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Embedded Derivatives in Modco and Similar Reinsurance Arrangements

by Richard H. Browne

Editor's Note: The section's GAAP list serve would be an appropriate forum for discussing concepts in this article.

At the AICPA 2002 National Conference on Current SEC Developments, the SEC staff announced their views that certain reinsurance agreements, such as modified coinsurance arrangements (modco), under which the ceding company retains the underlying assets and the reinsurer receives an investment return based on that underlying referenced pool of assets, contain an embedded derivative that must be accounted for in accordance with Statement of Financial Accounting Standards No. 133, *Accounting for Derivative Instruments and Hedging Activities* (FAS 133).

In January 2003, the FASB announced that it would clarify this interpretation of FAS 133 in a derivative implementation group (DIG) Issue. On April 10, 2003, the FASB posted the cleared DIG Issue No. B36, *Embedded Derivatives: Modified Coinsurance Arrangements and Debt Instruments That Incorporate Credit Risk Exposures That Are Unrelated or Only Partially Related to the Creditworthiness of the Obligor under Those Instruments*. DIG B36 is effective for the first fiscal quarter beginning after September 15, 2003.

DIG B36 includes an example of a modified coinsurance arrangement that includes an embedded derivative that must be identified and accounted for separately from the debt host at fair value, provided that the reinsurance arrangement is not already accounted for at fair value. This bifurcation would be necessary by both the ceding company and the assuming company.

DIG B36 requires application of the interpretation to both existing and future modco and

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475 N. Martingale Road, Suite 800
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Phone: 847-706-3500
Fax: 847-706-3599
World Wide Web: www.soa.org

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Jerry Enoch, Newsletter Editor
Lafayette Life Insurance Company
1905 Teal Road • Lafayette, IN • 47905
PHONE: (765) 477-3220
FAX: (765) 477-3349
E-MAIL: jenoch@llic.com

Keith Terry, Associate Editor
E-MAIL: Keith_Terry@FarmersInsurance.com

Joe Adduci, DTP Coordinator • NAPP Member
PHONE: (847) 706-3548
FAX: (847) 273-8548
E-MAIL: jadduci@soa.org

Clay Baznik, Publications Director
E-MAIL: cbaznik@soa.org

Lois Chinnock, Staff Liaison
E-MAIL: lchinnock@soa.org

Articles Needed for the Reporter

Your ideas and contributions are a welcome addition to the content of this newsletter. All articles will include a byline to give you full credit for your effort. *The Financial Reporter* is pleased to publish articles in a second language if a translation is provided by the author. For those of you interested in working in further depth on *The Financial Reporter*, several associate editors are needed. For more information, please call Jerry Enoch, editor, at (765) 477-3220.

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Preferred Format

In order to efficiently handle files, 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 to the newsletter editor. 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. Author photos are accepted in .jpg format (300 dpi) to accompany their stories.

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

Please send articles via e-mail or in hard copy to:

Jerry Enoch, FSA
Lafayette Life Insurance Company
1905 Teal Road
Lafayette, IN 47905
Phone: (765) 477-3220 | Fax: (765) 477-3349
E-mail: *jenoch@llic.com*

Thank you for your help.

SOCIETY OF ACTUARIES

The Chairperson's Corner

Feedback Needed!

by John F. Bevacqua

During the hot breakfast at last year's annual meeting in Boston, we conducted a survey of the members present, seeking to find out what the council has done well and where we can do better. With a surplus of over $400,000, the section is well positioned to support a number of possible projects, and it is the intent of the council to use the membership's feedback to determine how to prioritize possible endeavors. We received over 50 responses with very positive feedback on what the council has done, and some helpful recommendations on what the council can do going forward.

Some of the highlights from the survey responses include:

- High marks for the section's newsletter, *The Financial Reporter*
- The majority of respondents have not yet visited the section's Web site
- Approximately 50 percent of respondents indicated that they have enrolled in the section's list serves
- The majority of respondents indicated that online education would be valuable.

In addition to these general comments, we also received a wide range of suggestions on possible research topics, seminars, online education topics, and webcasts. The section council reviewed these suggestions during our meeting in January as part of our goal setting process, and determined that it would be helpful to share the list of possible projects with the membership and get your feedback. Possible projects discussed by the council include:

- Research on mortality improvement
- Periodic webcasts about current events in the financial reporting area
- Co-sponsoring seminars with other professional organizations (e.g. AICPA).

Borrowing a page from the Futurism section, the council would like to use the feedback in a Delphi-type study, which involves sharing many of the responses that we receive from the membership and, in turn, getting responses about the responses to ensure that we are adequately addressing the needs of our membership. We therefore have posted a survey on the section's Web site that lists possible projects, as suggested in our initial survey, and asks respondents to indicate their strength of interest in having the council move forward with each.

Upon considering the possible projects, it is important to recognize the mission of the section, which is "to encourage and facilitate the professional development of its members through activities such as meetings, seminars, research studies, and the generation and dissemination of literature in the field of life insurance company financial reporting." We therefore ask that you consider your developmental needs, what medium would be most effective for you to meet these needs and how we can improve upon our traditional approaches.

Please visit the section's Web site and complete the online survey—I am sure that you will be impressed with the list of possible projects.

John Bevacqua, FSA, MAAA, is partner at Deloitte & Touch LLP in Hartford, Conn. He can be reached at jbevacquafr@deloitte.com.

Letter From the Editor

A Fly on the Wall: What Is a Meeting of the Financial Reporting Section Council Like?

by Jerry Enoch

As new editor of the section's newsletter, I have recently experienced my first, full-day meeting of the section council, which consists of the leaders of the Financial Reporting Section. I generally avoid meetings whenever possible, and I don't have a habit of thinking about meetings that I don't have to attend, but I was curious about what happens at a meeting of the section council. If you don't have a bit of that curiosity also, you may want to move on to another article now.

This article is not a cover for a presentation of the minutes, and I am making no attempt to be even-handed. I'm going to take the liberty of writing about what I thought was most interesting and breeze by the rest.

We met around a long table in a nice airport hotel in Chicago during a cold wave in January (which seems like a bizarre time for financial reporting actuaries to meet). The meeting lasted from 10:00 a.m. until 3:30 p.m. The council works very congenially, which does not at all mean that there is unanimity. When we arrived, in front of each of us was a multipage summary of a survey of the members of various SOA sections. This is an excellent method of keeping early arrivers from getting restless and troublesome—it sure worked on me!

Early in the meeting we discussed the results of the survey that was taken at the section's hot breakfast meeting at the annual meeting in Boston. The council is very interested in input from section members and takes seriously its responsibility to act on behalf of the members and to serve the members. Periodically throughout the meeting, we desired more information about how the section as a whole feels about a matter. As you receive requests for feedback from the section in the future, please respond! Of course, having information does not always indicate a direction. For example, we know that some people think that 2001 CSO has been beaten to death at meetings; others want more sessions on 2001 CSO. Such is the nature of a group of people.

We had a lengthy discussion about goals for the section for the year. One of the first suggestions was to promote more interest in the section. We also discussed a desire to update the GAAP textbook, which has been a huge success, to include important topics that have emerged since its publication. We discussed topics for seminars that the section might sponsor during the year, and the possibility of having a periodic (if not quarterly) financial reporting update webcast. And the list went on.

We discussed progress on preparing for the financial reporting sessions at the spring meeting and picked topics for the financial reporting sessions at the annual meeting.

We discussed various liaisons, more seminars, various funding requests, the newsletter, etc. The council gives very serious thought to funding requests. You can be assured that the sense of fiduciary responsibility is very strong in this group.

For anyone who wonders why _____ was not mentioned as one of the primary topics of the meeting, I have several responses. First, I have not attempted to be complete, objective, or balanced in what I have written. Second, and most importantly, I suggest communicating your feelings with the section council members. They are listed on page two of this newsletter. Your communication will be taken seriously, and it might change the future.

I was very impressed with what this small number of people does. They deserve our thanks and our help.

- Jerry

Jerry Enoch, FSA, MAAA, is vice president and actuary at Lafayette Life Insurance Company in Lafayette, Ind. He can be reached at jenoch@llic.com.

similar arrangements for quarters beginning after September 15, 2003, which, for calendar year companies, means that compliance must begin with the upcoming year-end statements.

This article examines the characteristics of modified coinsurance and similar arrangements, which may result in the presence of an embedded derivative. It reviews the criteria that must be satisfied in order for an instrument to be considered an embedded derivative under FAS 133 and, finally, presents some of the considerations necessary to properly account for the embedded modco derivative according to FAS 133.

Modified Coinsurance and Similar Arrangements

Under modco arrangements the reinsurer participates, on a pro-rata basis, in all premiums and benefits from the underlying contracts. The ceding company retains control of the invested assets necessary to support the reserves for the underlying contracts. The reinsurer funds the statutory reserves on the reinsured portion of the risks through the *modco reserve adjustment*. The ceding company credits interest to the reinsurer on the statutory reserves at the *modco interest rate*.

