Towers Perrin, December 2008 http://www.towersperrin.com/tp/getwebcachedoc?webc=USA/2008/200812/Update_VariableAnnuities_1208.pdf

Phase II capital requirement is the regulatory assets requirement to ensure insurers have enough money to back up policyholders' benefits.

If we assume Gary plays a game that allows him to flip a coin two times in a row. The odds of wining are 90 percent, and the bet is $1.00. In theory, Gary is expected to win $1.60.

$$E(x) = 2 \times (0.9 - 0.1) = 1.6$$

This expected value is unconditional. It has an underlying assumption that Gary has at least $2.00 to start with. The average of outcomes converges to the expected value as the number of trials increases.

What if Gary has only $1.00 to start with? The amount he expects to make is $1.52 instead of $1.60, given everything else being equal.

$$E(x|Capital = 1) = 1 \times (0.9 - 0.1) + 1 \times 0.9 \times (0.9 - 0.1) = 1.52$$

The $0.08 reduction in expected value is due to the fact that favorable odds in the second trial cannot be realized if Gary lost in the first trial.

Similar to Gary's situation, if insurers do not have enough capital under all scenarios, some profits or losses cannot be realized.

Current stochastic pricing[2] focuses on the cost of capital when calculating distributable earnings in pricing, but overlooks the magnitude of capital requirements at a certain point in time that potentially ruins the companies.

Under C3 Phase II, the Total Assets Requirement (TAR) could reach high levels under stress scenarios. According to a Tillinghast study,[3] for VA policies with an aggressive guaranteed minimum withdrawal benefit (GMWB) for life feature issued in 2007, the C3 Phase II capital requirement as of Oct. 31, 2008 could go as high as 34 percent of account value.
The chart below illustrates the relationship between underlying VA fund return and TAR under a hypothetical scenario.

Statutory TAR under a Hypothetical Scenario
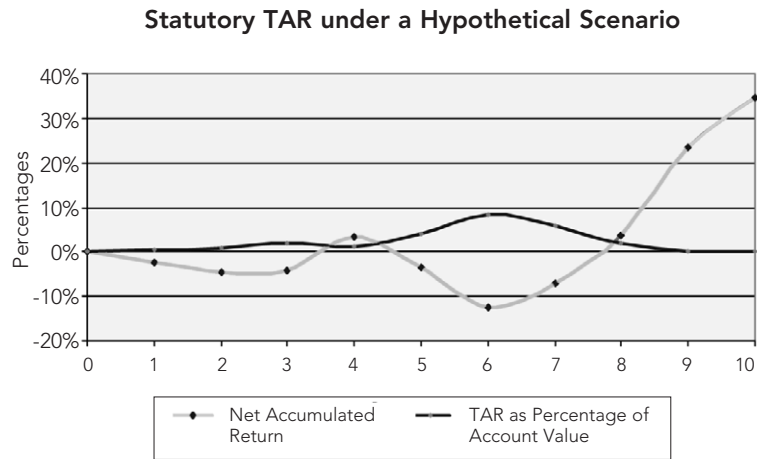
Net accumulated return is defined as wealth ratio[4] minus one. TAR is expressed as a percentage of account value. These two are negatively correlated. When the accumulated return increases, the capital requirement decreases. At year six, the accumulated return is -12.5 percent, the TAR is about 8.2 percent of account value. At year 10, the net accumulated return is 34.8 percent, and the TAR is about 16 basis points.

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[2] Stochastic Pricing for Embedded Options in Life Insurance and Annuity Products, Milliman, Inc. October 2008, *http://www.soa.org/files/pdf/research-2009-stochastic-pricing.pdf*

[3] Stochastic Pricing for Embedded Options in Life Insurance and Annuity Products, Milliman, Inc. October 2008, *http://www.soa.org/files/pdf/research-2009-stochastic-pricing.pdf* , table 2 on Page 4 of Footnote 2.

[4] Wealth Ratio – The cumulative return for the indicated time period and percentile (e.g., 1.0 indicates that the index is at its original level.)

For this particular scenario, what pricing actuaries need to be conscious of is the company needs to survive year six before they can calculate the present value of future profit over the 10-year time horizon.

If the company plans to reduce TAR by implementing risk/capital management strategies such as hedging, these strategies need to be reflected in pricing. The profitability before and after needs to be captured and the cost/benefit trade-off needs to be assessed.

