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Statement of Financial Accounting Standards No. 157 (SFAS 157) *Fair Value Measurements* (Including Introduction to Cost of Capital Risk Margins)

by Ken LaSorella

SFAS 157, *Fair Value Measurements*, defines fair value, establishes a framework for measuring fair value and expands disclosures. This article briefly summarizes SFAS 157 and then turns to the computation of a fair value liability (FVL) and the use of risk margins, with some expanded discussion of the cost of capital method for establishing the risk margin.

Recognition of Fair Value in US GAAP

US GAAP already requires a number of assets and liabilities to be accounted for at fair value. This typically applies to assets classified as "trading" or "available-for-sale" and SFAS 133 free standing and embedded derivatives (e.g., equity option in equity indexed annuity contracts, guaranteed accumulation benefit and withdrawal benefit in variable annuity contracts, credit derivatives in funds withheld coinsurance and modified coinsurance contracts and guaranteed minimum income benefit that is reinsured and net settled upon annuitization). Also, SFAS 141, Business Combinations, requires certain intangible assets, including the value of business acquired (VOBA), to be booked at fair value at the date of acquisition on the purchase GAAP (PGAAP) balance sheet. In addition, SFAS 142, *Goodwill and Other Intangible Assets*, requires the fair value of a reporting unit to be compared to its carrying value for the purpose of goodwill impairment testing. Although income statements and balance sheets are not affected, SFAS 107, *Disclosures About Fair Value of Financial Instruments*, requires disclosure of fair value of most financial assets (including policy loans) and liabilities for investment contracts and financial guarantees. Finally, the recent introduction of SFAS 159, *The Fair Value Option for Financial Assets and Financial Liabilities*, gives reporting entities the option of accounting for other financial assets and liabilities at fair value without having to apply complex hedge accounting.

Overview of SFAS 157

While SFAS 157 does not establish valuation standards, it does shed considerable light on concepts and principles of fair value determination. Fair value, as defined in SFAS 157,

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What's Inside

is based on a hypothetical transaction between market participants and represents, at the valuation date, the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction (i.e., not a forced liquidation or distress sale). Such transaction is assumed to occur in the principal market or, in the absence of a principal market, in the most advantageous market from the reporting entity's perspective. As such, SFAS 157 clarifies that fair value is an exit price from the perspective of the reporting entity. Regarding application to assets, fair value should be based on the highest and best use of the asset or group of assets used by market participants. The highest and best use can be either in-use or in-exchange, whichever maximizes value. In addition, in computing FVL, the liability is assumed to be transferred to a counterparty and to continue without being settled. Nonperformance risk is assumed to remain the same before and after the transfer. Hence, FVL should reflect nonperformance risk including, but not limited to, the reporting entity's own credit risk.

Valuation Issues

Valuation techniques are to be consistent with: the *market approach*, which uses prices and other information generated by market transactions involving identical or comparable assets or liabilities; the *income approach*, which uses valuation techniques to convert future cash flows or income into a single present value; and/or the *cost approach*, which is based on replacement cost. Reporting entities appear to have discretion regarding use of a particular valuation technique as long as it is appropriate in the circumstances and for which sufficient data are available.

Regarding inputs to valuation techniques, the objective is to use assumptions that market participants would use in pricing the asset or liability, including assumptions about risk. Inputs are categorized as observable, which are based on market data independent of the reporting entity, and unobservable, which reflect the reporting entity's own assumptions about the assumptions market participants would use. Valuation techniques should maximize the use of observable inputs and minimize the use of unobservable inputs. In addition, SFAS 157 establishes a fair value hierarchy that gives the highest priority to Level 1 inputs, which are quoted prices unadjusted in active markets for identical assets and liabilities. Level 2 inputs include quoted prices for similar assets or liabilities in active markets, quoted prices for identical or similar assets or liabilities in markets that are not active and inputs other than quoted prices that are observable for the asset or liability (e.g., observable yield curves, volatilities and default rates). Level 3 inputs are unobservable inputs for the asset or liability, which should be used only to the extent observable inputs are not available.

Regarding application to assets, fair value should be based on the highest and best use of the asset or group of assets used by market participants.

Since there is no active, complete, liquid and efficient market for the sale of in-force business, a valuation with Level 1 inputs is not possible. Consequently, a valuation technique, such as a present value technique, is often used with at least some Level 3 (unobservable) inputs. These include the reporting entity's assumptions about market participant assumptions for mortality, morbidity, persistency, expenses, risk and other unobservable inputs. To the extent possible, higher level inputs would also be incorporated into the valuation technique, such as observable yield curves and implied volatilities.

Clarification of Guidance for Using Present Value Techniques

FASB Concepts Statement No. 7, *Using Cash Flow Information and Present Value in Accounting Measurements*, provides guidance for using present value techniques to measure fair value (an application of the income approach). Appendix B of SFAS 157 clarifies that guidance. The components of a present value measurement are: a) an estimate of future cash flows; b) expectations about possible variations in the amount or timing of the cash flows, representing uncertainty; c) the time value of money, represented by the rate on risk-free monetary assets (the U.S. Treasury yield curve is mentioned); d) the price for bearing uncertainty (risk premium); e) other case-specific factors that would be considered by market participants; and f) nonperformance risk in the case of a liability, including the reporting entity's own credit risk. The Discount Rate Adjustment Technique and the Expected Present Value Technique are discussed. The former discounts conditional cash flows at an observed market rate of return. This is a typical technique applied to value bonds, where conditional or promised cash flows, assuming no defaults, are discounted at the required market rate of return. Risk is entirely reflected in the discount rate. The Expected Present Value Technique

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One particular component of fair value determination, the risk premium or risk margin, has generated considerable interest, research and discussion.

is presented in two methods. Method 1 adjusts expected cash flows for systematic (market) risk and discounts such risk-adjusted cash flows (certainty-equivalent cash flows) at risk-free interest rates. Method 2 adjusts for market risk by adding a risk premium to the risk-free interest rate. Consequently, expected cash flows are discounted at a risk-adjusted rate that corresponds to an expected rate associated with probability-weighted cash flows.

Risk Margins

One particular component of fair value determination, the risk premium or risk margin, has generated considerable interest, research and discussion. The International Actuarial Association (IAA) Risk Margin Working Group (RMWG) has done extensive research resulting in multiple drafts of the document: *Measurement of Liabilities for Insurance Contracts: Current Estimates and Risk Margins*. Besides discussing objectives of risk margins and desirable characteristics, the latest draft discusses a number of risk margin approaches, which include: quantile approaches, methods which use confidence limits, including the conditional tail expectation, CTE (e.g., if a reserve is derived for each stochastic scenario, the CTE60 reserve is the average of the highest 40 percent, the CTE99, average of the highest 1 percent); cost of capital method (to be more fully discussed below); discount-related risk margins, which include risk-adjusted returns and deflators; and explicit assumptions, similar to margin for adverse deviations (MfADs) and provisions for adverse deviation (PADs). The treatment of the cost of capital approach is quite thorough, but does not deliver a precise implementation approach. Consequently, there still could be some confusion regarding application of the method.

Cost of Capital Method

In its most basic form, the cost of capital method defines a risk margin as follows:

$$RM_t=(k-i_t)\times RC_{t-1}$$

where k is the cost of capital assumed to be demanded by the market and i is the rate of investment return on assets backing required capital (RC). On the surface, this appears straightforward. However, several questions arise when attempting quantification. Should k be pre-tax or after-tax; should it be the cost of equity capital or a weighted average cost of capital (WACC); finally, should it be derived from entity-specific market data (such as application of CAPM with a company's beta) or be based on a reference company or sector? Similarly, is i pre-tax or after-tax; is it the risk-free rate or asset portfolio rate: if risk-free, Treasury yield curve (as referenced in Appendix B of SFAS 157), the Libor swap curve, other swap curve, or reference portfolio? Likewise is RC based on regulatory required capital (minimum or some multiple), the amount required to maintain the current rating, or economic capital?