It is useful to think of modco as consisting of traditional coinsurance of the risks, combined with a loan from the reinsurer to the ceding company. The loan balance is maintained at an amount equal to statutory reserves via the modco reserve adjustment, and the loan interest rate is the modco interest rate. Using this interpretation, the reinsurer's balance sheet would show both a reserve for future policy benefits and also a "funds withheld asset" equal to the loan balance. The ceding company's balance sheet would show a reserve liability to the policyholder, invested assets in the underlying portfolio, a reserve recoverable from reinsurers asset, and a "funds withheld liability" equal to the loan balance:

Direct Writer

Assets	*Liabilities*
Invested Assets	Reserve
Reserve Recoverable	Loan (FWA)

Reinsurer

Assets	*Liabilities*
Loan (FWA)	Reserve

In most modco arrangements in the United States, the modco interest rate is equal to the earned interest rate on the underlying portfolio of invested assets, which are typically held in a trust, or some other legally segregated portfolio, or is based on the ceding company's return on general account assets. The reason for this is that this approach will assure transfer of investment risk and allow the arrangement to qualify for reinsurance accounting (for the ceding company) under NAIC rules.

It is precisely this situation, when the reinsurance arrangement provides for sharing of investment results on a referenced pool of assets, that is the concern of DIG B36. The conclusion is that, to the extent the investment return includes credit risk beyond the counterparty credit risk of the ceding/assuming company, or other risks not clearly and closely related to the funds withheld asset/liability, the arrangement will include an embedded derivative. In order to see how this conclusion is reached, it is necessary to understand the criteria under FAS 133 for a particular instrument to qualify as an embedded derivative.

FAS 133 Embedded Derivative Criteria

A financial instrument that contains an embedded derivative is called a hybrid instrument, which consists of a host contract and the embedded derivative. In order to be considered an embedded derivative, the following criteria must be met:

1. The embedded derivative must qualify as a derivative as defined in paragraph 6 of FAS 133. The following required characteristics of a derivative are described in paragraph 6:

   - There must be an *underlying* and/or a *notional*. Usually, the value of the embedded derivative is determined from the application of the underlying

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to the amount of the notional. In the case of a modco arrangement, the notional is the funds withheld asset/liability, and the underlying is the return on the referenced pool of assets (i.e., the modco interest rate).

- At inception, there must be no or insignificant required net investment in the embedded derivative.
- Investment cash flows must be net settled in cash at each settlement date defined in the contract.

2. The economic characteristics and risks of the embedded derivative must not be clearly and closely related to the economic characteristics and risks of the host.

   DIG B36 indicates that if the return on the underlying portfolio includes credit risk associated with the issuers of the underlying securities, this credit risk is to be distinguished from the credit risk of the ceding company (the counter-party risk), and this prevents the embedded cash flows from being clearly and closely related to the debt host (the funds withheld asset/liability) issued by the ceding company. The DIG reads: "The risk exposure of the ceding company's general account assets or its securities portfolio is not clearly and closely related to the risk exposure arising from the overall credit worthiness of the ceding company, which is also affected by other factors. Consequently, the economic characteristics and risks of the embedded derivative instrument are not clearly and closely related to the economic characteristics and risks of the debt host contract."

   It should be noted that this treatment of credit risk is very different than the treatment of interest rate risk. Regarding interest rate risk, FAS 133, paragraph 61, suggests that when an embedded derivative related to interest rate risk exists and the host contract is a debt instrument, then in most cases the risks and characteristics of the embedded derivative are considered to be clearly and closely related to the risks and characteristics of the debt host.

3. The hybrid instrument is not carried at fair value under otherwise generally accepted accounting principles, with changes in the fair value of the instrument reported in earnings at each reporting period.

The conclusion of DIG B36 is that many modco arrangements contain an embedded credit derivative. For these, it will be necessary to bifurcate the funds withheld asset/liability (the hybrid instrument) into the embedded credit derivative and the host contract. Once the embedded derivative is identified and separated, it should be recorded as an asset/liability, and changes in its fair value should be recorded in GAAP earnings.

The conclusion of DIG B36 is that many modco arrangements contain an embedded credit derivative.

Bifurcation of the Funds Withheld into the Credit Derivative and the Host Contract

The funds withheld (FW) provide a return based on the modco interest rate, which is earned on a notional amount equal to the statutory reserves. The modco interest rate, which is the return on the referenced pool of assets, may be thought of as consisting of a risk-free rate of return plus a spread for the credit risk associated with the issuers of the securities in the referenced pool of assets. Therefore, at any point in time the market value of the FW asset (from the reinsurer's point of view) is the market value of a risk-free asset with the same cash flows as the FW less the discount for the credit risk associated with the issuers of the securities in the reference pool. In particular, at the inception of the reinsurance arrangement there is an anticipated level of default activity that has been reflected in the determination of this discount for credit risk. This suggests that variations in this anticipated level of credit risk should be reflected in changes in the value of the embedded derivative.

Said another way, there is a "baseline" level of anticipated credit risk associated with the FW asset. As long as this baseline does not change, the value of the embedded derivative should not change. In subsequent periods the fair value of the embedded derivative may become positive or negative, reflecting deviations from the baseline in anticipated default experience. In subsequent periods the fair

value of the embedded derivative will reflect changes in the anticipated cash flows from the FW asset that occur because of credit quality changes in the reference pool.

The host contract would therefore be a "credit risk free" asset with the same anticipated cash flows as the FW asset. These anticipated cash flows would reflect the baseline level of default activity in the reference pool. The embedded derivative represents the risk associated with changes from the baseline.

To illustrate these points, the following section contains a simple example based on the modco reinsurance of a five-year SPDA contract, with underlying investments all in five-year zero coupon bonds. This example suggests that one approach to determining the fair value of the embedded derivative may be based on discounting projected cash flows of the FW asset. The very broad subject of fair value accounting is well beyond the scope of this article. For an excellent discussion of principles of fair valuation of liabilities in an insurance context, some practical techniques, and a very good list of references on these topics, the reader is referred to the American Academy of Actuaries public policy monograph, *Fair Valuation of Insurance Liabilities: Principles and Methods*, published in September 2002.

A Simple Example

The example is based on a five-year SPDA with investments made in five-year zero coupon bonds, assumed to yield 4.75 percent. Credited interest is anticipated to be 4 percent. There is a 3 percent commission and a surrender charge of 4 percent graded out to 0 percent on any withdrawals. Withdrawal rates are assumed to be zero percent in year

Table 1

Year	Deposit	Commission	BOY Fund	Interest Credited	Withdrawals	EOY Fund	EOY CSV =Stat Res
1	10,000	300	10,000	400	-	10,400	9,984
2	-	-	10,400	416	541	10,275	9,967
3	-	-	10,275	411	1,069	9,618	9,425
4	-	-	9,618	385	1,500	8,502	8,417
5	-	-	8,502	340	8,842	-	-

Table 2

Year	BOY Assets	4.75% Investment Income	Surrenders	Assets Transferred	EOY Assets
1	9,700	461	-	177	9,984
2	9,984	474	525	(33)	9,967
3	9,967	473	1,047	(32)	9,425
4	9,425	448	1,485	(29)	8,417
5	8,417	400	8,842	(25)	-

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one, 5 percent in year two, 10 percent in year three, 15 percent in year four and 100 percent at the end of year five. The following table (Table 1) shows the anticipated fund development for a single deposit of $10,000.

Deposits net of commissions are assumed to be invested in zero coupon bonds yielding 4.75 percent. The direct writing company will maintain assets backing the business equal to the statutory reserves, with any excess transferred to surplus. Table 3 shows the cash flows from assets, which are anticipated at inception. Investment income represents accrual of discount, and the 4.75 percent rate is assumed to be adjusted for anticipated defaults. The assets transferred represent the adjustment to assets in the reference pool to maintain a balance equal to statutory reserves.

The FW asset is always balanced to equal the statutory reserves. Table 4 shows the development of the anticipated FW asset cash flows. The cash flow is equal to assets released, which are equal to the surrenders plus assets transferred from Table 2.

Now let us assume that, at the end of year one, the anticipated default experience on the reference pool of bonds has deteriorated, to the extent that the expected return is now 4.5 percent, rather than 4.75 percent. Assume also that no other anticipated assumptions have changed (withdrawal rates, credited interest). We can now project the cash flows from the FW assets under the anticipated experience at the end of year one as follows in Table 4.

The present value of FW asset cash flows at the end of year one, reflecting the revised anticipated default experience is now 9,899. The present value of FW assets cash flows at the end of year one, based on the baseline default experience, is $9,984. This suggests that an estimate of the value of the embedded derivative is given by the difference, or $9,899 – $9,984 = (85).

In this example, the present values were taken at 4.75 percent. Appropriate discount rates to use in estimates of fair value based on discounted cash flows is beyond the scope of this article. Again, the reader is referred to the Academy's public policy monograph, *Fair Valuation of Insurance Liabilities: Principles and Method* for discussions about this issue.