> " If the company plans to reduce TAR by implementing risk/capital management strategies such as hedging, these strategies need to be reflected in pricing. "

Implications of Conditional Stochastic Pricing

Conditional stochastic pricing believes that actuaries should examine asset requirement (balance sheets) to ensure the companies' solvency or rating status is intact in any given scenario path before analyzing the distribution of profitability (income statements) over time and across scenarios. Pricing actuaries need to consider or incorporate risk/capital management such as hedging or reinsurance, or a strategy of raising capital, especially under stressful scenarios in pricing. This methodology has a number of implications for VA pricing and enterprise risk management.

1) Capital First

Well capitalized companies can offer relatively competitive products. These companies can sustain large capital swings; get compensated from staying in business longer and having more chances to realize favorable odds.

On the other hand, companies who are not able to raise or afford huge capital, have to either have high prices, or less competitive product designs, or an effective risk management program in place to lower TAR to reach the same profitability goal. This forces companies to find other ways of attracting customers and generating sales.

2) Incorporate risk management in pricing

In order to ensure the company can go through tough times, risk management such as hedging, reinsurance, etc., need to be considered to reduce TAR under severe scenarios. In this case, the cost of implementing and operating a risk management program and the costs and benefits associated with these need to be taken into account in pricing.

3) Monitor In-force Business

Unexpected things can happen. Risk dynamics may change as the market evolves over time. Pricing assumptions may not be realized. Conditional stochas-

tic pricing logic can also be used to monitor an in-force block on a regular basis. In particular, the future capital position needs to be projected and profitability needs to be analyzed along with capital positions. Certain measures may be taken to ensure the business stays in shape.

4) Control Sales and Rethink Acquisitions
Experience in the insurance industry showed that a pooling of non-correlated exposures reduces risk for the pool and achieves greater predictability. Unfortunately, VA with guarantees does not belong in this category. Higher than expected sales volume may not always be a good thing because it may result in higher than expected capital requirements. Therefore, sales need to be monitored and managed regularly to ensure companies are immunized to potential capital swing in the future. Similarly, before acquiring a block of a similar line of business, consideration needs to be given on the impact on the consolidated capital position.

Practical Challenges to Implement Conditional Stochastic Pricing

To implement this methodology, pricing actuaries should be conscious of asset requirements from regulators and rating agencies and their impact on the company's financials relative to its business size and examine and analyze profitability along with the TAR amount under any given scenarios.

In practice, there are a number of modeling challenges when implementing conditional stochastic pricing:

1) From a modeling perspective, both income statement and balance sheet related items need to be captured and analyzed from model output for each time interval and over all scenarios. This could lead to another layer of technical and modeling challenges. Actuaries need to capture the balance sheet items (such as TAR results) under

> " Experience in the insurance industry showed that a pooling of non-correlated exposures reduces risk for the pool and achieves greater predictability. "

each scenario and along the path from model output, along with the profitability results. More profitability analysis needs to be done under capital-hefty scenarios because these results (either profits or losses) may not be realized.

2) As a common practice, a few sample pricing cells are selected to represent the potential sales, and sales volume is usually arbitrarily assumed or based on sales history. The TAR amount may not look enormous when testing a few pricing cells, but it can be when the scale is applied. Actuaries need to review the TAR not only in absolute dollar amount, but also review it relative to benchmarks such as assets under management (account value), guaranteed amount, or risk exposure, etc., associated with guarantees.

3) Stochastic-on-stochastic simulations are needed to estimate statutory and GAAP earnings. If hedging needs to simulate in the projection, there should be stochastic-on-stochastic-on-stochastic, which can be technically challenging.

4) For the C3 Phase II capital calculation, calibrated scenarios at each node over all scenarios (usually used at nested level) may be difficult to generate and validate. Some approximation may not be avoidable.

5) When actuaries find that the impact of asset requirements is too severe under a number of scenarios, they can consider reducing the tail risk via product design or risk management such as hedging or reinsurance, which means more sets of sensitivity runs.

6) Pricing is usually done at line of business level, whereas asset (or capital) requirements are assessed at both line of business level as well

as enterprise level. For companies that have multiple lines of business, this could create some challenges if asset requirements from other lines of business are not available for aggregation.

Conclusion

Conditional stochastic pricing suggests assessing the business circumstance such as total asset requirements to ensure the companies' solvency or ratings status stays intact under each stochastic path before doing profitability analysis. Introducing conditional pricing methodology creates a number of challenges for pric-

ing actuaries and risk managers, but it leads to a better understanding of the business, more precise pricing and better risk/capital management, and eventually will help the company sustain capital swings and have a smooth ride along the way. ☐

The views in this paper represent the author's personal opinions. It does not represent any statements or views of the corporation the author affiliates with.