While the RMWG drafts are extremely useful, many of the questions have been fairly thoroughly addressed in previous papers, most notably those of Girard: "Market Value of Insurance Liabilities: Reconciling the Actuarial Appraisal and Option Pricing Methods" (*North American Actuarial Journal, NAAJ, 2000*) and "An Approach to Fair Valuation of Insurance Liabilities Using the Firm's Cost of Capital" (NAAJ 2002), Duran and Ho responses to Girard (NAAJ 2002), and the 2002 American Academy of Actuaries monograph: *Fair Value of Insurance Liabilities: Principles and Methods*. Girard has gone into extensive detail regarding leveraged cost of capital, taxes and a reporting entity's own credit risk. Duran introduced an additional direct method for computing FVL and has also addressed inclusion and exclusion of taxes in FVL. Because the early works were quite detailed and specific, a lot of time and effort can be saved by not reinventing this wheel.

Regarding questions raised, a few will be answered in what follows; the answers to others will be narrowed down; and still others will merely be identified or reformulated, deferring to experts conducting research to provide more definitive answers in the near future. To best answer some of the questions, all constraints will be temporarily removed and a simple example will be introduced that will allow us to move from the somewhat familiar actuarial appraisal method to the cost of capital method.

Assumptions for Sample Calculations

Assume the following:

- only a one-year time horizon (i.e., full settlement occurs at the end of one year);
- one expected net liability outflow, (L), equal to 910 (where expected is best-estimate without provisions for adverse deviation or market value margins);

- the cost of capital, (k), equal to 0.10;
- return on invested assets, including those backing required capital, (i), equal to 0.06;
- the tax rate, (T), equal to 0.40 (for computational ease);
- the statutory reserve and the tax value of liabilities (TVL), equal to 950;
- the statutory value of assets, the tax value of assets (TVA) and the fair (market) value of assets (FVA), all equal to 1,000;
- the above two bullets imply required capital, (RC), equal to 50.

With these extremely simplified assumptions, pre-tax statutory income and taxable income will be the same, 100, computed as investment income of 60 less net claims of 910 plus reserves released of 950. Current tax would be 0.40 times 100, or 40, resulting in statutory net income of 60.

Since the contracts expire at the end of one year, the RC of 50 can be released, resulting in distributable earnings to shareholders of 110 (i.e., net income of 60 plus capital released of 50). Since investors are assumed to demand 10 percent, discounting 110 at 10 percent gives discounted distributable earnings (DDE) of 100. This can be considered to be a type of shareholder equity on a fair value balance sheet, as will be seen more clearly.

Indirect Method of Deriving FVL

The above method, which is the actuarial appraisal method (AAM), can be used as an indirect method to derive FVL. The known total available assets, FVA, can be partitioned into an amount for shareholders, DDE, and the residual, atFVL ('at' representing after-tax, subsequently explained). Since the example covers a period of only one year, subscripts can be avoided and FVL can be defined as:

(1) atFVL=FVA–DDE

So, atFVL=1000–100=900.

Since the 900 has been derived by subtracting a DDE that reflects taxes, we might consider it to be an after-tax FVL (hence the symbol: atFVL). If 900 is booked directly into a fair value balance sheet, and if SFAS 109 (similar to its international counterpart, IAS 12) continues to operate as is, it would attract a deferred tax liability (DTL) of 40 percent of the difference between the TVL of 950 and the FVL of 900, resulting in a DTL of 20. The fair value balance sheet would then have assets of 1,000, liabilities of *920* and equity of 80, which is not equal to DDE of 100.

This phenomenon has been encountered in practice in both US GAAP and Canadian GAAP (CGAAP).

This phenomenon has been encountered in practice in both US GAAP and Canadian GAAP (CGAAP). The starting point for VOBA is often the present value of after-tax statutory book profits less the net cost of capital (similar to in-force business value in embedded value reporting). Likewise, CGAAP reserves are often computed including the present value of future taxes. Such after-tax values are often adjusted algebraically for deferred taxes before being booked (to the PGAAP and CGAAP balance sheets, respectively). The same deferred tax algebra can be applied to FVA–DDE. In essence, a tentative DTL is computed, which is then grossed-up to a pre-tax basis and subtracted from the after-tax liability. The adjustment follows:

Tentative
DTL=T×(TVL–atFVL)=0.40×(950–900)=20

DTL=(Tentative DTL of 20)/(1–0.40)=33.33

FVL=atFVL–DTL=900–33.33=866.67

To test the result, DTL=0.40×(950–866.67)=33.33 (test passed).

Entering an FVL of 866.67 and a DTL of 33.33 into a fair value balance sheet gives liabilities of 900 against FVA of 1,000, resulting in fair value equity of 100, matching DDE. The fair value income statement would show investment income of 60 less net claims of 910 plus FVL released of 866.67, giving pre-tax income of 16.67. Current tax (unchanged) of 40 less released DTL of 33.33 gives net tax of 6.67. The resulting after-tax income is 10.00 (i.e., 16.67–6.67). With opening equity of 100, an ROE of exactly 10 percent emerges, a most desirable result (consistent with assumed shareholder demand).

Development of the Cost of Capital Risk Margin

With the indirect method DDE as a starting point,

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However, it can also be reasoned that it is good for investors to have a DTL.

we can proceed to develop an appropriate risk margin that can be used with a direct method (which would be preferred by most accounting systems). From (1), DDE=FVA–atFVL.

Adding and subtracting DTL on the right side of the equation gives: DDE=FVA–(atFVL–DTL)–DTL, where the amount in parentheses is FVL. Therefore,

(2) DDE=(FVA–FVL)–DTL

This is an important equation because it will lead to a standard cost of capital formula.

Assuming investors require k on their investment, DDE, the required return is:

(3) k×DDE=k×(FVA–FVL)–k×DTL

When asked if k is a pre-tax or after-tax rate, the answer is often yes. From the investor's perspective, it is a pre-tax rate. Hence, CAPM computes k as a pre-tax risk-free rate plus beta times the market risk premium. However, from the reporting entity's (company's) perspective, distributable earnings and k are after corporate taxes, hence k is an after-tax rate. Proceeding from the company's perspective, the change in FVL (release at the end of the year) plus investment income should be exactly enough to pay the net liability cash outflow and provide investors with some profit. The question is how much profit. Since assets in excess of those needed for FVL (i.e., FVA–FVL) are assumed to earn i×(1–T), the after-tax required profit (RP) that must ultimately result from releases of FVL is that shown in Formula (3) less i×(1–T)×(FVA–FVL), leading to:

(4) atRP=[k–i×(1–T)]×(FVA–FVL)–k×DTL

Substituting the full formula for net DTL, T×[(FVA–TVA)–(FVL–TVL)], into (4) and dividing by (1–T) gives the pre-tax RP:

(5)

$$RP_t = [\frac{k}{(1-T)} - i_t] \times (FVA_{t-1} - FVL_{t-1}) - \frac{k \times T}{(1-T)} \times [(FVA_{t-1} - TVA_{t-1}) - (FVL_{t-1} - TVL_{t-1})]$$

However, a further simplification has typically been made that pulls out k/(1–T)×T×(FVA–FVL) from the last term and combines it with k/(1–T)×(FVA–FVL) in the first term, giving the RP shown by Girard, Duran and others:
(6)

$$RP_t = (k - i_t) \times (FVA_{t-1} - FVL_{t-1}) + \frac{k \times T}{(1-T)} \times (TVA_{t-1} - TVL_{t-1})$$

Direct Method of Deriving FVL

At this point, it is worth revisiting our simple example to check if FVL by the direct method, discounting liability cash outflows and RP, produces the same FVL derived by the indirect method. Using subscripts of 0 and 1 for values at the valuation date and beyond, respectively:

$FVL_0=(L_1+RP_1+FVL_1)/(1+i_1)$. Since $FVL_1=0$, $FVL_0=(910+RP_1)/(1.06)$, and, using (6), $RP_1=(0.10–0.06)\times(1000–FVL_0)+(0.10/0.60)\times0.40\times(1000–950)$
Or, $RP_1=43.33–0.04\times FVL_0$. Substituting gives: $FVL_0=(910+43.33–0.04\times FVL_0)/(1.06)$,
Solving for FVL_0 gives 866.67, the same FVL previously derived via AAM.