Two additional observations related to this example should be made. First, in our simple example we assumed that during year one

Table 3

Year	Deposits	Allowance	BOY Mod Co Res	ModCo Interest	EOY Mod Co Res	Modco Adjustment	Surrenders	Net Settlement
1	10,000	300	9,700	461	9,984	9,523	-	177
2			9,984	474	9,967	(491)	525	(33)
3			9,967	473	9,425	(1,015)	1,047	(32)
4			9,425	448	8,417	(1,456)	1,485	(29)
5			8,417	400	-	(8,817)	8,842	(25)

Table 4

Year	BOY FW Assets	Investment Income	Assets Released	EOY FW Assets	FW Asset Cash Flow
0					(9,700)
1	9,700	461	177	9,984	177
2	9,984	474	491	9,967	491
3	9,967	473	1,015	9,425	1,015
4	9,425	448	1,456	8,417	1,456
5	8,417	400	8,817	-	8,817

Table 5

Year	BOY FW Asset	Investment Income	Assets Released	EOY FW Asset	FW Asset Cash Flow	PV Asset Cash Flows
0	-	-	-	-	-	
1	-	-	-	9,984	-	9,899
2	9,984	449	466	9,967	466	-
3	9,967	449	990	9,425	990	-
4	9,425	424	1,432	8,417	1,432	-
5	8,417	379	8,796	-	-8,796	-

there were no changes in anticipated product experience with respect to persistency or crediting strategy. If in fact these factors had changed, it would be necessary to re-determine the baseline scenario to reflect the current persistency or crediting expectations, but with the original anticipated default experience. To see why this is true, note that if the anticipated default experience does not change, the value of the embedded derivative should not change even if the other factors do change. Also, the baseline scenario would need to be updated to true up for actual inventory changes during the first year.

Second, under most modco arrangements, the ceding company has the ability to move assets in and out of the reference pool, subject to certain asset type and quality restraints, as long as the book value of the assets is maintained equal to the statutory reserves. Such asset movements will cause shifts in the anticipated FW asset cash flows resulting from changes in anticipated default activity within the investment constraints. These would also need to be reflected in the estimate of the value of the embedded derivative.

What is the Host Contract?

Some public comment about the proposed DIG has concerned the question about whether the host contract is really a debt instrument that appropriately belongs under the scope of FAS 133. These arguments would contend that the host contract is the entire reinsurance contract and any associated segregated asset agreements. Indeed, the two final observations made in the preceding section show how the cash flows under the host are intricately related to the underlying policy behavior that is transferred via the reinsurance agreement and to the asset balancing allowed within investment constraints. Whether this view will gain favor with the SEC remains to be seen.

Other Similar Situations

It is possible that the guidance in DIG B36 may be generalized or expanded to include similar insurance and reinsurance situations. Whenever an insurance or reinsurance contract provides for a total return based on a referenced pool of assets on a guaranteed basis, it will be necessary to analyze the instruments carefully to determine whether embedded derivatives exist. Possible examples that come to mind include any participating business that provides for a total return on a referenced pool of assets, and perhaps contracts with experience rating formulas that provide a total return to the contract holder.

Conclusion

DIG B36 interpretation will be effective in 2003. Therefore, both ceding and assuming companies should be taking inventory of their modco reinsurance treaties, their coinsurance/funds withheld treaties and similar arrangements, and reaching conclusions about the presence of embedded derivatives. It should be noted that coinsurance/fund withheld type treaties are similar to modco arrangements and would also be included within the scope of DIG B36. Implementation of accounting for embedded modco derivatives will consume significant time and resources, and will introduce new elements of volatility in GAAP income.

Richard H. Browne, FSA, MAAA, is senior manager at KPMG LLP in Chicago, Ill. He can be reached at rhbrowne@kpmg.com

Current AAA Recommendation for RBC C-3 Phase II

by Max J. Rudolph

Editor's Note: The section's Statutory Issues List Serve would be an appropriate forum for discussing concepts in this article.

Recently there has been a number of articles detailing large losses and accelerated DAC amortization of equity-driven products. This has confirmed that better methods are required, both to value these product lines and to set capital requirements. Recognizing this, the Life Risk Based Capital Working Group of the NAIC (LRBCWG) asked for a recommended capital standard from the American Academy of Actuaries (AAA). In response, the Life Capital Adequacy Subcommittee's C-3 Work Group (the Work Group), chaired by Bob Brown, formulated an approach for setting regulatory risk-based capital requirements for variable products with guarantees. This recommendation excludes index guarantees and has been dubbed RBC C-3 Phase II.

The focus of this project has been on variable annuity products.

The Work Group presented its recommendations to the LRBCWG in December 2002 and is currently evaluating comment letters reacting to the recommendation. This article presents the current recommendations of the Work Group. Although the final requirements will probably differ somewhat from what is presented here, disseminating this information will allow a broader group of actuaries to influence the process and prepare for the eventual regulation.

Actuaries that work with annuity products may recall Phase I of this project. It uses interest rate scenarios to stress test single premium life insurance and fixed annuities, using a company's actual mix of assets and liabilities. In both phases of this project, an attempt is made to overcome the shortcomings of the factor-based approach to risk-based capital. No company's block of business is "average." Using a company's actual mix of business and running a broad range of scenarios will develop a company-specific distribution of risk exposures.

While the primary purpose of this project is to develop capital requirements, the same methodologies are appropriate for pricing and risk management of many product lines. A separate Academy group is focusing on the appropriate methodology to use for statutory reserves of equity-driven products. While there are many issues (taxes, guideline versus law, etc.) that arise only for reserves, both groups are very aware of the savings in time and effort if the respective methods can be supported by the same modeling effort. A follow-up article is planned to address the work being done by the reserve group.

It is expected that the new capital requirements will be effective for year-end 2004. New reserve requirements may be effective that soon, but will likely come later. The rest of this article will provide an overview of the recommended methodology.

General Description

The approach that the Work Group has recommended uses a modified conditional tail expectation (CTE) measure. Actuarial certification of results will be required. Modeling hedges is allowed if the insurer is following a clearly defined hedging strategy. It is expected that a conservative factor approach, instead of scenario analysis, will be allowed for minimum guaranteed death benefit (MGDB) blocks.

What Products are Covered?

The focus of this project has been on variable annuity products. This is due primarily to the non-diversifiable nature of equity risk when combined with death benefit and living benefit guarantees common to these products. For example, an MGDB option might guarantee a death benefit that accumulates (or rolls up)

the initial premium at 5 percent per year. With negative results for the most recent three consecutive years in most equity markets, current net amounts at risk might forecast a significant probability of large future losses at some companies. The Work Group's goal is to better recognize that risk and provide an early warning.

While equity-indexed products are outside the scope of this recommendation, the Work Group recommendation initially included variable life products if doing so would increase RBC. The reserve work group, however, is not currently considering variable life products, and additional discussions to maintain consistency are ongoing.

Scenarios

Companies are encouraged to use their own models to generate fund returns, but must calibrate to assumptions based on historical returns. Using pre-determined historical periods to define calibration points will allow proprietary models while maintaining comparability between companies. Much of the work so far has used Regime Switching Log Normal (RSLN) models. An RSLN model developed by Dr. Mary Hardy, ASA, FIA at the University of Waterloo is available for educational purposes on the SOA Web site at *www.soa.org/research/rsemw.html*. These models assume that, most of the time, equity returns follow a distribution that can be described as stable, with moderate volatility. However, in order to describe the reality of a fat tail, an unstable, high-volatility distribution is needed. From period to period, the model jumps from one regime to the other using a Markov process. Two-regime versions of these models describe the major American and Canadian equity indices quite well.

Required Capital

The RBC requirement recommended is the 90 CTE (modified) value plus the starting value of the tested liabilities, minus the reserve held. For each scenario, the greatest present value of the negative statutory surplus at all future calendar year-ends during the projection period is calculated for the entire book of covered business. Results for all scenarios are then sorted for use in the modified CTE methodology.

The recommendation combines these results with the common stock component (C-1cs) of the RBC covariance formula.

Modified CTE Methodology

While the modified CTE measure is new to many actuaries, the jump is a short one if distributions of results have been used in the past for analysis. It helps to consider an example. Take a distribution of 100 scenarios where the sorted results range from –3 to 96, with each incremental result one higher than the one previous. (Think of it as a series from 1 to 100 with each scenario result being four less than the corresponding scenario number, or y=x-4.) Let's assume the tail we are interested in is the worst 10 percent; in this case, the worst 10 scenarios. This is how CTE 90 and modified CTE 90 are defined. In this example

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the worst 10 results are -3, -2, -1, 0,...,6. The CTE 90 result is the average of all these results, or +1.5 (15/10). In the modified CTE 90 methodology, any positive results are counted as 0, so the result is -0.6 (-6/10). You would hold 0.6 units beyond the starting value of the tested liabilities to calculate required assets (statutory reserves plus capital). This method allows a separate result generated from the same distribution of results (e.g., modified CTE 60) to define statutory reserves.

Assumptions

Discussion continues regarding the use of prudent best-estimate assumptions. The modified CTE methodology provides a basis for determining conservatism that is not available today in point estimate reserves. This will require a paradigm shift for many practitioners. Depending on the combination of policy features being valued and the degree of in-the-moneyness at the valuation date, a conservative assumption (e.g., lapses) might be higher or lower than the best estimate. Best-estimate assumptions should be used in the models. However, when the direction of conservatism is known and actual experience is not credible, the actuary should lean toward conservatism.

Terminology

Several terms in the recommendation might be new to the practicing actuary. A glossary is included in the Work Group's paper, but here is a head start, using examples to define the terms.

- Gross wealth ratio—Using a five-year horizon, if the gross wealth ratio is 1.10, then the fund has grown by 10 percent over the five-year period (before expenses). Similarly, a 0.6 ratio means that the fund is now worth 60 percent of its original value. A ratio of 1.0 means the value at the end of five years is the same as it was at the beginning. It does not mean there have been no fluctuations along the way.

- MGDB (minimum guaranteed death benefit)—If a product guarantees a death benefit that could be larger than the surrender value due to fund performance, then the contract features an MGDB.