NAIC Update – September 2009 Meeting

by Donna R. Claire

For me, the biggest news from the September 2009 NAIC meeting was that changes to the Standard Valuation Law to allow PBA have now been passed by all needed committees of the NAIC, including the Executive and Plenary Committees. There is a caveat that the Valuation Manual must be passed by December of 2009.

The remainder of this article summarizes my notes on the meetings I attended.

Life and Health Actuarial Task Force

Larry Bruning, chair of the Life and Health Actuarial Task Force (LHATF), started off the LHATF meeting by reminding everyone that the revisions to SVL had passed the PBR (EX), Solvency Modernization, and the A committee since the last LHATF meeting. There is still work to be done on the Valuation Manual. At this point, due to the lack of specificity on the net premium approach from the ACLI, it looks like the SVL revisions will likely go to the 2011 legislative sessions.

Valuation Manual

As with the last LHATF meeting, much of the meeting was spent reviewing the work of the LHATF subgroups working on various sections of the Valuation Manual:

a. **VM-00, 01, Process and Coordination:** Mike Boerner heads the LHATF team on this part of the Manual (as well as heading the Academy team on the Valuation Manual in general). Bob DiRico heads an Academy subgroup on Consistency that is assisting with these sections, making sure that the overall direction and definitions are consistent for various product lines. Bob's group had offered a proposed amendment regarding what is covered in reserves. LHATF generally accepted these recommendations and exposed a new draft of VM-00 for comment.

b. **VM-20, Life:** Pete Weber heads the LHATF group on VM-20. Pete has had numerous conference calls and most of the work on this part of the manual has been completed. The major outstanding item is the net premium approach, discussed in more detail below. In addition, the discussions on economic scenarios and default/spread analysis impact this section of the manual.

c. **VM-21 Variable Annuities:** This section would bring in the Variable Annuity CARVM Actuarial Guideline, which goes into effect at year-end 2009. There is a draft VM-21 done, and it will be discussed on a conference call.

d. **VM-30, 31, PBR Reporting and Review:** Katie Campbell heads this effort. One outstanding issue is concerns about reliance on others regarding information. There are also some concerns regarding the wording of the actuarial opinion. There will be a follow-up conference call on these issues.

e. **VM-50, 51, PBR Experience Reporting:** Fred Andersen is heading this effort. He stated that some companies have requested that they want to have a centralized collection agency with a global budget. Fred plans to have a conference call to continue these discussions.

Related Issues

There were a number of topics discussed at LHATF, most related to SVL and the Valuation Manual. These include:

Preferred Mortality: Tim Harris provided an update on preferred mortality work done by the Academy of Actuaries and Society of Actuaries. When performing a gross premium calculation, one of the considerations is what type of margins should be used on mortality. After reviewing the work done by the group, LHATF advised the SOA/Academy group to continue work on developing a range of reasonable margins, and provide guidance as to what an actuary should consider when setting margins from that range. The report will be available on the Academy Web site, www.actuary.org.

Payout Annuities: Although it will not be an issue from day one, a PBA approach will also be used on annuities. The SOA has developed the experience table. A joint SOA/Academy group is looking at developing a new valuation table. I gave the report from this

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group. LHATF determined (1) a new Valuation Table is needed for payout annuities; (2) this Valuation Table will include yearly projection factors; and (3) the new Valuation Table will not be tiered for size. Note, this last issue was considered because the A/E ratio of the biggest payout annuities—those over $50,000 a year—was 71 percent; the A/E ratio for the smallest annuities—those less than $2,500—had an A/E ratio of 111 percent. However, there were too many practical issues to develop a Valuation Table that was separated by amounts.

Net Premium Approach: The A committee has made as a condition the passage of a Valuation Manual by the end of 2009 which includes some formulaic minimums. John Bruins gave a presentation regarding a net premium approach to PBA reserving, which the ACLI states is needed for federal income tax deductibility of reserves. The ACLI is in the process of developing a net premium approach and expects to have information to present to LHATF in the next few months. Note that this is the biggest open issue on the life insurance PBA (VM-20).