A couple of comments about (5) and (6) might help clarify some issues. Encountering Formula (5) without seeing its full derivation has caused some confusion as to why the deferred tax component is multiplied by k/(1–T), implying an after-tax rate of return of k on net DTL. However, as demonstrated in the development of after-tax RP, k times the net DTL term arises merely as an algebraic consequence caused by adding DTL (allowing –atFVL to become –FVL), subtracting DTL to offset the addition, and multiplying both sides of the equation by k. However, it can also be reasoned that it is good for investors to have a DTL. This means that taxes are not based on the timing of fair value income. Hence, until such money is eventually paid to tax authorities, investors will have benefited. This is the opposite of the RC situation. While investors have funds tied up in RC that cannot be distributed, they demand a risk rate of return of k on such funds. The flip side is that funds that are released to investors rather than being paid to tax authorities should be worth the same k rate of return to investors. The second area of confusion comes from whether k or k/(1–T) should be compared to i. As can be seen in (5), k/(1–T) is matched with i. However, if (6) is

used, an unadjusted k is matched with i. As long as deferred taxes are reflected in RP, it makes no difference which form is used. However, if the objective of the FASB (and the IASB) is to produce a risk margin in FVL that removes the appearance of taxes, then truncating the deferred tax components in (5) and (6) will lead to completely different risk margins. Assuming a positive net DTL, truncation in (5) overstates RP, since the truncated term is a negative in RP; truncation in (6) understates RP. Assuming the FASB's (and IASB's) position is that tax effects should not be reflected in FVL, the path of least resistance is the use of a truncated form of risk margin. If a truncated form is used, some actuaries believe it is appropriate to adjust the cost of capital assumption to compensate for lost precision.

Addressing Some Initial Questions

Getting back to some initial questions, in the above formulae, k reflects the cost of equity capital. However, it can also be based on a WACC, in which case RC would represent all capital, not just equity capital. A problem with using a constant WACC in a cost of capital approach is the implicit assumption that debt remains at a constant percentage of DDE. Otherwise, WACC must vary with time. It may be easier to directly reflect the cost of debt in the cost of capital. Assuming the amount of debt and the pre-tax cost of debt service are represented by D and d, respectively, RPt can be increased by $(d_t - i_t) \times D_{t-1}$. The same logic may be applied to other debt-like capital such as preferred stock, surplus notes and capital notes. For simplicity, k was assumed to be constant. While a constant k is typical in practice, such k usually varies by country of operation and might further vary by product line within a reporting entity. In addition, k may be allowed to be time-dependent, reflecting the term structure of interest rates. It may also be time- and state-dependent, allowing a risk premium to be added to scenario-specific risk-free rates in stochastic approaches to FVL, which are usually applied to value financial options and guarantees on a market consistent basis. However, the farther removed from basic market data, the more difficult is reconciliation with market prices. Finally, an entity-specific k derived from actual market data would probably be inappropriate. It is better to derive a starting point for k from a reference company (or market sector average) reflecting the same credit rating. The starting k might have to be adjusted to eliminate the effects of franchise value (value of future new business capacity) inherent in a market-derived k (if deemed material). The objective is to derive a k applicable to only in-force business. Regardless, entity-specific market data would be useful to properly reflect the company's nonperformance risk in the final k.

The objective is to derive a k applicable to only in-force business.

Appendix B of SFAS 157 presumes certainty-equivalent cash flows are discounted at risk-free rates, as would be achieved by a replicating portfolio of risk-free assets. Hence, i should be a risk-free rate. Despite reference to the Treasury yield curve, some would argue that a spread should be added to offset the liquidity premium inherent in Treasury yields. Liquidity is not required or desired to match some liability cash flows. In addition, certain options are actually valued in the market using the swap curve along with implied volatilities. Consequently, some believe the swap curve or some variant thereof is a better surrogate for a truly risk-free yield curve. Finally, as with k, i may also be time- and state-dependent for use in stochastic approaches, which are typically used to value financial options and guarantees on a market consistent basis.

Regarding the amount of RC, the RMWG appears to favor economic capital as opposed to a multiple of regulatory capital. However, the difference may be more apparent than real. As technology evolves and more companies employ enterprise risk management techniques, it will become more common to hold economic capital. Consequently, a company's rating and its distributable earnings will be impacted by its level of economic capital. The same is true of a company holding a multiple of regulatory capital. As a practical matter, however, it may currently be easier to project a multiple of regulatory capital than economic capital, which might require a quantile method projection to determine future total required assets. While RC allocation methods are beyond the scope of this article, whether based on economic capital, regulatory capital, or other metric, the method employed will influence product-specific FVL.

Finally, an overriding principle is that of internal consistency. For example, the market k for a company that invests in risky assets already reflects the riskiness of that portfolio, offsetting any additional expected return from such risk-taking (theoretically). Consequently, such k should not be used with an assumption that all invested assets earn risk-free rates of return. By the same token, if all assets were invested in risk-free instruments, the amount of economic

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capital, or multiple of regulatory capital necessary to maintain a rating, would be reduced. Likewise, it would be inappropriate to assign economic or required capital to cover C-3 (asset-liability mismatch) risk when a replicating portfolio of risk-free assets is assumed. Consequently, it is important for assumptions about k, i and RC to remain internally consistent. Although not recommended, it is possible that an entity-specific cost of capital based on the company's beta, asset portfolio and RC, might deliver a more accurate cost of capital than one based on a reference company, risk-free rates and economic capital, if the latter assumptions are not internally consistent.

Summary

In summation, any of the direct methods of FVL valuation are capable of producing the same value as determined via an indirect method if consistent assumptions are used (Girard certainly drove this point home). However, the cost of capital method has the most direct linkage to shareholder expected return. Also, if risk is to be reflected in explicit assumptions, it may be difficult to obtain market data to derive margins to be added to expected cash flows. In addition, it is unlikely that release of such margins would deliver a desirable pattern of ROE. The same is true of quantile methods.

Finally, actuaries reflect taxes in actuarial appraisals, pricing, management targets and embedded value. It is unlikely that the current accounting systems will allow tax timing effects to be reflected in FVL. For now, it appears a compromise has to be made that defines cost of capital without regard to taxes. Regardless, SFAS 157 has greatly clarified the principles of fair value determination and allows the principles to be applied with considerable flexibility. In this regard, SFAS 157 represents substantial progress for fair value determination.

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Section Council Update

by Jerry Enoch

As I write, it is a few days before the full day face-to-face meeting of the section council in March. I am excited about what your section council is doing. A few years ago, it seemed that the work of the council was primarily to have a newsletter and to develop sessions for the annual meeting and the spring meeting. Then the Society of Actuaries (SOA) adopted an operating model in which the sections were challenged to take a more important role in the lives of our members. Learning to do this takes time, and this section council has embraced the challenge.

Some of the reasons I am excited about the council include the way we work together and the enthusiasm for the task. We have monthly teleconferences (plus an additional conference a month ago), but we probably accomplish most of our business through ad hoc e-mails, in which we typically get broad and quick participation. This group is not living from scheduled meeting to scheduled meeting.

I am also excited about the way these council members get involved any time they can contribute. In the March issue, I wrote about our "Big Three" emphases for the year: (1) research, (2) continuing education and (3) the principle-based approach, each with a designated leader. Everyone has embraced these important tasks and proactively contribute, even if they are leading another area.

I'm also excited about various initiatives that the council is addressing.

Valuation Actuary Forum. We are currently exploring the possibility of starting an annual forum for valuation actuaries, modeled on the successful Chief Actuaries' Forum and the Smaller Insurance Company Chief Actuaries' Forum. These forums provide peer-to-peer discussion of practical issues that they face and strong networking opportunities. They are a marvelous complement to the information delivered at the annual meeting, the spring meeting and the Valuation Actuary Symposium. This forum might begin to fulfill my dream that we establish one successful recurring service for members in each of the next few years, similar to the Basic GAAP and the Advanced GAAP Seminars. Ideally, this forum would follow the Valuation Actuary Symposium.

We are currently addressing a number of issues as we try to shape this forum, and the time for a go/no-go decision for 2008 implementation is rapidly approaching. In 2008, the forum would probably occur immediately before the Valuation Actuary Symposium, which begins on a Thursday. In successive years, we will learn how best to use this vehicle to meet members' needs. I encourage valuation actuaries to watch for publicity about this event, if we move forward. I know that I will be signing up at the first opportunity!

Use of Our Surplus. The section has built up a surplus over its quarter of a century, but the purpose of a section is to serve its members, not to build up a surplus. The SOA has established guidelines for the amount of surplus that a section should have, and we are working to manage our surplus within those guidelines. This is a nice problem to have, but it is a significant responsibility to best use this surplus for our members. This problem coincides with an increased need for large research projects, and research projects will probably be an important part of our near-term future. Other needs will also be met, as they have been in the past.