- VAGLB (variable annuity guaranteed living benefit)—This product feature guarantees a minimum surrender value, maturity value or income benefit at specified election dates while the policyholder is living.

Other Sources of Information

The Work Group's recommendation can be found at *www.actuary.org/pdf/life/rbc_16dec02.pdf*. The Canadian Institute of Actuaries (CIA) published a paper that provides a good methodology resource. It reports the work of the CIA Task Force on Segregated Fund Investment Guarantees and is available as one of the appendices to the above paper.

Special Thanks

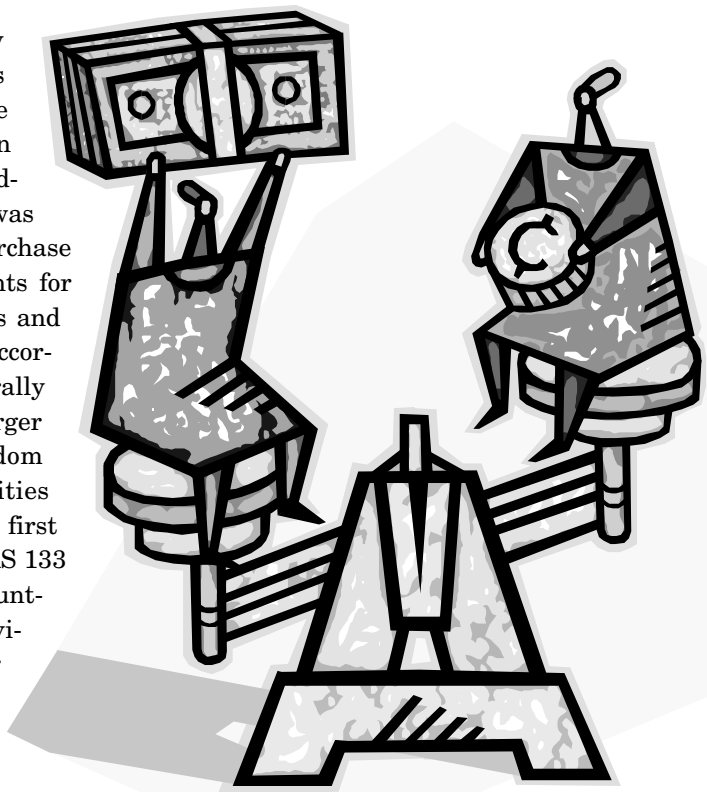
The author would like to thank the members of the Life Capital Adequacy Subcommittee's C-3 Work Group and especially its chair, Bob Brown, for their help reviewing this article.

Max J. Rudolph, FSA, MAAA, is vice president and actuary at Mutual/United of Omaha Insurance in Omaha, Neb. He can be reached at max.rudolph@mutualofomaha.com.

Purchase GAAP for Equity-Indexed Annuities

by Vincent Y. Tsang

Editor's Note: The section's GAAP List Serve would be an appropriate forum for discussing concepts in this article.



The insurance industry in the United States went through an active merger and acquisition era from the late 1980s until the mid-1990s. Accordingly, much guidance was written about how to prepare purchase GAAP (PGAAP) financial statements for SFAS 97 universal life type policies and SFAS 60 traditional life policies in accordance with the United States Generally Accepted Accounting Principles. Merger and acquisition activities seldom involved equity-indexed annuities (EIA), because these policies were first developed in the mid-1990s. As SFAS 133 provides primarily for GAAP accounting guidance for EIA policies, previously established PGAAP rules for SFAS 97 policies may not be strictly applicable to purchased EIA policies. In particular, the most challenging items for preparing PGAAP financial statements for EIAs are (i) the initial PGAAP reserves and (ii) the proper bifurcation of the initial PGAAP reserves into the initial value of the host contract and the fair value of the embedded derivatives of the purchased EIA policies. The first item is essential for preparing PGAAP financial statements at the purchase date. The second item is necessary for determining PGAAP reserves for the purchased EIA policies in subsequent reporting periods.

For illustrative purposes, assume that Company B (the assuming company) purchased a closed block of EIA policies from Company S (the ceding company) using a 100 percent coinsurance treaty. For simplicity, also assume that there is no unearned revenue liability for the assumed EIA policies. For Company B, the initial PGAAP balance sheet of the assumed business may be stated as follows:

Assets	Liabilities and Equity
Invested Assets	PGAAP Reserves (GAAPV)
Deferred Tax Assets (DTA)	Deferred Tax Liabilities (DTL)
Value of Business Acquired (VOBA)	Equity (E)
Total Assets	**Total Liabilities and Equity**

The PGAAP equity at the purchase date is the purchase price. Goodwill is zero, because the purchased block is a closed block and there are no new EIA policies. The value of the invested assets at the purchase date is the market value of the transferred assets. The initial book value of the assets, after the transfer, equals the statutory reserves of the assumed policies. Values of invested assets in future periods will be reported at either book or market, depending on Company B's classifications of these transferred

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assets under SFAS 115. As the value of DTL/DTA depends on the initial PGAAP reserves and initial VOBA, one may complete the initial PGAAP balance sheet of the purchased policies by determining either the initial PGAAP benefit reserves or the initial VOBA.

(I) Determining Initial PGAAP Reserve

The Define Initial Reserve Method (DIR) is a widely used method for assumed SFAS 60 policies. The initial PGAAP reserves for assumed SFAS 60 policies are determined in accordance with the assuming company's GAAP assumptions for the assumed policies as of the purchase date. For policies subject to FAS 97, paragraph 17 of SFAS 97 provides specific guidance for determining GAAP reserves for either directly written or assumed universal life type policies. For most cases, the initial PGAAP reserves are the account balances. Thus, one may argue that SFAS 97 also uses the DIR to define account balances as the initial PGAAP reserves for the assumed universal life type policies. The only difference is that the account balances are independent of the assuming company's GAAP assumptions for the assumed SFAS 97 policies.

An EIA is similar to a deferred annuity from an economic perspective. SFAS 133 and issue papers of the FASB's Derivative Implementation Group (DIG) indicate that an EIA is a hybrid contract and that its GAAP reserve is the sum of the value of the host contract and the fair value of the embedded derivatives. This specific point implies that SFAS 97 guidance on GAAP reserves for universal life type policies does not apply to either directly written or assumed EIA policies and that the initial PGAAP reserves for the assumed EIA policies are not necessarily related to their account balances.

As DIR can be used to define initial PGAAP reserves for both assumed SFAS 60 and SFAS 97 policies, DIR may also be considered as a viable method to determine initial PGAAP reserves for assumed EIA policies. If the initial PGAAP reserve of the assumed EIA policies is determined, it can be shown that:

$$VOBA = \frac{GAAPV - [Invested - Assets - P - Tax\ Rate * (TaxV - DACTax)]}{1 - Tax\ Rate}$$

$$DTL = \frac{Tax\ Rate * [TaxV - DACTax) - Invested\ Assets + P]}{1 - Tax\ Rate}$$

Where:

P = Purchase Price

TaxV = Tax Reserve

DAC Tax = Unamortized Policy Acquisition Expenses per section 848 of the Internal Revenue Code.

For assumed EIA policies, possible values of the initial PGAAP reserves include, but are not limited to, the following:

(a) Aggregate account balance of the assumed EIA policies

(b) Ceding company's GAAP reserves (that is, the sum of the value of the host contract value and fair value of embedded derivatives) of the assumed EIA policies at the purchase date

(c) Reinsurance premium before ceding commission of the assumed EIA policies at the purchase date, and

(d) Reinsurance premium net of ceding commission of the assumed EIA policies at the purchase date.

The GAAP reserve for an EIA policy is the value of the host contract plus the fair value of the embedded derivatives. As SFAS 133 does not consider account balance to be an appropriate measure of GAAP liability for any directly written EIA policy, this guidance may imply that the account balances of the assumed EIA

policies are similarly not appropriate for the initial PGAAP reserves.

Using the ceding company's GAAP reserves of the assumed policies at the purchase date as the initial PGAAP reserves has the advantage of reserve continuity. However, there is no GAAP guidance suggesting that the ceding company and the assuming company should have the same GAAP reserves for reinsured EIA policies at the purchase date. In fact, the two companies' senior management teams may have different disciplines in setting future participation rates or caps of the reinsured EIA policies. The changes in senior management's discretion can indirectly affect future policyholder behavior. Accordingly, the ceding and the assuming companies are likely to have different GAAP reserves for the reinsured EIA policies at the purchase date, because they may have different estimates of the fair value of the embedded derivatives.

Even if the two companies have the same disciplines and assumptions to estimate the fair value of embedded derivatives, there is no guarantee that the ceding company's practice to determine GAAP reserves for the reinsured EIA policies at the purchase date is appropriate. If the assuming company wants to use the ceding company's GAAP reserves as the initial PGAAP reserves for the assumed EIA policies, it would be an additional burden on the assuming company to ensure that the ceding company's GAAP reserves for the ceded policies are reasonable. Based on these shortcomings, the ceding company's GAAP reserves of the ceded EIA policies may not be the most appropriate choice for the initial PGAAP reserves.

Using the reinsurance premium before ceding commission as the initial value of PGAAP reserves is comparable with the normal practice of using initial premiums as GAAP reserves at issue for directly written EIA policies. In fact, reinsurance premium before ceding commission equals the sum of statutory reserves for the assumed EIA policies at the purchase date. As reinsurance premium before ceding commission is independent of the ceding company's GAAP assumptions and practice, the initial PGAAP reserves can be determined objectively under this method.