Reinsurance Subgroup of LHATF: Tomasz Serbinowski is now chairing this group. The point of the group is to make sure reinsurance will be handled reasonably under PBA. Tomasz gave a brief report—most of this group's recommendations have already been accepted. This group will need to review the impact of a net premium approach on reinsurance once the net premium approach is finalized.

Joint CADTF/LHATF Subgroup: Leslie Jones is temporarily chairing this group. This group is trying to make sure the capital testing and reserve testing rules are as consistent as possible. They will continue to have conference calls.

> " The ACLI is in the process of developing a net premium approach and expects to have information to present to LHATF in the next few months. Note that this is the biggest open issue on the life insurance PBA (VM-20). "

Economic Scenarios: Nancy Bennett gave a presentation from the Academy's Economic Scenarios Implementation Work Group. The regulators have asked questions regarding the generator developed by the Academy's Economic Scenario Work Group, and the Economic Scenario Implementation work group did analysis. The Academy's group used a stochastic log volatility model. The goal of the group is to have the same calibration criteria so that companies can use the same generators for both reserves and capital. The report will be available on the Academy Web site, *www.actuary.org.*

Prescribed Default Costs to be used on Existing Fixed Income Investments: Gary Falde and Alan Routhenstein gave an update from the Academy on several possible methods that LHATF could use to develop default costs/spreads to be used under PBR. A lot of work has been done, but work is still needed on this to get results that look reasonable to all parties.

GLIBs: LHATF had exposed revisions to Actuarial Guideline 33. These changes were made to address how a new benefit—deferred annuities with guaranteed living income benefits that allow cash surrender before and during the payout phase—would be valued under Actuarial Guideline 33 for reserves. LHATF determined that the correct answer is to bifurcate the benefit, and that Type C (lower) interest rates be used when there are cash values remaining, with Type A (higher) interest rates thereafter. The amendments to AG33 were adopted by LHATF. Note: This is a bandage approach, and is the type of issue PBA could handle better.

Nonforfeiture Changes for PBA: There is a proposal to change the nonforfeiture law (de-linking the interest rate from the valuation interest rate). The ACLI believes these changes need to wait until the net premium approach reserve changes are resolved.

Accident and Health Working Group (a subgroup of LHATF):

The Accident and Health working group met via conference call prior to the LHATF meeting due to the shortened time of the LHATF meeting, and the results

reported at the LHATF meeting. Steve Ostland chairs this group. The group is looking at what changes are needed to the 2010 Statements for Health products. The group is working with the SOA/Academy to develop a replacement for the 1987 Group Disability Table.

Life Risk Based Capital Working Group

Philip Barlow ran the RBC meeting. Peter Boyko presented an update to the RBC C-3 Phase 3 report, which had minor changes to the March report. This was exposed for comment.

PBR (EX) Task Force

This group is charged with shepherding the PBA project through the various NAIC Committees. The new PBR (EX) Chair is Commissioner Hamm from North Dakota. They heard a report from LHATF on the PBA project. The group adopted the rules for corporate governance for PBA, which will be made part of the Valuation Manual. The group exposed for comment a memo on the role of the NAIC as a statistical agent.

Summary

In summary, PBA has made significant progress over the past couple of years. It's almost here! ☐

Visions for the Future of the Life Insurance Sector

by Mike Boot

The economic crisis that dominated the news during 2008 and 2009, the expansion of technology, changing accounting standards, access to capital, and changing demographics are some of the challenges facing the life insurance sector. To provide a catalyst for discussion and to showcase the thought leadership of actuaries, the Financial Reporting, Product Development and Reinsurance Sections of the SOA sponsored "Life Insurance 2020 Foresight–A Call for Essays." Members of the SOA responded by authoring short essays with their unique and thoughtful vision of the future. We are proud to be able to present this collection of essays selected from among those submitted.

The full list of essays can be found at:
http://www.soa.org/library/essays/life-essay-2009-toc.aspx

Helping To Take The "Ill" Out Of Illustration Certifications—**Using The Update To The Illustration Practice Notes**

By Donna Megregian

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This article is intended to give a high level overview of the recent release of the update to the illustration practice notes. Guidance for illustration testing should be sought from the Illustration Model Regulations and Actuarial Standard of Practice (ASOP) 24, as well as review of the practice notes.

For many product actuaries, year end doesn't always signal good tiding and great joy in their job when they are responsible for the annual illustration certification for their company's products. This process can be painful, and is best performed with great planning and assistance from every possible angle. Assistance for this process is offered in the form of practice notes.