Research. We have several large research projects for consideration. Several of these are arising from cooperation with SOA Staff Fellow Mike Boot and working groups of the Academy. In the longer term, we will consider a research project to analyze the Exposure Draft on International Financial Reporting Standards, similar to the one we just completed about the discussion paper. Major research projects are an important part of our future, and we will be developing skill in performing these.

Principle-Based Approach. Jason Morton has established liaisons with several groups, supplemented by active involvement by the section council. This overlaps research, as already discussed, and continuing education. One continuing education idea under consideration is an article about the principles that underlie the principle-based approach.

Surveys. We are currently working on two surveys. One is a survey of practices of valuation actuaries. The results of this survey might be publicized

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Since our goal is to serve the entire membership, the survey is very important in helping us know how best to serve you.

through a newsletter article or a webcast. They would also be useful for the Valuation Actuary Forum. If you are contacted to participate in this survey, please do so. We are not aware of a similar survey in the last few years.

The second is our triennial survey of the entire section membership. We look forward to getting the results of this survey. While we have nine members on the section council, with diverse backgrounds, we don't assume that we are representative of our entire section membership. Since our goal is to serve the entire membership, the survey is very important in helping us know how best to serve you. I can't promise you that completing the survey will be fun, but I can promise you that the survey will be closely studied and that your participation is important to us.

Cooperation with Other Sections. I think that one strength of the SOA is the extent to which sections cooperate with each other. The semi-annual meetings of the Council of Section Chairs (and Vice-Chairs) facilitate this, and many sections look for opportunities to work with each other. We have had a relationship with the Management and Personal Development (MPD) Section for several years. We are now attempting to increase the number of financial reporting actuaries that get management and personal development training by jointly creating some sessions that are oriented toward financial reporting actuaries, an application of target marketing. If this proves successful, the MPD Section can create sessions that target actuaries in other areas. Another example of inter-section cooperation is the series of conference calls that I am having with the chairs of the Product Development and Reinsurance Sections, facilitated by SOA Staff Fellow Mike Boot. Our sections have some similarities, and we are able to learn from the experience of each other. A third area of cooperation is through the SOA's Committee on Life Insurance Research, some of whose members are drawn from various sections. Whether a particular research project is done solely independently or through the Committee on Life Insurance Research, the committee provides a means for the various sections to know what the others are doing.

Conclusion. In order to stop writing before you stop reading, I will leave some important things unsaid. While there is more to do in every area, you can probably understand why I am excited about our section council. Our area of the profession is moving quickly, and if we're not progressing quickly also, we are falling behind. This group knows how to get things done. We have section elections soon. I hope that many of you will be motivated to run for council and become a part of this team next year—or to join us as a Friend of the Council. S

Highlights of Section's IFRS Research Project

by Tom Herget

The International Accounting Standards Board (IASB) has been studying insurance accounting for 10 years. In May 2008 it issued a Discussion Paper (DP), *Preliminary Views on Insurance Contracts*, discussing the many issues surrounding accounting for insurance contracts and presenting current views in a number of areas. This DP can be found on the IASB's Web site, *www.iasb.org*, under the current IASB project section. In February 2008, the SOA published an 85-page research report on the impact of these Preliminary Views on popular U.S. life, health and annuity products. This report is now being widely read and discussed around the world.

The SOA's report was conveyed to the IASB, the FASB, the SEC, the International Actuarial Association (IAA), the International Association of Insurance Supervisors (IAIS), the CFO Forum (European companies) and GNAIE (North American companies). It has been presented to actuarial organizations on three continents. The study's creators are very hopeful that it sheds light on the positives and negatives of the IASB's DP.

The March issue of *The Financial Reporter* contained an article that described how this research project was conducted. This article presents the highlights of the results of the project.

Chapter 1 contains a brief primer on the DP's three building blocks for calculating liabilities: current estimates of future cash flows, margins (risk margins and service margins) and discount rates. It also contains a summary of other features of the DP along with a delineation of certain limitations of the research project.

Chapter 2 contains an overview of the approach and assumptions for the blocks of business studied.

The muscle of the report is in Chapter 3. Here the report graphically displays and compares the incidence of earnings between US GAAP (GAAP) and the (tentative) IFRS basis. After the reader establishes comfort with the patterns shown by GAAP, he or she can then see how IFRS would perform.

The GAAP income graphs generally show relatively level, gradually decreasing profits over the contract period. In the models used, some blocks of new business had significant nondeferrable acquisition costs, so these (term, long-term care and participating life) have GAAP losses in year one, followed by gains in later years.

Figure 3.7-1 Supplemental Health New Business, IFRS Baseline and U.S. GAAP
[first year premium of $3.2 million]

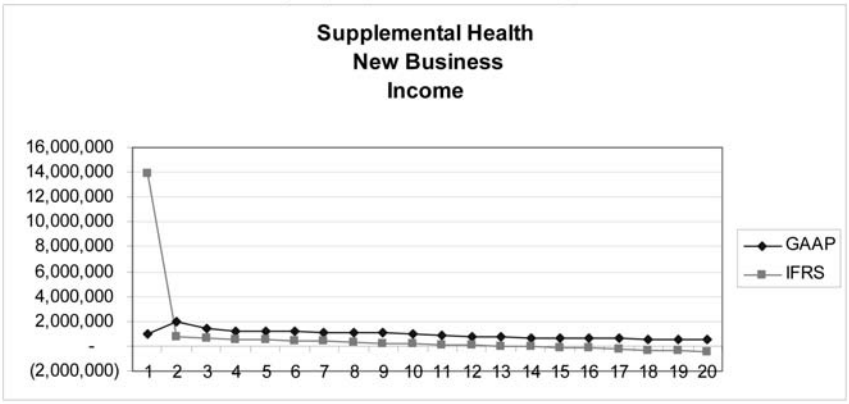
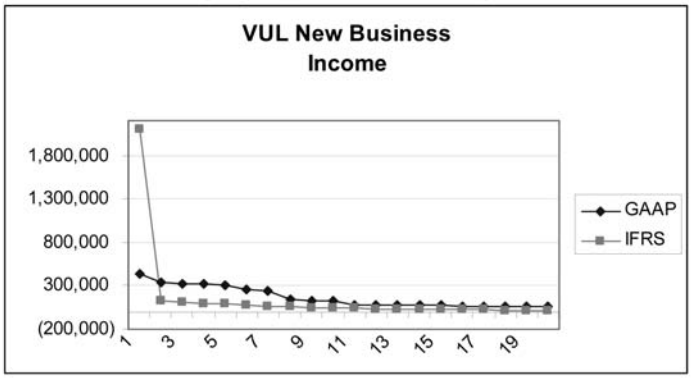


Figure 3.5-1 Variable Universal Life New Business, IFRS Baseline and U.S. GAAP
[first year premium of $3.2 million]



The baseline IFRS results shown use what the DP calls current exit value (Implementation B). Current exit value allows for the emergence of profit or loss at the point of issue, since there is no calibration of margins to the premiums charged.

In contrast with GAAP income, the baseline IFRS results for the first year show large first year profits (UL, supplemental health, term and VUL). Products that rely on investment spreads for a significant source of profit (SPDA, SPIA, long-term care and

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Figure 3.2-4 Term Life New Business, Implementation A and Baseline IFRS
[first year premium of $28 million]