Please keep in mind that statutory accounting principles are based on a solvency perspective and the resulting statutory reserves may not reflect the general principles of GAAP. Using statutory reserves as the initial GAAP benefit reserves, without examining all related GAAP issues, is similar to fitting a square peg in a round hole.

This suggested choice does not imply that a statutory reserve is a substitute for a GAAP reserve. It simply states that the reinsurance premium before ceding commission (that is, the sum of statutory reserves of the assumed EIA policies) is a readily available value that may be used as the initial PGAAP reserves. The overall reasonableness of this method still depends on whether or not the resulting initial value of the host contract and the resulting implied internal rate of return (IRR) are reasonable. In subsequent periods, PGAAP reserves of the assumed EIA policies should not be statutory reserves and should be based on guidance from SFAS 133 (that is, PGAAP reserves equal the sum of the host contracts and the fair values of the embedded derivatives).

For most transactions, the ceding commission is a negotiated value between the buyer

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and the seller, and may be materially different from the actuarial appraisal value. If the ceding commission is significant, defining the initial PGAAP reserves as statutory reserves minus ceding commission may artificially reduce the assuming company's beginning PGAAP reserve for the assumed EIA policies to an unreasonable level. This situation is most significant for back-end loaded EIA contracts with a long-term point-to-point design where equity-related interests are not credited until the end of the term.

... it is my opinion that reinsurance premium before ceding commission appears to be a reasonable choice for the initial PGAAP reserves of the assumed EIA policies.

Among these four choices, it is my opinion that reinsurance premium before ceding commission appears to be a reasonable choice for the initial PGAAP reserves of the assumed EIA policies.

If the sum of statutory reserves is not considered a reasonable measure for the initial PGAAP reserves or the DIR method is not considered acceptable, the assuming company may consider determining the initial VOBA.

(II) Determining the Initial VOBA

An alternative method to complete the initial PGAAP balance sheet of the assumed EIA policies is to determine the initial VOBA. A common practice is to define the initial VOBA as the present value before tax of statutory profits discounted at a risk-adjusted rate (for example, 12 percent). If the initial VOBA is known, the initial PGAAP reserves and DTL are:

$$GAAPV = \frac{VOBA - [Invested\ Assets - P - Tax\ Rate * (TaxV - DACTax)]}{1 - Tax\ Rate}$$

$$DTL = \frac{Tax\ Rate * [(TaxV - DACTax) - Invested\ Assets + P]}{1 - Tax\ Rate}$$

Under this method, the initial VOBA may be reasonably related to the purchase price. If the initial value of the invested assets equals statutory reserves (SAPV) minus Tax Rate times DAC Tax, the tax reserves equal statutory reserves, and the purchase price equals VOBA times (1-Tax Rate), the formulae for initial PGAAP reserves and DTL can be simplified to:

$$GAAPV = VOBA + SAPV - \frac{P}{1\text{-}Tax\ Rate}$$

= Statutory Reserve
= Reinsurance Premium before Ceding Commission

$$DTL = Tax\ Rate * VOBA - Tax\ Rate * DAC\ Tax$$

The net PGAAP liability (GAAPV minus VOBA) is then the aggregate statutory reserve minus the present value of projected before-tax statutory profits discounted at a risk-adjusted rate. As the risk-adjusted rate is greater than the assumed investment earned rates, the net PGAAP liability is greater than the gross premium valuation reserve at the purchase date and there is no need for loss recognition, a desirable result.

(III) Host Contract and Bifurcation Basis of Assumed EIA Policies

So far, we have discussed only the initial PGAAP balance sheet of the assumed EIA policies. Additional steps are needed to report PGAAP reserves of the assumed policies in subsequent periods.

From a GAAP perspective, an EIA is a hybrid contract that must be bifurcated into a host contract and a group of embedded derivatives. Guidance from Issue Paper B6 of the Derivative Implementation Group states that the initial value of the host contract is the difference between the basis of the hybrid contract and the fair value of the embedded derivatives at issue. This guidance is very helpful for direct writers because the basis of the hybrid contract at issue is normally the initial premium paid by the policyholder. The definition of "the basis of the hybrid contract," however, is not as obvious

for assumed EIA policies at the purchase date.

In order to avoid unexplainable GAAP gains or losses at the purchase date, the initial PGAAP reserves of the assumed EIA policies at the purchase date should be the bifurcation basis. Although using the reinsurance premium before the ceding commission as the initial bifurcation basis offers the advantage of being comparable with the practice used by the direct writer, reinsurance premium can be used as the bifurcation basis only if it equals the initial PGAAP reserves.

Regardless of the approach used by the assuming company to complete the initial PGAAP balance sheet of the assumed EIA policies, care must be taken to ensure that the initial value of the host contract and its IRR are reasonable. For example, if the initial PGAAP reserves are adjusted to a level such that the initial value of the host contract (that is, initial PGAAP reserve minus the value of embedded derivatives) is even higher than the guaranteed benefit floor at the end of the EIA term, the host contract can have a negative IRR, a counter-intuitive result. On the other hand, if the initial PGAAP reserves are reduced to a level such that the initial value of the host contract is substantially less than the guaranteed benefit floor, the associated IRR can be higher than the expected earned rates of invested assets, an undesirable outcome.

(IV) Summary

Although the initial PGAAP balance sheet can be prepared by determining either the initial PGAAP reserve or the initial VOBA of the assumed EIA policies, it is the net PGAAP liability that really matters. For a closed block of EIA policies, an increase in initial PGAAP reserves for assumed EIA policies would lead to an equal increase in initial VOBA.

The assuming company has many possible ways to prepare the initial PGAAP balance sheet of the assumed EIA policies. The final value of the initial PGAAP reserves should be examined in light of the host contract's initial value and the associated IRR. Ideally, the IRR of the host contract for the assumed EIA policies should be comparable with the IRR of the assuming company's directly written EIA policies. If the host contract's IRR is either negative or higher than the expected asset yield rates, the associated initial PGAAP reserves should be considered questionable and further reviews are warranted. The alternative approach of determining the initial VOBA is also an acceptable approach, if the initial VOBA is reasonably related to the purchase price of the assumed business.

In my opinion, the reinsurance premium before ceding commission of the assumed EIA policies at the purchase date appears to be a viable candidate for the initial value of the PGAAP reserves for the following three reasons:

1. Reinsurance premium before ceding commission is not an arbitrarily chosen number and is related to the reinsurance transaction,

2. Using reinsurance premium before ceding commission to establish initial PGAAP reserves is comparable to the practice of using initial premiums from policyholders to establish initial GAAP reserves for directly written EIA policies; and

3. Reinsurance premium before ceding commission equals statutory reserves of the assumed policies. If the statutory reserve computation method is either the CARVM-Updated Market Value Method or the Market Value Reserve Method, the resulting statutory reserves are related to the guaranteed benefit floors. Thus, the resulting host contract's IRR is likely to be reasonable.

After the initial PGAAP reserves and initial VOBA are determined, PGAAP reserves and VOBA in subsequent periods should be reported in accordance with guidance from SFAS 133 and SFAS 97, respectively.

This article provides practical suggestions for practitioners to prepare PGAAP financial statements of assumed EIA policies. It may ignite more discussions among actuaries, accountants and other professionals who are

Vincent Y. Tsang, FSA, MAAA, is manager of Actuarial Services at PolySystems in Chicago, Ill. He can be reached at vtsang@polysystems.com.

Can You Sign an Actuarial Opinion?

by Donna R. Claire

Editor's Note: The section's Statutory Issues List Serve would be an appropriate forum for discussing concepts in this article.