Earlier in 2009, the Illustrations Work Group (IWG) completed a revision to the Illustration Practice Notes (IPN). A presentation on the IPN was given at the 9th annual Product Development Symposium and a webcast that took place in September. The update is available at *http://www.actuary.org/pdf/practnotes/pnasop24Update.pdf.* It is my first priority to encourage any illustration actuary (or anyone interested in the illustration certification process) to read through the IPN, ASOP 24, and the Illustration Model Regulation (at a minimum, it's continuing education which is good for you!). Just so we are clear as to what practice notes are, practice notes are intended to give an idea of various practices that are currently being performed in a specific area. They are not intended to be interpretations of actuarial standards or regulations, nor codifications of generally accepted actuarial practice. Practice notes are intended to help an actuary consider various aspects of a problem in order to get comfortable with a decision they have made or need to make.

The IPN were revised for a few reasons. First, the IPN were categorized by subject matter to assist the reader in finding answers more easily. Second, the IPN were to reflect the changes that were made in ASOP 24 when it was revised in 2007. Finally, the IPN were to reflect new and evolved practices since the previous notes were released.

The extensive 81-page document is intended to be more organized relative to the previous practice notes. The IPN is categorized into 19 areas of interest (labels sections A-S alphabetically), ranging from experience assumptions and reinsurance to a specific section relating to Equity Indexed-Link products. As a whole, the prior version of the IPN remained intact. Only minor revisions and additions were made due to recent practices and ASOP 24 updates.

Equity Index-Linked Questions

Certainly the arrival of an Equity Index-Linked section is new to the new IPN. This section (D when looking in the IPN) goes through such questions as:

- What investment return assumption are actuaries using in the self/lapse-support tests?
- Are gains from mid-year surrenders included in the investment return assumption when performing the self/lapse-support tests?
- Neither the Model nor the ASOP appear to offer specific guidance in setting the assumed return of an index. What are commonly used approaches to setting it?
- When would it be appropriate to update the illustrated rate?
- If my index-linked product offers multiple index buckets, how many illustrated rates do I need?

Like many other topics, sometimes what you are looking for may be related to sections other than equity index-linked section and advice in that section may be helpful for consideration.

In-force Illustration Testing

More companies seem to be asking questions about how to handle illustrations on in-force business. The ASOP offers some guidance on what could be considered safe harbors for not having to retest in-force business, but certainly, as in all cases, actuarial judgment should be used. If assumptions have not materialized as expected (i.e., mortality, interest, lapses, etc.), it may be prudent to look at in-force business to assess if the illustrated scale (DCS) is still supportable. The IPN does offer guidance in section P on in-force testing. New questions related to prior distribution of surplus (P9) and products with both guaranteed and nonguaranteed timeframes (J4) have been added to the IPN to assist in in-force testing.

Summary

Of course there is no end-all be-all resource for how certifications should be done for compliance with the Illustration Model Regulation and ASOP 24. The Illustration Practice Notes hopefully provide to the illustration actuary a decent survey of what other companies are thinking about and processes they are using to certify each year. The updates and changes are good to go through if you haven't done so, and it is a nice review for those familiar with the process or wanting to perhaps get more things to think about as you go through your annual certification.

The IWG tried to encourage questions throughout the process and if there are any additional thoughts about the IPN, please direct them to Dianna Pell at pell@actuary.org. □

Why Predictive Modeling For Life Insurance And Annuities?

by Andy Staudt

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Mark Twain wrote that "the art of prophecy is very difficult, especially with respect to the future." While this will always be true, it is even more true if we continue to rely on methods that require unnecessary assumptions to model the past, let alone the future. Yet predictive modeling offers an alternative where, by making use of more advanced statistical methods and algorithms, we can avoid making some of these simplifying assumptions. We can then start to both better understand what has happened historically as well as make more educated estimates as to where we are going in the future.

To help understand why predictive modeling should be a necessary (but by no means sufficient) tool for the life actuary, this article identifies examples of various limitations in traditional mortality experience analyses. It also posits various predictive modeling techniques as a means of avoiding these constraints.