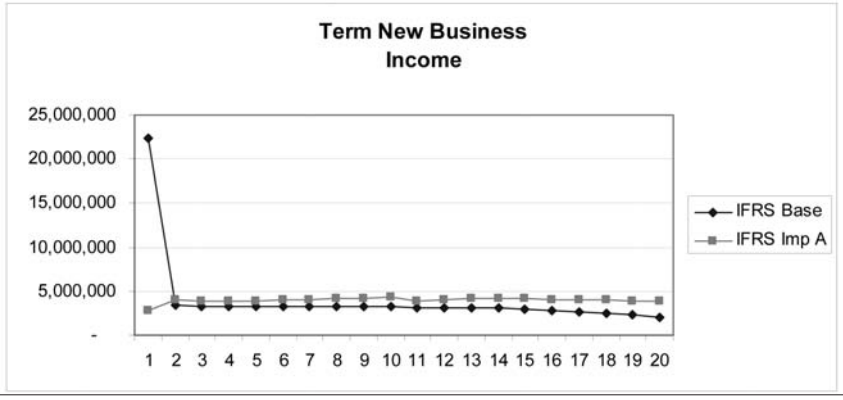
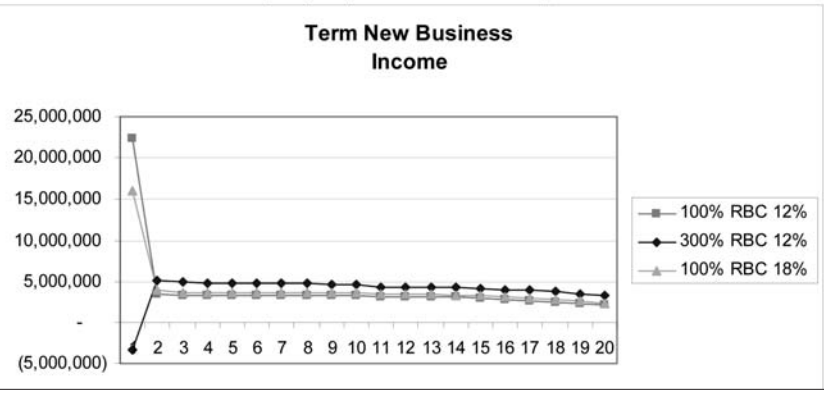


Figure 3.2-10 Term Life New Business, Risk Based Capital Factor Sensitivities
[first year premium of $5.8 million]



participating life) generally show significant day one losses since cash flows were projected using what companies expect to earn or intend to credit to the policies based on an expected earned rate, while the cash flows are then discounted back at a risk-free rate. Products that don't have a significant source of interest earnings, such as term life or supplemental health, show significant IFRS gains at issue.

Some graphs display entry value results (Implementation A), for which the margins have been calibrated to the premium so that there are no day one profits. Since this alternative approach uses different margins than the baseline IFRS calculations, the two approaches show different earnings patterns. Look at figure 3.2-1.

The method and assumptions used to generate the risk margin component of the IFRS liability are also important contributors to the gain or loss at issue. The DP lists eight methods the actuary might consider. Although the stated objective of the risk margin is to capture the amount that market participants would require as a compensation for risk, there is no further guidance provided as to its calibration. There is no widely traded and deep market to determine this, and for those transactions that do occur, individual circumstances would likely bias its basis.

For most products analyzed, the study's authors used an expected 12 percent cost of capital (that is, on a pre-tax basis including a risk-free component) applied to 100 percent of RBC. This is the company action level under U.S. Statutory rules and serves as a proxy for economic capital as the basis for risk margins. The authors used this approach in part since it would be familiar to most U.S. actuaries. The resulting present value of risk margins may appear at first glance to be on the low side, but the current thinking at the International Actuarial Association is that the margins used in such an approach should not include any provision for C1 (asset default) or C3 (asset-liability mismatch) risks, as they are provided for by the use of the risk-free rates and by capital, respectively. Excluding this from the RBC calculation significantly reduces the calculated figures and makes the 100 percent RBC a more reasonable capital surrogate. In order to illustrate the importance of this choice, the paper presents results for every product using two alternative cost of capital assumptions: a significantly higher level of capital, 300 percent of RBC, and a higher level of total cost, 18 percent. Look at figure 3.2-10.

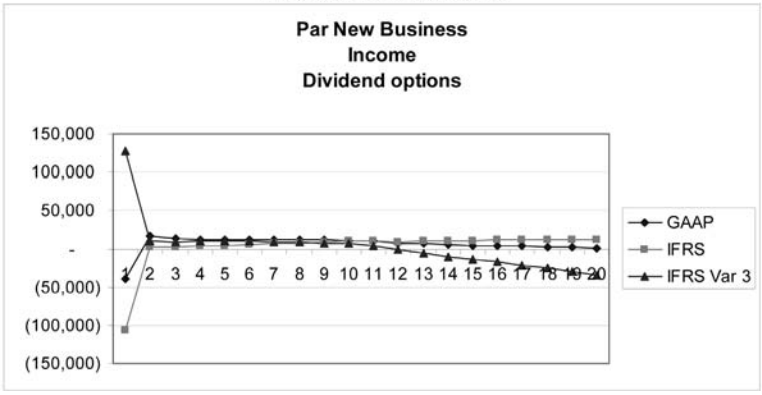
Below is one of the tables in the report that shows the emergence of year one IFRS profits for new business (using 100 percent RBC). The first column shows day one; the second shows days 2-365 (values are in $000):

	Day 1 gain/loss	Days 2-365 gain/loss	Year one premium
Universal Life	546	131	5,800
Term Life	20,575	1,797	28,000
Immediate Annuity	-7,417	3,286	117,000
Long Term Care	-29,267	316	27,000
Supplemental Health	13,480	379	3,200
Fixed Deferred Annuity	-12,030	8,418	200,000
Par Whole Life	-102	-4	133

There were over 150 comment papers submitted to the IASB on the DP. Many expressed dissatisfaction over one item that this research paper quantifies: the existence of large earnings in year one for some products, primarily fueled by the selection of risk margins that are not calibrated to the actual premium charged.

One of the more interesting graphs shows the IFRS profit emergence if policyholder dividends are not deemed a component of cash flows (since they do not represent a legal obligation). In such a case par life insurance business displays a windfall year-one profit (the entire expected premiums are in the cash flows but not the related dividends), modest gains for 10 years, then notable and growing losses thereafter, as policyholder dividends must be funded from previously taken gains, now existing in surplus. Look at figure 3.9-4.

Figure 3.9-4 Par Life New Business, Baseline IFRS, U.S. GAAP and Variation 3
[first year premium of $133,000]



One thing the savvy reader can observe is that without proper calibration of margins, IFRS profits after year one for several products will be very low since they would have been reported as year one gains. The opposite occurs for products with significant losses at issue.

Chapter 4 of the paper shows resulting balance sheet values. The reader can see the relationship between IFRS and net (of outstanding DAC asset balance) GAAP liabilities. The reader can also gauge the relative level of IFRS liabilities between its cash flow and risk margin components. The figures included in this chapter illustrate that the relative difference between GAAP and IFRS liabilities do not appear as stark as the income figures in Chapter 3, as income reflects the change in these values.

Chapter 5 includes comments on the results of several sensitivity tests applied to IFRS income for each product shown in figures included in Chapter 3. The authors comment on the significance of the impact that the choice of risk margin methods and assumptions can have. For the cost of capital method as applied, the sensitivity of the assumptions used had less of an impact than one might have anticipated.

Chapter 6 discusses practical issues in calculating the IFRS liabilities that were identified in the course of the project. A significant amount of measurement guidance and education will be needed by the financial reporting actuary applying the preliminary views of the IASB as described in its DP. Stochastic models may be needed in many cases in determining the risk margins and certain assumptions. Economic capital modeling will be a valuable precursor to IFRS calculations. Based on conversations with the ATFs, work flow and run time will be a significant issue as these values will be needed to produce financial reporting values, rather than simply after-the-fact testing that many of the current calculations from which these values are derived have been used historically. Finally, the process needs to be transparent enough to enable adequate auditing of the work product.

Chapter 7 addresses areas where further research will be needed. Discounting, premium recognition, policyholder dividend recognition and measurement, risk margins, credit characteristics of liability, market-based assumptions and product development impacts will all need attention in the near future prior to adoption and implementation.

All insurers need to follow this rapidly evolving topic, as IFRS currently has a good chance of replacing US GAAP within the next five years. The IASB has focused on the balance sheet concepts; this paper reveals the impact of some of its features on the income statement. All readers should prepare to get involved, as this new accounting development could well be the report card of the future. Brace yourself to react to the upcoming Exposure Draft (expected in 2009) and contribute to the Final Standard (2010?).

I would like to thank Henry Siegel, chair of the Academy's Financial Reporting Committee, for being the project's creator and to Sam Gutterman of PricewaterhouseCoopers and his troops for their direction, analysis and report writing. Also, thanks go to the Actuarial Task Forces for their calculations, to the Project Oversight Group for riding herd on the many drafts and to the SOA research staff for their oversight. Finally, I want to recognize the sponsors of the project, the SOA's Financial Reporting Section, the Product Development Section and the Committee on Life Insurance Research.

The reader can find the paper on the SOA Web site at *http://www.soa.org/research/life/research-financial-standards.aspx*.

Principle-Based Reserves Update

by Karen Rudolph

(Editor's note: Karen Rudolph has agreed to supply the Financial Reporter with regular updates on PBA activities. Thanks to Karen and watch for future updates in the PBA Corner.)