Background

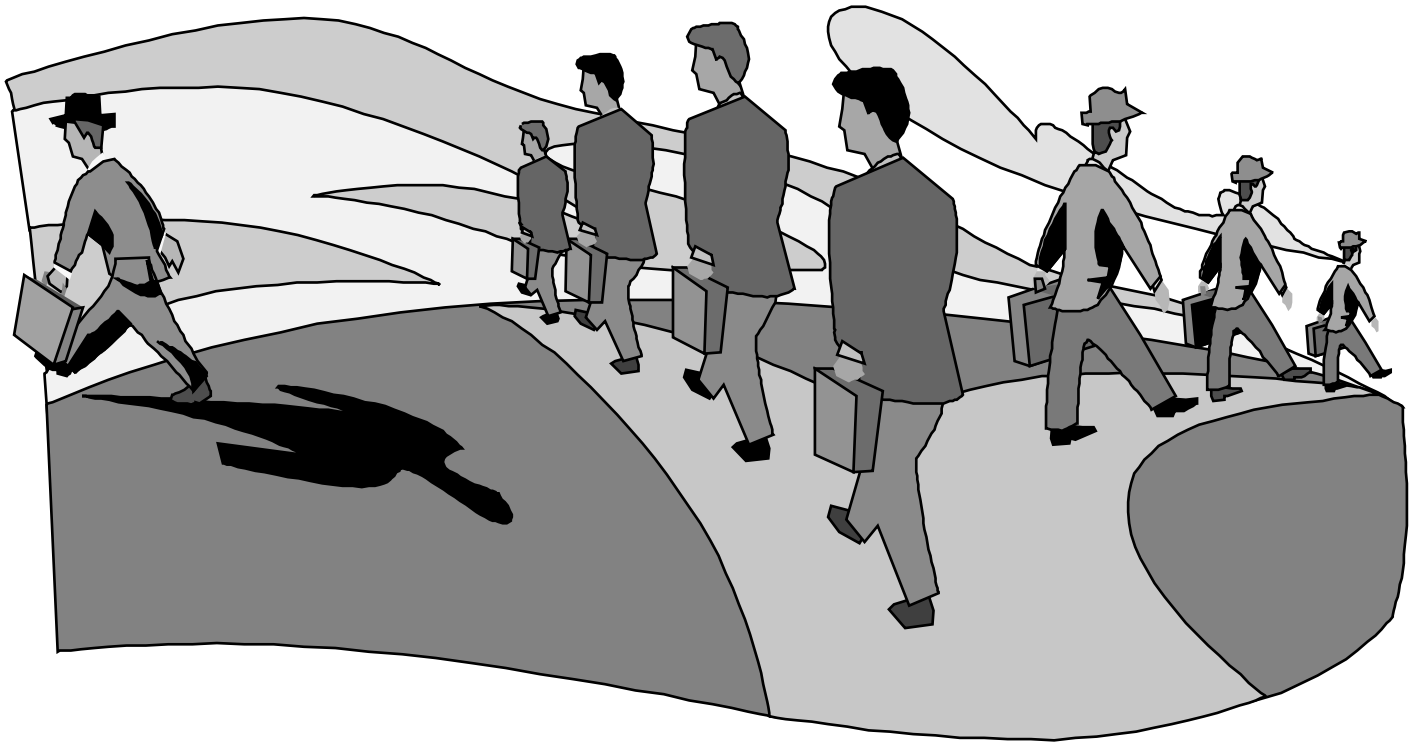
When the Society of Actuaries changed the syllabus in 2000, students were no longer tested on nation-specific topics. In order to sign a Prescribed Statement of Actuarial Opinion (PSAO) in the United States, there is a requirement that an actuary be tested on, at a minimum, applicable economic, regulatory and legal environments. The American Academy of Actuaries determined that students who took exams under the 2000 syllabus do not meet the minimum standards for signing actuarial opinions, such as those required for the Statutory Annual Statement. The American Academy of Actuaries solved this problem by designing and offering a seminar that covers the information described above. The Canadians faced the same issue and solved it similarly, with seminars sponsored by the Canadian Institute of Actuaries.

The Seminar

The Academy's seminar is intensive. The course itself is three days long, followed by a three-hour, open-book exam on the fourth day. About 1700 pages of information, similar to an actuarial exam, are studied prior to attending the seminar. The syllabus can be used to build a reference library for valuation actuaries. This seminar has been offered once a year for the past three years. This year's seminar will be November 11-14, 2003 in Washington, D.C.

The course is designed to cover all of the topics a qualified actuary should know before signing annual statement blanks. On the life side, these include topics such as valuation of liabilities and assets, relationship between cash flows from assets and related liabilities, dividends, reinsurance, policy forms and coverages, statutory insurance accounting and nonforfeiture. On the health side, topics covered include principles of insurance and underwriting, social insurance, premiums, loss expense and contingency reserves, statutory insurance accounting and expense analysis.

The seminar is a mix of lectures, with many opportunities for interaction between the teachers and students, and case studies. Although the purpose of the seminar is to fill a void in the SOA syllabus, the Academy seminar is also useful for those moving into valuation from another area and for those who want to refresh their knowledge of the subjects. Those attending all of the sessions may record 18 hours of professional development credit. The diverse mix of actuaries new to the subject and seasoned professionals in certain aspects of valuation has resulted in lively question-and-answer sessions. Some people who take the course as a refresher have even decided to take the exam.



The Instructors

From the start, the Academy designed the exam to be oriented toward practitioners. It is important that the attendees hear what the regulators want from those who would know—the regulators themselves. For the 2003 seminar, regulatory actuaries Bob Conover (Calif.) and Kerry Krantz (Fla.) are part of the scheduled faculty.

It is also important that people involved in actually doing the work (both company employees and consultants) let the attendees hear about the practical issues involved in statutory valuation (e.g., details one needs to get regarding certain policies; how one tests for XXX reserves; what CARVM means for a variable annuity with GMDBs; how to develop LTC reserves; how to prepare an actuarial memorandum.) Instructors scheduled for 2003 seminar include Bob Likins, Esther Milnes, Bill Cutlip, Alan Ford, Bob Cummings, Darrell Knapp and me (Donna Claire).

Sometimes developing opinions can get into gray areas, so it is useful to get a reality check from a lawyer (i.e., actuaries do have standards that must be followed; otherwise one may not have a career.) The Academy's legal staff is therefore part of the faculty at the seminar (Lauren Bloom and Kit Pardee).

Reactions to the Seminar

The seminars are relatively small, with a cap of 50 students in each seminar. The reactions have been very positive, from both the newer ASAs/FSAs and the more seasoned professionals. The reactions have also been quite positive from the faculty. I have been involved in this seminar from the beginning, and it is my favorite. Each year, I learn new things—how to perform certain aspects of the asset adequacy testing or developing active life claim reserves in a better way.

If you want more information about the seminar, please check for the qualifications seminar on the Academy Web site, *www.actuary.org/seminar/index.htm*.

Donna R. Claire, FSA, MAAA, is president of Claire Thinking, Inc. in Fort Salonga, N.Y. She can be reached at clairethinking@cs.com.

More Efficient Monte Carlo Simulations for Mortality Assumption Testing

by Douglas L. Robbins

Editor's Note: The section's Statutory Issues List Serve would be an appropriate forum for discussing concepts in this article.

The advent of Model Regulation XXX, now passed in most states, has imposed on the industry a need to quantitatively evaluate the anticipated mortality rates underlying many blocks of life insurance business. The most common method of doing this has been developing a probability distribution for total claims (given the anticipated mortality for the block being tested) and seeing where actual claims over a given period fall. If the actual result is at an unacceptably high percentile of the predicted claims distribution, then current anticipated mortality is rejected in favor of some higher set of rates.

Developing a closed-form distribution for aggregate claims, however, can be problematic when many policies of varying face amounts are involved. For that reason, the most common industry method of creating this distribution has been Monte Carlo testing. In the most common version of this methodology, each policy in the block is independently assigned a random number between zero and one—once per scenario. If the random number is lower than the anticipated mortality rate for that policy, that is considered a "death," and the face amount for that policy is tabulated. If the random number is higher, then that is considered a "survival," and zero is entered. For each scenario run, the face amounts of all "deaths" are summed to give a total claim amount. The resulting sample, over a large set of simulations, provides the empirical claims distribution.

This process can create the need for the generation of quite a large quantity of random numbers. For a block of 100,000 policies over 10,000 simulations, for example, the requirement would be for one billion random numbers. Occasionally, an actuary faced with such a requirement could run into a real time crunch. Is there a way to reduce this random number requirement, and thus computer run time?

There is, and it was first suggested to me by my father, Edward Robbins. (He in turn would credit reading from one of several good 20-plus-year old *Transactions* articles that deal with compounding of distributions in risk theory. Neither of us has been able to pinpoint exactly which article inspired his thinking on this.)

To see how run time can be reduced, it is helpful to think of the one billion required simulations as though they were done in a spreadsheet (despite the fact that the testing would doubtlessly *really* be done via some program). In that spreadsheet, the identifiers of the 100,000 policies being tested run down column A. The face amounts pertaining to each policy are then entered down the rows of column B.

Then, in each of the next 10,000 columns, for each of the 100,000 policies, there are a series of ones and zeros, with a one representing a death (the generated random number being less than the anticipated mortality rate for this policy), and a zero representing survival. Then at the bottom of each of these 10,000 columns, a sumproduct function is done between this column of zeros and ones and the face amount column, producing a total claim amount in dollars for that trial. The resulting 10,000 total claim amounts become the empirical distribution for analyzing the actual mortality results over the test period.

Now it is true that the above methodology is one correct way of forming the required empirical distribution. But it is not the only correct way. Distributionally, there is a way to fill in the 10,000 entries in each row, using far fewer random numbers.

In the above methodology, each entry in our one billion-cell grid is a Bernoulli trial. The random numbers we are drawing are tested against the Bernoulli probability density function (PDF) relevant to the given row's anticipated mortality rate, in order to assign a one or zero. However, it is clear that if we have an infinite series of repeated Bernoulli trials with the same probability of success (in this case death), a geometric distribution will provide the probability that our first success occurs on precisely trial number "n."

For example, say an established NFL quarterback can be assumed based on experience to have a 5 percent chance of throwing an interception on any given pass. It is then clear that at any time, the chance of his next pass being an interception (assuming we don't know anything else about the type of pass it will be, quality of defense, etc.) is 5 percent. The chance of his first interception coming on his second pass from now, must be 95 percent times 5 percent equals 4.75 percent. The chance of it being on his third pass is 95 percent (squared) times five percent equals 4.51 percent, and so on.

These values form the geometric PDF, which is defined as P(N=n) = (1-q)^(n-1)*q, where q is the probability of success (in our case death) on any given trial. The values of the pdf can be summed in order to form the cumulative distribution function (CDF).

Let us now go back to drawing random numbers. To start filling in our one billion-cell grid of ones and zeros under the *old* methodology, we used an initial random number and compared it to the Bernoulli PDF, filling in cell one. Instead, we now compare it to the CDF of the Geometric distribution. By the logic above, the cdf entry pertaining to that random number can be thought of as the timing of the first observed death in a series of independent trials, all with the same probability (the anticipated mortality for this row).