FIGURE 1

Multivariate Analysis

Historically, the driving motivation for predictive modeling in many industries has been the desire to simultaneously analyze the effect of different factors on an item of interest—a process known as multivariate analysis. In contrast, most mortality analyses are univariate, where the effect of factors such as age, gender or smoking status on mortality are evaluated and presented in isolation. Although univariate analysis does provide a strong indication of how mortality experience varies, based on an explanatory factor, any combination of these results invariably leads to some redundancy or inadequacy. For example, if in our data set, smokers have higher mortality, but only women are smokers, then the effect of smoking will be captured twice, both by the gender variate as well as by the smoking status variate. Combining these two variates will lead to an overstatement of the mortality for women smokers. One band-aid for this problem works by slicing the data into various buckets (i.e., male/smokers, female/ smokers, male/non-smokers, etc.) and evaluating the mortality experience for each bucket separately. This technique certainly solves the problem; however, as we increasingly want to slice along more and more dimensions, the credibility in each bucket decreases rapidly. As such, we turn to multivariate techniques that allow us to model the correlations and interactions among many different variables simultaneously.
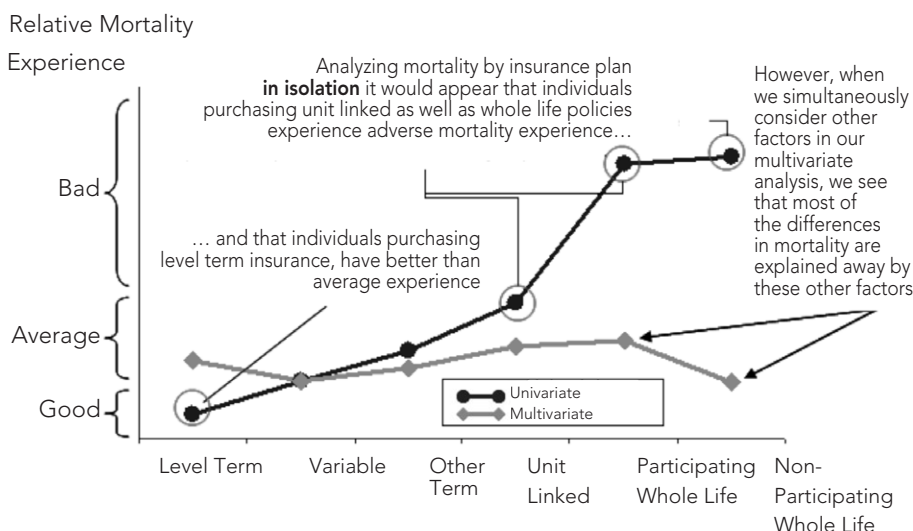
Figure 1 shows how a univariate analysis may produce misleading and inaccurate results by ignoring correlation among several explanatory variables. Based on our univariate analysis, we may be inclined to believe there is significant disparity in mortality experience based on type of policy purchased. However, the multivariate result suggests that the type of policy has a much less pointed effect on mortality because variables, such as face amount of insurance purchased and/or issue age, explain away much of the variation by type of policy.

Controlling for the Environment

To predict future mortality, many mortality studies will use only the most recent years of historical experience as changes in the mix-of-business as well as changes in underwriting practices. Further, general mortality improvement over time will mitigate the extent to

which past experience is predictive of future experience. However, we can carve these biases out of our data by including in our analysis direct or proxy variables, such as calendar year, which control for these changes over time. This practice then allows us to fit models using many years of data—which increases the credibility of our results—mitigating the effects of combining experience over these extended time periods. Furthermore, we are not only able to control for these historical changes, but we can extrapolate into the future general mortality change over time to gain a better estimate as to future mortality. Figure 2 shows exactly this type of analysis where we have removed the historical mortality improvement. This allows us to combine five years of experience to fit our mortality model, as well as our projection of future mortality improvement. This graph also shows intervals around our historical model fit representing our confidence in these estimates, as well as intervals around our projections giving us an indication of the possible error in our predictions. This type of analysis could easily and effectively be merged into dynamic, stochastic mortality models to develop a unified understanding of future behavior.