The NAIC calendar for 2008 is well underway. An overview of recent activity within certain aspects of the groups associated with the evolution of the Valuation Manual is presented here. The NAIC's Principle-Based Reserving (EX) Working Group anticipates that work on the Standard Valuation Law (SVL) will be complete during the Spring 2008 National Meeting and ready for plenary during the Summer 2008 National Meeting. The deadline for this article falls concurrent with the spring meeting.

Valuation Manual (VM)

Work continues under the control of the LHATF rather than Academy working groups. The Academy's Life Reserve Working Group (LRWG), in particular, has been submitting proposed changes to the VM wording as it emerged from the winter meeting. Certain parts of those proposed changes are summarized below.

1. Stochastic Exclusion Test: Originally named the Material Tail Risk Test, the Stochastic Exclusion Test is a 12 scenario test, one of which is considered baseline. The other 11 scenarios are generated by specified patterns of random shocks to economic conditions on the projection start date. The objective of the test is to provide a straightforward method of demonstrating whether a group of policies produces scenario amounts that are sensitive to economic conditions. If not, the principle-based reserve calculations need not include stochastic testing. Assumptions for this demonstration are prudent estimate assumptions. This test is performed annually, within 12 months of the valuation date. The test involves calculating a ratio using the baseline scenario asset amount (a), the largest scenario asset amount (b) and an amount representing the present value of benefits and expenses, (c). The ratio is (b-a)/c and must be less than a threshold (to be determined by the NAIC) in order to be considered as "passing" the test for dependence on economic conditions.

2. Reinvestment Assumption: VM-20 emerged from the winter meeting with a prescribed net spread on Treasury rates as applied to reinvestment assets. The LRWG has submitted an amendment that will effect two changes. First, the spread will be a gross spread rather than a net spread. It is felt that using a net spread together with a prudent estimate default charge assumption would result in excessive margin. Second, current gross spreads as of the valuation date, on reinvestment assets, are graded over three years to an ultimate gross spread. The ultimate gross spread for four specific asset types will be given in the VM. For a company whose reinvestment strategy includes assets other than those specified by the VM, the gross spreads used should reflect differences in these assets from the assets specified (i.e., quality rating, years to maturity and asset type).

3. General Considerations for Reinsurance: Text requiring certain reinsurance provisions (stop loss or maximum limits on benefits receivable) to be considered in the reserve calculations by stochastic analysis has been modified to allow the company flexibility in the method used to include these provisions in the principle-based cash flows. Revised wording states that all reinsurance agreements in force shall be included in calculating the reserve if doing so would

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increase the reserve. Such a reinsurance agreement must also comply with *the Accounting Practices and Procedures Manual* before being considered in force.

4. Projection Period: Projection period is expressed as a period long enough such that projecting further would not produce a materially greater reserve. The actuary can estimate the present value of obligations beyond the end of the projection period, but because the working reserve is zero, does not know the statutory reserve at that point in time. The proposed change is to add wording to the effect that the present value of remaining obligations (beyond the end of the projection period) be immaterial in determining the length of the projection period.

5. Discount Rate: In the discounting of projected cash flows, the VM currently specifies a path of discount rates equal to the path of net asset earned rates. As long as the model segment is projecting an asset amount greater than zero, this path provides a satisfactory estimate of an appropriate discount rate. However, for certain model segments and scenario combinations, the asset amount may be entirely depleted. In this circumstance, the wording change proposed would use a path of risk-free rates specified by the NAIC.

6. Simplification Wording: During the December 2007 Meeting, the wording allowing for simplifications and approximations was removed. The Life Reserves Working Group is recommending this wording be included based on concerns raised by small companies and companies with smaller blocks of business or business with no sensitivity to economic conditions. Simplifications and approximations are allowed if the company can demonstrate that their use does not materially change the resulting reserve.

7. CTE Level: During the December 2007 Meeting, the language describing the stochastic reserve specified a different CTE level depending on product type (30 CTE for whole life; 20 CTE for variable life; 35 CTE for all others in scope). The LRWG feels strongly that the CTE metric is designed to capture variation in the shape of the tail of the distribution. Therefore it is unnecessary to require different CTE levels by product type. Furthermore, varying CTE levels would complicate any aggregation across product types. In addition to this change, the PBR Life Subgroup of the NAIC is proposing wording for a drafting note indicating that varying levels of CTE for different product types should be explored.

In the discounting of projected cash flows, the VM currently specifies a path of discount rates equal to the path of net asset earned rates.

8. Definition Change: The term "Reported Reserve" has been used throughout VM-20 to imply the minimum reserve standard. The LRWG is advocating a permanent change from Reported Reserve to Minimum Reserve, since a company could choose to hold, or report, a reserve total higher than minimum.

NAIC Principle-Based Reserve (EX) Working Group of the NAIC

This working group has drafted a paper describing the position of the NAIC on assurance of company reserves. In light of the removal of the reviewing actuary, this committee has discussed the following alternatives:

- Develop a Centralized Actuarial Reviewing office to perform annual reviews to confirm that companies valuing business under a principle-based approach are in compliance with the VM;
- Require the annual review by an independent actuary, where the reviewing actuary is hired directly by the state insurance department;
- Incorporate the requirement of an independent reviewing actuary into the state's examination and analysis process;
- Combine the concept of a Centralized Actuarial Reviewing office and incorporate the requirements of this annual review into the state's examination process.

The topic of assurance of company reserves is on the NAIC spring meeting agenda. The EX working group supports placing the assurance needed on reserves calculated using principle-based reserves into the examination and analysis function. The responsibility for the review would rest with the state of domicile. The state would have discretion in determining whether the review would be

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performed by an independent actuary (hired by the insurance department) or an actuary on staff with the insurance department. Companies considered for review, the frequency and depth of the review would also rest with the state as part of its risk-focused examination process. The committee has agreed that consistency should be a goal for these reviews, as well as establishment of a centralized function that would prepare and compare reviews and the review processes of states in order to promote uniformity and minimize duplicative effort. The review process will no doubt evolve over time.

Timeline

The PBR (EX) Working Group has also updated its timeline. LHATF is expected to complete its work on the SVL at the spring meeting. PBR (EX), A Committee and then Plenary should be reviewing the SVL revisions during the summer meeting. Work on the Valuation Manual is expected to be complete by the Fall 2008 Meeting, with presentation to the PBR (EX) and A Committee subsequently, and review by Plenary at the Winter 2008 Meeting. Other technical issues impacting the Annual Statement Blanks and SSAP should also be addressed during the summer/fall meeting sessions. S

Attend the 1st Valuation Actuary Forum

The Valuation Actuary Symposium is a perennial favorite among financial reporting actuaries. Similarly, the Chief Actuaries Forum and the Smaller Insurance Company Chief Actuaries Forum are perennial favorites among their constituencies. Seeing an opportunity to build on these successes, the Financial Reporting Section is creating a forum for valuation actuaries that is patterned after these successful forums.

The first Valuation Actuary Forum will be attached to the Valuation Actuary Symposium in Washington, D.C., and will be held during the late morning and afternoon of Sept. 26, 2008. With the content of the Valuation Actuary Symposium fresh in their minds, participants will discuss valuation actuary issues in casual large group and small group settings. The forum will be an excellent opportunity for participants to internalize what they have heard at the symposium, to share and learn approaches of addressing valuation actuary issues and to bridge the gap between the ideal and real-world practice.

Participation will be limited. Details are still being worked out. If you are an appointed actuary or have another high level valuation actuary role, mark this time on your calendar and watch for additional information.

PBA Reserves and Capital Modeling Efficiency: Representative Scenarios and Predictive Modeling

by Steven Craighead

In modeling principle-based approaches for reserves and capital, it is necessary to conduct extensive scenario testing on each business model. The resultant scenarios are then used in specific ways to determine the proper reserves and impact on overall company capital. This is especially critical for new types of insurance policies with complex options. However, it is also our desire to reduce the computer run-time required to obtain these reserve or capital values. In the past this has been typically done by the use of representative scenarios, where, based on how many scenarios map to each representative, we determine a probability weight associated with each. However, given the relatively simple historically used approaches to the mapping process, the weights obtained may not accurately reflect the character of the scenarios mapped.