In other words, say that our q for this row is actually 1 percent. Our first random number drawn is 0.5. Under the *old* methodology, this would fill only one grid cell, with an entry of zero (survival). Under the *new* methodology, drawing 0.5 from the geometric CDF with a parameter q = 0.01, produces a result of 69. This results in us going across the first row of

our grid, filling in 68 zeros and then a one in the 69th cell. (Verbal interpretation: the first observed death in a large number of identical trials came on trial number 69. All earlier trials resulted in survival.)

Only at the 70th cell do we then need a new draw of a random number. That number is used to fill in cells starting with the 70th entry on the top row. Say we draw 0.005. That is clearly a result of one from our CDF, so cell 70 also gets an entry of one, and then we start again with the 71st cell. The next draw might be 0.98, producing a result of 389 zeros and then a one in the 460th cell. The program would continue filling in values in this way through the end of the first grid row.

At the end of that row, the program would have to stop no matter what. The reason is that the compounding of Bernoulli trials into a Geometric distribution only works if the trials have identical q's. (And except in infrequent cases, the q will change when starting with a new policy.) Any CDF result taking things beyond the end of the row results in just filling in the remainder of that row with zeros and then starting over at the next row.

Once the entire grid of 1 billion cells is filled in with ones and zeros, the stochastic implications of the grid under this new methodology are the same as for the old one. Thus the interpretation of the column totals is stochastically exactly the same.

What is the expected result of all of this in terms of run time? Since the expectation for any geometric trial result is 1/q, the expected run time for any row would be about q times the run time required to fill the row in one cell at a time. In general, overall run time should be about the average q times the old run time!

Douglas L. Robbins, FSA, MAAA, is a consulting actuary at Tillinghast-Towers Perrin in Atlanta, Ga. He can be reached at doug.robbins@tillinghast.com.

Generalized Mortality Table Analysis

by Larry Warren

Editor's Note: The section's Statutory Issues List Serve, GAAP List Serve, or Chief Actuaries List Serve would be an appropriate forum for discussing concepts in this article.

In this article, we discuss the need to search for alternative mortality tables (other than the 1975-80 and 1990-95 tables), which may be more appropriate for a particular company or specific products. It must be recognized that differences or variations from company to company can exist in the following areas which impact future mortality patterns:

A. Underwriting Rules/ Guidelines/Practices

Variations in underwriting rules, guidelines and practices obviously impact future mortality patterns. While underwriting guidelines vary from company to company, the degree to which the underwriters adhere to these guidelines (i.e. are underwriting exceptions often made?) must also be considered.

The average face amount per life insured plays a dramatic role in the overall underwriting screening process.

B. Average Size of Policy (Face Amount)

The average face amount per life insured plays a dramatic role in the overall underwriting screening process. For example, two companies may have identical stringent underwriting guidelines, yet one company (Company A) may be writing policies with average face amounts in excess of $500,000, while another company (Company B) may be writing policies with face amounts averaging $100,000. Thus, the actual underwriting requirements being obtained from Company B would be very limited relative to Company A.

C. Distribution System

The nature of the distribution system of a company or for a particular product can have a significant impact on the degree of potential anti-selection of the policyholder.

D. Market Segment (Upscale, Middle America, etc.)

It is a well-known fact that the market segment has its own variation in mortality patterns, resulting from social, economic and cultural differences.

Traditionally, actuaries have been recognizing the impact of the above variations by utilizing scaling factors that were applied to the assumed underlying mortality table (i.e. 75-80 select/ultimate, 90-95 select/ultimate, etc.). Higher scaling factors would normally be associated with less rigorous underwriting or higher risk classification (*i.e.* scaling factors for tobacco users exceed that for non-tobacco users, which exceeds that for preferreds).

I am proposing that, in addition to utilizing scaling factors, we consider shortening the select period. It will be shown that even a modest decrease in the select period (e.g. two years) can have a major impact.

First year select and ultimate mortality tables have typically been used as the starting point before applying scaling factors. Conceptually, first year select mortality and the subsequent select mortality rates (*e.g.* years 2-15 in the 1975-80 Sel/Ult Table) would be representative of fully underwritten business. Ultimate mortality rates however, would be more reflective of business with minimal or no underwriting. Therefore, to the extent that the variations discussed above (i.e. underwriting, average size, distribution system and market segment) are properly recognized, the appropriate table to use should fall somewhere between a first year select and ultimate table and a pure

ultimate table. For example, the appropriate table may be to use a 13-year select period, thereby the starting point may be deemed the third year of the 15-year select period of the 75-80 Sel/Ult Table. For purposes of analyzing the effect of this concept, we have developed the following new tables.

Table A was constructed *using a 13-year select period* by shifting each issue age of our model office back two years and then starting with third year select mortality of the 75-80 select/ultimate table.

Table B was constructed *using an 11-year select period* by shifting each issue age of our model office back four years and then starting with fifth year select mortality of the 75-80 select/ultimate table.

Table C was constructed *using a 23-year select period* by shifting each issue age of our model office back two years and then starting with third year select mortality of the 90-95 select/ultimate table.

Table D was constructed *using a 21 year select period* by shifting each issue age of our model office back four years and then starting with fifth year select mortality of the 90-95 select/ultimate table.

The results of our analysis are shown in Exhibits 1, 2 and 3.

The relationships shown in Exhibit 1 arise from differences in the ratio of the qx's (mortality rates) in the early years as compared to those in the later years.

For purposes of developing Exhibit 1, we assumed that a company changed its underwriting guidelines/requirements three years ago. Therefore, we analyzed the mortality experience for all policies in their first, second, and third durations.

We started with a simple model using the assumption that a $10,000,000 face amount was issued each year at the beginning of the projection for each issue age (25, 35, 45 and 55) and experiencing Linton "B" lapse rates (20 percent, 12 percent, 10 percent, 8.8 percent, 8 percent, etc.). We also formed a composite issue age by assuming the distribution of face amount by age was 15 percent, 35 percent, 35 percent and 15 percent for male issue ages 25, 35, 45 and 55 respectively.

We used the model to calculate actual to expected mortality ratios (for each mortality table) for policies in their first three policy years. (Expected mortality was calculated applying lapse rates and multiplying the appropriate qx's to the face amount exposed in durations one through three). Actual mortality was arbitrarily assumed to equal 80 percent of the 1990-95 table. This assumption was totally arbitrary and has no impact on this analysis. Next, we calculated the 20-year present value of future claims (for a single year of issue, representing new business) using the qx's of each mortality table separately. That is, the actual to expected mortality ratio obtained by using the 1975-80 mortality table was applied to the 1975-80 mortality table in calculating the 20-year present value of claims, and analogously for the other mortality tables (i.e. Tables A, B, C, D, 90-95 Select and Ultimate).

In Exhibit 1, scenario 1, we find that for Table A, the present value of future claims are 16.6 percent lower than the 1975-80 Table and for Table B, 21.8 percent lower*.

In scenario 2, using the 1990-95 Table as a base, we find that the corresponding reductions are 20.3 percent and 27.4 percent for Tables C and D respectively.

It should be noted that all six tables are based on the same actual mortality. The ranking in order of highest present value of future claims to lowest is shown on page 26.

The vast differences from table to table in projected claims as shown above is extraordinary. It is of utmost importance that the actuary recognize the significant financial impact in his selection of the appropriate mortality table.

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Exhibit 1: Relationship of Mortality Projections and the Underlying Mortality Tables
(For A Single Year Of Issue)

The relationships shown in exhibit 1 arise from differences in the ratio of the qx's in the early years as compared to those in the later years

Scenario 1: Present Value of Future Claims*
(based on the mortality experience of the first 3 policy years)

Issue Age	(1) males based on 75-80 table	(2) based on table A (2 yr-shift)	(3) based on table B (4 yr-shift)	(4) ratio table A (2 yr-shift)	(5) ratio table B (4 yr-shift)	(6) reduction table A (2 yr-shift)	(7) reduction table B (4 yr-shift)
25	$27,337	$27,293	$25,892	99.8%	94.7%	0.2%	5.3%
35	$54,334	$45,375	$44,736	83.5%	82.3%	16.5%	17.7%
45	$123.820	$100,759	$98,616	81.4%	79.6%	18.6%	20.4%
55	$370,761	$310,079	$275,793	83.6%	74.4%	16.4%	25.6%
composite**	$122,069	$101,753	$95,426	83.4%	78.2%	**16.6%**	**21.8%**

The relationships shown in exhibit 1 arise from differences in the ratio of the qx's in the early years as compared to those in the later years

Scenario 2: Present Value of Future Claims*
(based on the mortality experience of the first 3 policy years)

Issue Age	(1) males based on 90-95 table	(2) based on table C (2 yr-shift)	(3) based on table D (4 yr-shift)	(4) ratio table C (2 yr-shift)	(5) ratio table D (4 yr-shift)	(6) reduction table C (2 yr-shift)	(7) reduction table D (4 yr-shift)
25	$40,456	$34,887	$33,862	86.2%	83.7%	13.8%	16.3%
35	$63,082	$49,418	$43,693	78.3%	69.3%	21.7%	30.7%
45	$158.473	$125,167	$111,268	79.0%	70.2%	21.0%	29.8%
55	$377,786	$303,289	$283,282	80.3%	75.0%	19.7%	25.0%
composite**	$140,281	$111,831	$101,808	79.7%	72.6%	**20.3%**	**27.4%**

* Based on a single year of issue of $10 million face amount for each age assuming Linton B lapses at 6 percent discount rate over a 20-year period.
** Using the distribution of 15%,35%,35%,15% for ages 25,35,45,55 respectively.