Optimal Variable Banding

It is a common modeling practice to combine or band together continuous, or pseudo-continuous, variables into discrete groups. In mortality analyses, examples might include banding together age (e.g., 15-to-19, 20-to-24, 25-to-29, etc.) and face amount (e.g., <25K, 25K-100K, 100K-500K, etc.). This process, loosely referred to as discretization, can be a powerful technique for deriving interpretable meaning out of an underlying dataset; however, if applied naively, it can also blur the true underlying relationship—leading to a loss in a model's predictive power. Traditional methods to banding variables include creating bands with equal interval-widths, such as those described above, or creating bands where the amount of data in each band is roughly equivalent. The former is effective at creating evenly spaced groups, while the latter is effective at ensuring that the results derived by band are equally credible. However, these methods are often not optimal because they create bands without consideration of the variable of interest (in our example, mortality) as well as interactions with other variables. Alternatively, predictive models developed using decision trees are able to optimally band together variables so as to not
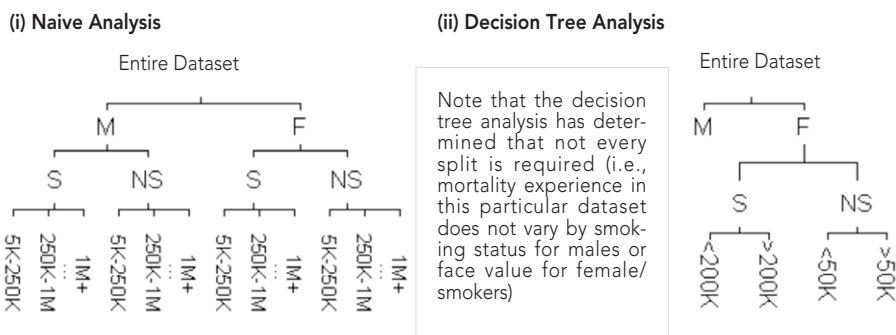

FIGURE 2
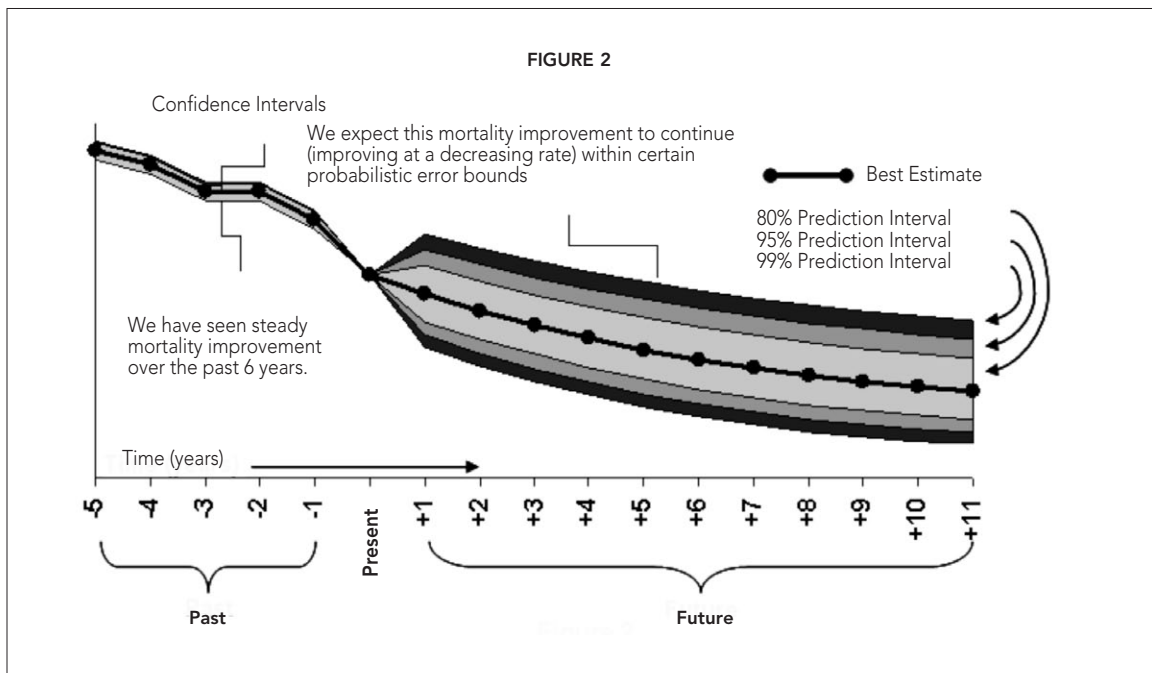
only optimize the various splits in a continuous variable (both in terms of number of bands as well as in terms of the size of various bands), but also to identify how to best group or cluster these bands with other variables. This maximizes the homogeneity of groupings (both in terms of similarities within groups as well as dissimilarities between groups), increasing the credibility of the result. Figure 3 shows just this type of analysis. And although it is not obvious from these graphs, decision tree analysis can also rank the splits, prioritizing those that are most effective and ignoring those that add little or no value.
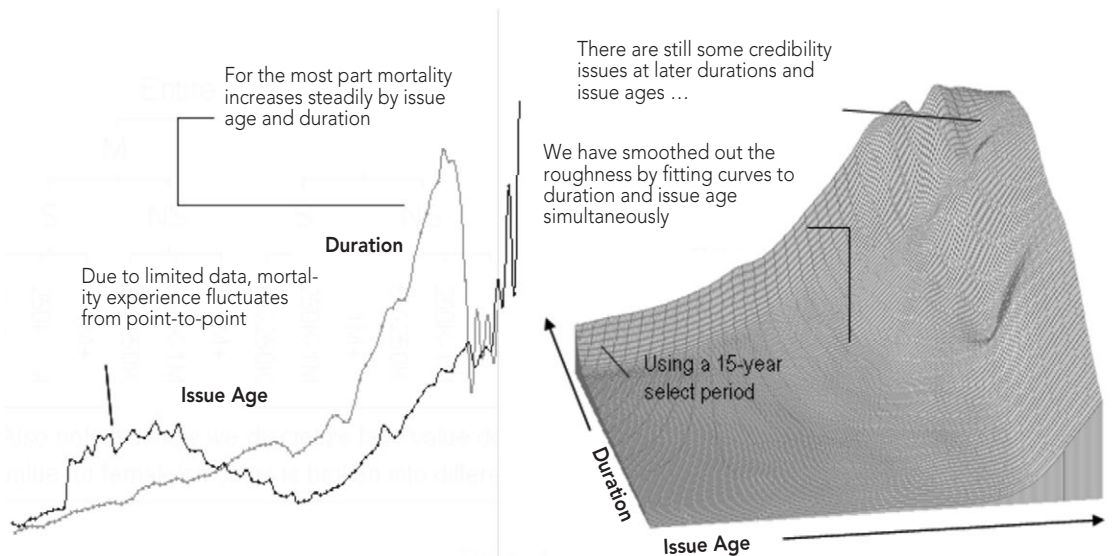
Removing Noise from our Estimates