If, however, we are able to use representative scenarios to train a separate smaller model to replicate the full business model, we could then use all the scenarios within this less time-expensive model and not use the probability weights at all. In other words, we wish to develop a new technique which combines the use of both representative scenarios with that of predictive modeling.

In the study below we consider two ways of determining representative scenarios, and then we use the results of each in combination with a very effective statistical tool to create predictive models. Although we still have to process our time-expensive business model on the representative scenarios, and separately calibrate the time-inexpensive predictive model, we have found that the results are very good. We conclude that either method of choosing scenarios is effective for reserve calculations, but that one method is superior in estimating capital.

I will briefly discuss the two methods used to select representative scenarios.

Representative Scenarios

There are several (actuarially) published as well as commonly known methods to determine representative scenarios from a larger collection. In our research we will use one published method and one commonly used by statisticians. We will not introduce any weighting within our scenario selection process, and we will treat the selection process as directly formulated by the sources; however, later we will discuss the use of weighting in the control of bias.

(1) Chueh[1] describes three separate algorithms to select representative scenarios. In particular, the second algorithm uses the following metric to create a distance between two separate interest rate scenarios paths:

$$D_2 = \sqrt{\sum_{t=1}^{30}\left(\prod_{k=1}^{t}\frac{1}{1+i_k}-\prod_{k=1}^{t}\frac{1}{1+i_k^P}\right)^2}$$

Here i_t is a one-year rate at time t. i_t^P is the pivot interest rate at time t.

Notice that this is ultimately a sum of squares metric with the interest rates represented as discount factors through time. In her paper, she observed that this metric gave a good overall representation of results both in the center and the tails. We will only use this metric in our analysis below because the required conditional tail expectation (CTE) calculations for reserves is set at 65 percent (CTE65) and capital is set at 90 percent (CTE90). To properly calculate CTE65, we need to have the stochastic results well represented in both the central portion as well as the tail, whereas CTE90's calculation would need scenarios primarily within the tail.

(2) The other algorithm[2] that is frequently used by statisticians is the CLARA Cluster Algorithm. The CLARA algorithm can either use a sum of squares or a sum of absolute values metric to measure distance. In our work below we will use a sum of absolute

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values to indicate distance between separate scenarios. Now let's look briefly at predictive modeling.

Predictive Modeling

Predictive modeling is a means that one can take to design or create a model that can be used to predict an outcome with approximately the same probability that is observed with the actual data. There are many different techniques, but while working independently with the Academy Valuation Basis Table subcommittee, we found one outstanding process. This modeling technique is called Projection Pursuit Regression[3] (PPR). See the accompanying PPR appendix, which summarizes the process.

Combination of Methods

In the past, most actuarial research concentrated only on the use of representative scenarios and weighting the results based on the probabilities associated with each representative. We have found that this approach alone does not adequately represent the overall behavior that one obtains when using all of the scenarios. However, the goal of model efficiency is to reduce the entire processing time of the various reserve or capital models. *This has been mostly done in the past by either reducing the number of model points used with the liabilities or assets or by reducing the number of scenarios processed through the model.*

Independently, we have observed that PPR models are very effective, not overly sensitive to outliers within the calibration data, and replicate the overall behavior of high dimensional models well. Another nice feature of PPR is that it is very quick when asked to evaluate additional input besides that of its training data.

In past experience, we have also observed that the CLARA algorithm is very effective in selecting representative scenarios. This is due to the fact that the process discovers a majority of the extreme scenarios, which contribute to the tail of the reserve or the capital distribution.

When one uses representative scenarios and then uses probability weighting of results, the final results are very dependent upon how those weights are obtained or used. However, if one does not use these weights at all, but only uses the representatives as training data for a predictive model, we can then process all scenarios through the resulting predictive model. For this to work well, we hope that the number of representative scenarios will be rich enough to adequately span the high dimensional business model. Also, we hope that the predictive model will also adequately model the business model as well.

We will now test the hybrid approach of using representative scenarios as training data and then processing all the scenarios through the predictive model.

Next, we briefly discuss what data we use in our analysis.

Data Sources

Craighead[4] describes and models from over 100 insurance-related datasets. In our work below, we will concentrate on his 1993 dataset associated with business model 4 and the associated 10,000 interest rate scenarios that were used in the generation of these values. Craighead discusses the generation process of these scenarios as well. We have restricted ourselves to this specific dataset because it was determined within that this specific data set has such complex behavior, that if one is able to adequately model the underlying data, the remaining datasets are very easily modeled.

Now let's discuss how we will conduct our experiments.

Process Outline

Using the basic information of the 10,000 scenarios and the 10,000 associated capital values mentioned above, we conduct 100 separate experiments using random samples of 5,000 scenarios for each representative set size. On each of these scenario sets, we apply either the Chueh Algorithm (with a specific modification discussed below) or the CLARA Algorithm and choose separate representative subsets. Once a specific representative set is selected, the representative scenarios, in addition to their associated capital values, are used as the training data for a PPR model. Once the PPR model is trained (or calibrated), the entire sample of 5,000 scenarios is then projected using the resultant PPR model. Using the PPR model, we calculate both the CTE65 and CTE90 (we refer to these as Model). Also, based on the specific sample of 5,000 capital values, we also calculate the CTE65 and CTE90, (we refer to these as Actual). We then calculate the relative error associated between Actual and Model, by the formula: RE = (Actual – Model)/Actual.

In our analysis with the Chueh Algorithm, we modify the distance formula to include not only the 90-day rates but also the 10-year rates, by the following formula:

$$D_2 = \sqrt{\sum_{t=0}^{20}(\prod_{k=0}^{t}\frac{1}{1+i_{90k}} - \prod_{k=0}^{t}\frac{1}{1+i_{90k}^{P}})^2 \cdot}$$

$$\overline{+\sum_{t=0}^{20}(\prod_{k=0}^{t}\frac{1}{1+i_{10k}} - \prod_{k=0}^{t}\frac{1}{1+i_{10k}^{P}})^2}.$$

Where the CLARA algorithm uses the following distance formula:

$$\sum_{t=0}^{20}(\mid i_{90:t} - i_{90:t}^{P} \mid + \mid i_{10:t} - i_{10:t}^{P} \mid)$$

Note: We use the 90:t or 10:k notation to indicate 90-day rates or the 10-year rates in year t or k.

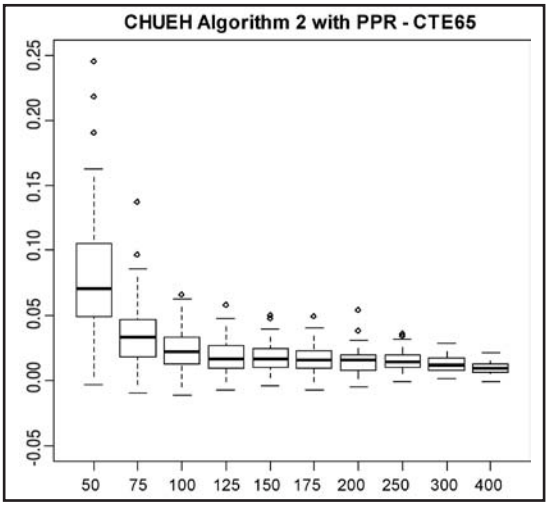
Results

Regarding the Chueh Algorithm experiments, we examine separate sets of representative scenarios. The various representative set sizes are 50, 75, 100, 125, 150, 175, 200, 250, 300 and 400.

Regarding, the CLARA Algorithm, we use representative set sizes of 50, 75, 125, 175, 200, 250, 300, 400 and 500.

As mentioned before, for each of these representative set sizes, we repeat the random sampling of 5,000 scenarios 100 times. By conducting this repeated sampling we can observe the effectiveness of the overall process and approximate the sample error associated in our tests.

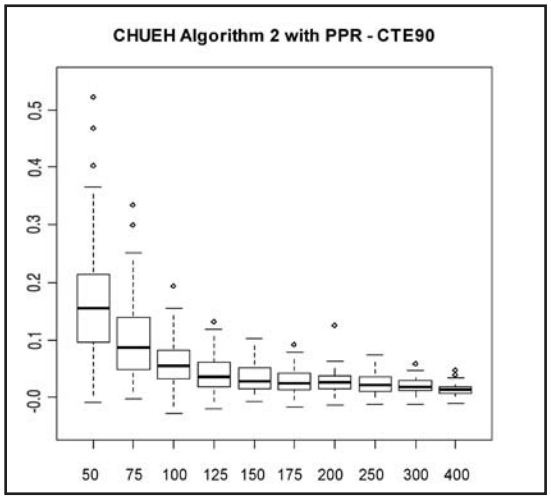
The next two box-whisker graphs as the results of the experiments associated with the Chueh distance. Following each graph are the associated statistics for each set of 100 tests. See the Wikipedia[5] discussion on how to interpret box-whisker plots.