Note: The mortality experience underlying this analysis was arbitrarily chosen to equal 80 percent of the 90-95 Table. All ratios shown, however, are independent of this assumption.

Table A was constructed by shifting each issue age of our model office back two years and then starting with third -ear select mortality of the 75-80 select/ultimate table.

Table B was constructed by shifting each issue age of our model office back four years and then starting with fifth-year select mortality of the 75-80 select/ultimate table.

Table C was constructed by shifting each issue age of our model office back two years and then starting with third-year select mortality of the 90-95 select/ultimate table.

Table D was constructed by shifting each issue age of our model office back four years and then starting with fifth-year select mortality of the 90-95 select/ultimate table.

Exhibit 2: Ratio Of Actual To Expected Mortality
(Based On The Following Tables...)

Exhibit 2 displays the phenomenon of the relationship between the mortality table and perceived mortality improvements.

DURATION	75-80 SEL/ULT TABLE	TABLE A*	TABLE B**
1	100%	68%	58%
2	90%	70%	63%
3	81%	70%	65%
4	75%	70%	65%
5	70%	67%	63%

* Table A was constructed by shifting each issue age of our model office back two years and then starting with third year select mortality of the 75-80 select/ultimate table.
** Table B was constructed by shifting each issue age of our model office back four years and then starting with fifth year select mortality of the 75-80 select/ultimate table.

Note: Similar results would be obtained using the 90-95 sel/ult tables.

FROM YEARS	75-80 SEL/ULT TABLE	TABLE A	TABLE B
1-2	10%	-2.9%	-8.6%
2-3	10%	0%	-3.2%
3-4	7.4%	0%	0%
4-5	6.7%	4.3%	3.1%
1-5	8.5% *	0.4% *	-2% *

* Effective annual compounded mortality improvement rate.

Note: Negative means mortality worsening.

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Exhibit 3: Comparison Of Mortality Rate Increase By Duration *

Exhibit 3 demonstrates the underlying reason for the relationship between the mortality tables and perceived mortality improvements as shown in exhibit 2.

Duration	QX 75-90	Percent Increase	Table A **	Percent Increase	Table B **	Percent Increase
1	1.1	-	1.61	-	1.88	-
2	1.47	34%	1.9	18%	2.09	11%
3	1.88	28%	2.17	14%	2.33	11%
4	2.23	19%	2.42	12%	2.57	10%
5	2.57	15%	2.7	12%	2.88	12%
6	2.89	12%	3.0	11%	3.23	12%
7	3.24	12%	3.38	13%	3.72	15%
8	3.62	12%	3.83	13%	4.26	15%
9	4.05	12%	4.47	17%	4.81	13%
10	4.58	13%	5.11	14%	5.37	12%
11	5.34	17%	5.73	12%	5.92	10%
12	6.01	13%	6.36	11%	7.22	22%
13	6.84	14%	7.14	12%	7.96	10%
14	7.76	13%	8.78	22%	8.78	10%
15	8.75	13%	9.69	10%	9.69	10%
16	10.69	22%	10.69	10%	10.69	10%
17	11.79	10%	11.79	10%	11.79	10%
18	12.98	10%	12.98	10%	12.98	10%
19	14.28	10%	14.28	10%	14.28	10%
20	15.69	10%	15.69	10%	15.69	10%

* Composite model office mortality rates using the 1975-80 select/ult mortality table.

** Table A was constructed by shifting each issue age of our model office back two years and then starting with third year select mortality of the 75-80 select/ultimate table.

** Table B was constructed by shifting each issue age of our model office back four years and then starting with fifth year select mortality of the 75-80 select/ultimate table.

	PV of Future Claims	Reduction in PV in Relation To 90-95 Sel/Ult
1. 1990-95 Sel/Ult	140,281	--
2. 1975-80 Sel/Ult	122,069	13.0%
3. Table C	111,831	20.3%
4. Table D	101,808	27.4%
5. Table A	101,753	27.5%
6. Table B	95,426	32.0%

If actual to expected mortality ratios were based on the first five policy years of experience, then the corresponding reductions would be 9.5 percent and 13.2 percent respectively.

It is not uncommon for actuaries to observe significantly decreasing ratios of actual to expected mortality and then wonder where all the mortality improvement is coming from and how long it will last. In my opinion, while some portion of the mortality improvement may be "legitimate," the other portion (perhaps the greater part) results from using an inappropriate mortality

table. Exhibit 2 was therefore developed to display the relationship between the mortality tables and the phenomenon of perceived mortality improvements.

In Exhibit 2, we arbitrarily assumed decreasing mortality ratios (100 percent grading down to 70 percent over five years) under the 1975-80 Sel/Ult Table. This assumption is reflective of what would appear to be an effective annual compounded mortality improvement rate of 8.5 percent as shown in this exhibit. Under Table A, we were able to show that, over the same 5-year period using the same mortality assumption, the annual mortality improvement rate was essentially non-existent (.4 percent). Using Table B, the annual mortality improvement rate is -2 percent, reflective of the fact that, relative to Table B, the mortality ratios actually increased over this 5-year period. It should be noted that similar results would be obtained using the 1990-95 Sel/Ult Table.

Again this exhibit demonstrates the fact that mortality improvements are related to the underlying mortality table being used. What appear to be significant mortality improvements may in fact be the result of using an inappropriate mortality table.

As we discussed earlier, the relationship of the ratio of the mortality rates in the early years to the mortality rates in the later years, is what gave rise to the great variation in the present value of future claims for each table. The phenomenon we observed, however, in Exhibit 2 relating to perceived mortality improvement is based on another relationship, which is the annual mortality rate increase of each table as shown in Exhibit 3.

Exhibit 3 demonstrates this relationship between the mortality tables and perceived mortality improvements as shown in Exhibit 2.

In Exhibit 3, we show a comparison between the composite model office mortality rates using the 1975-80 Select/Ultimate Table, Table A and Table B. The major distinction of interest between these tables, however, is not the magnitude of the rates themselves (since this is typically adjusted for by utilizing a scaling factor), but the annual increases from year to year.

As can be observed, the 1975-80 Sel/Ult Table has very high select mortality rate increases for the first two years (34 percent and 28 percent for years two and three respectively) and moderately high mortality rate increases of 19 percent and 15 percent for the next two years (years four and five respectively), before grading down into the 12 percent-10 percent range.

Table A, however, has only moderately high mortality rate increases of 18 percent and 14 percent for years two and three respectively and then grades down into the 12-10 percent range, while Table B has relatively low-level mortality rate increases generally between 10 percent and 12 percent throughout. The tables show a mortality rate increase of 22 percent at durations 16, 14 and 12 for the 75-80 table, Table A and Table B respectively, which reflects the grading discontinuity from select mortality to ultimate mortality.

In an earlier article entitled, "The Relationship of Mortality Projections and the Underlying Mortality Tables Used," I have shown that the choice in the selection of a mortality table (1975-80 Table vs 1990-95 Table) can have a *major impact* on mortality projections and hence on product pricing and reinsurance premium determination.

For example, the present value of future claims was shown to be 13 percent lower for males and 10 percent lower for females, using a projection based on the 1975-80 Select and Ultimate Table (based on a composite model office) as opposed to using the 1990-95 Select and Ultimate Table.

In light of the above discussion, it is my belief that actuaries *must* begin to ask whether there are other tables as demonstrated in this article, besides the 1975-80 and 1990-95 tables,

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that may be more appropriate to use and what is the effect of using these other tables?

From a direct writer's perspective, the product actuary should be asking whether the mortality table currently being used is possibly overstating or understating future mortality. If it is overstating future mortality, then this could result in a higher premium and a less competitively priced product—and possibly result in significantly reduced market share. If, on the other hand, it is understating future mortality, then this could result in lower premium (perhaps a loss leader) and greatly diminished profits, or losses.

From a ceding company's perspective, if the mortality table being used overstates future mortality, then the ceding company actuary may be more likely to negotiate a reinsurance premium that will prove to be too high (or a coinsurance allowance too low) and in effect pass on too much profit to the reinsurers. If the mortality table understates future mortality, then the reinsurance actuary may have problems obtaining reinsurance on what he believes would be favorable terms.

From a reinsurance company perspective, if the mortality table used overstates future mortality, then they would be more likely to develop a less competitive quote and could lose market share. On the other hand, if the mortality table used understates future mortality, the reinsurer runs the risk of underpricing, resulting in losses.

Each actuary must develop a tailor-made mortality table, which he believes is most appropriate for his company's business. Sensitivity tests should be done using two or more tables routinely as a matter of practice.

In conclusion, it is almost naive to believe that different companies with vastly different underwriting rules, average policy sizes, distribution systems and market segments would use the same mortality table with only a difference in scaling factors. This "one shoe fits all" philosophy currently being used in this industry should be re-evaluated.

Larry Warren, FSA, MAAA, is senior vice president and chief at National Benefit Life Insurance Company in New York, NY. He can be reached at larry.warren@pfsfhq.com.

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