To produce a workable mortality table varying by duration and issue age, it is necessary to smooth out the discontinuities in estimates of mortality by issue age and duration. These invariably result when working with imperfect data. To do this, many methods rely on first computing point estimates of mortality by issue age and duration and then adjusting these point estimates to meet some generally accepted criteria (e.g., mortality should increase by issue age, and mortality should increase by duration). The problem with this approach is that (1) it does little to suggest how much mortality should increase by issue age and how much mortality should increase by gender and (2) that this two-step procedure produces a result exogenous to the system, requiring user interaction, rather than a result that is optimized from within the system. Alternatively, rather than adjusting our point estimates of mortality at each issue age and duration point to produce a smooth mortality table, we can combine steps 1 and 2 and fit multi-dimensional functions, or curved planes, to the data. Furthermore, we can constrain these functions to represent realistic patterns, give more weight to more credible subsets of the data and be optimized over the space of all realistic functions. Figure 4 shows point

FIGURE 3

(i) Naive Analysis

(ii) Decision Tree Analysis

Note that the decision tree analysis has determined that not every split is required (i.e., mortality experience in this particular dataset does not vary by smoking status for males or face value for female/smokers)

Also note that how we discretize face value depends on which cluster of data we wish to model (i.e., face value for female/smokers is broken into different groups than face value for female/non-smokers)

FIGURE 4

For the most part mortality increases steadily by issue age and duration

Due to limited data, mortality experience fluctuates from point-to-point

There are still some credibility issues at later durations and issue ages …

We have smoothed out the roughness by fitting curves to duration and issue age simultaneously

Using a 15-year select period

estimates at various issue ages and durations. Note that the curves produced by connecting the dots are quite jagged; combining them to produce a realistic mortality table will be no trivial task. The figure on the right, however, shows how we can fit multi-dimensional curves to smooth out the noise in our estimates and produce a workable mortality experience table.

Conclusion

The above examples conceptually demonstrate applications of predictive modeling within the life insurance industry. We have presented our examples within the context of mortality; however, the techniques described above could easily be applied to better understand and model other assumptions or lines of business such as:

- Dynamic policyholder behavior in interest-sensitive products or products with guarantees.
- Life insurers specializing in direct marketing who may greatly benefit by taking a page from the credit card companies' book. They could use customer characteristics to model propensity to buy, and subsequently propensity to persist, to selectively market to individuals who are expected to result in the highest level of profitability.
- Disability insurance claims that may best be handled using anomaly detection algorithms, which can be used to flag potentially fraudulent claims and allocate resources thusly. ☐

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