	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
50	-0.00351	0.0497	0.0709	0.07809	0.1041	0.2453
75	-0.00928	0.01813	0.03358	0.03522	0.04689	0.1372
100	-0.01093	0.01309	0.022	0.02356	0.03324	0.06634
125	-0.00691	0.009314	0.01696	0.0184	0.02673	0.05787
150	-0.00395	0.01067	0.01695	0.01802	0.02449	0.05027
175	-0.00752	0.009906	0.01561	0.01607	0.02322	0.04944
200	-0.00456	0.008315	0.01554	0.01497	0.02025	0.05378
250	-0.00115	0.009923	0.01409	0.0148	0.01956	0.03615
300	0.001184	0.008013	0.0117	0.01257	0.01735	0.02898
400	-0.00084	0.005982	0.009175	0.009458	0.01271	0.02113

Notice how the median (the dark heavy) line moves down as the number of representative scenarios increase. Notice also how the relative errors remain mostly positive. This indicates that the Actual CTE65 values are larger than the Model CTE65 values. This indicates that this approach is liberally biased, by an average of 94bp for the 400 representatives' samples. Notice as the number of representatives increases, how both the box and separately the whiskers narrows around the median.

Now observe the Chueh CTE90 results:



	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
50	-0.00876	0.09702	0.1555	0.1663	0.213	0.5213
75	-0.00218	0.04898	0.08644	0.09739	0.1393	0.3344
100	-0.02871	0.03181	0.05445	0.05984	0.08232	0.193
125	-0.01989	0.01837	0.03506	0.041	0.06137	0.1316
150	-0.00775	0.01512	0.02786	0.03508	0.05139	0.1021
175	-0.01698	0.01273	0.02499	0.02686	0.04207	0.09204
200	-0.01434	0.015	0.02569	0.02674	0.03762	0.1256
250	-0.01233	0.01032	0.0212	0.02454	0.03543	0.07377
300	-0.01203	0.01183	0.01737	0.01974	0.02955	0.05846
400	-0.01069	0.006189	0.01342	0.01289	0.01795	0.04684

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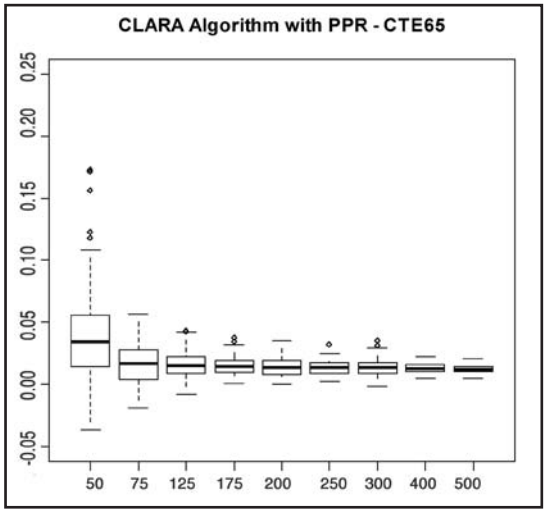
Notice how the collective CTE90 results are not as good as the collective CTE65 results, where using 400 representatives the median relative error is 134 bp versus that of 92 bp. Also observe the absolute distance from the maximum and the minimum. Again, note that these results are so liberally biased. Note also how the small circles above the top whiskers indicate that there are two outliers in the plot of the 400 representatives.

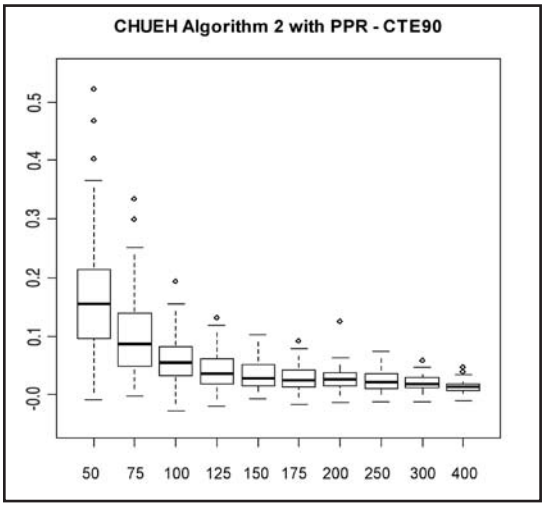
Now examine the corresponding CLARA Algorithm results. The next two graphs display the box-and-whisker plots based on the same process except that the CLARA Algorithm is used to select the representative scenarios.



	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
50	-0.03666	0.01428	0.03394	0.03885	0.05481	0.1731
75	-0.01942	0.004485	0.01637	0.0158	0.02794	0.05635
125	-0.00832	0.009057	0.01548	0.01636	0.02218	0.0428
175	0.000665	0.009482	0.01404	0.01523	0.01897	0.03734
200	-0.00041	0.008229	0.01337	0.01446	0.01932	0.03488
250	0.002103	0.009004	0.01372	0.01372	0.01747	0.03151
300	-0.00138	0.009033	0.01319	0.01361	0.01737	0.0354
400	0.004923	0.00996	0.01287	0.0131	0.01612	0.02231
500	0.004738	0.01029	0.01179	0.01231	0.01441	0.02046

Note how the CTE65 results have a tighter interquartile range than the CTE65 Chueh results. Also, note that the process is liberally biased just like the Chueh technique. Comparing the median values for 400, we see that the median value is 129 bp versus that of 92 bp from the Chueh CTE65. Note though even with a higher median value, the difference between the maximum and the minimum is tighter around the median that that of the Chueh.
Now the CTE90 results:

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
50	-0.03344	0.04874	0.08013	0.1027	0.1484	0.4273
75	-0.03633	0.002239	0.02523	0.02672	0.0496	0.09426
125	-0.02789	0.006763	0.02003	0.01907	0.03103	0.08259
175	-0.01918	0.003258	0.01248	0.01382	0.02327	0.06151
200	-0.02165	0.001014	0.01065	0.01294	0.0219	0.05468
250	-0.01053	0.003376	0.009998	0.01089	0.01766	0.03989
300	-0.01077	0.002906	0.007679	0.008806	0.01451	0.04095
400	-0.00422	0.001636	0.005093	0.005152	0.008281	0.01846
500	-0.00379	0.000105	0.002869	0.003092	0.005355	0.01331



For the CTE90 results, we again see that these results are liberally biased, but median results as well as the minimum and maximum relative errors are very tight and vastly superior to those of the Chueh Algorithm. We have noted from prior experience using the CLARA algorithm (set to use the sum of absolute value of the differences metric), that the algorithm chooses more tail scenarios than any other technique.

Issues Regarding Bias

Though our process is positively biased and understates the reserves and capital, we see that the average error is reasonable given the speed enhancement. Of course one may increase the size of the representative set and this will reduce bias. Donald Krouse (AEGON) has given some insight into what a practitioner may take to reduce this bias. Based on his suggestions, one could introduce weights to the scenario selection process or by experimenting with other various metrics. This may help, because the bias may arise from the fact that the training scenarios may over- or under-emphasize certain attributes within the scenarios. Also, the PPR model itself can lead to

biased results just due to the fact of how it calibrates (as discussed within the appendices). The practitioner may want to introduce weighting to the calibration process or manipulate other settings (as briefly outlined within the Techniques and Diagnostics for PPR appendix) to see if bias can be eliminated. Currently, we have used other predictive models such as neural networks and other types of machine learning, to eliminate the bias, but we have found that PPR is still superior because it does not suffer from the curse of dimensionality. Furthermore, it simulates the underlying structure of the complex capital model quite well, where these other techniques poorly calibrate to the representative sets.

Conclusions

We see that the Chueh technique and the CLARA technique are relatively comparable when calculating the CTE65 results while examining the 400 representative sets. Here we see that the median relative error for the Chueh algorithm is 92 bps with a range of results of 220 bps. Also, note that the CLARA CTE65 has a median of 129 bp with a tighter range of 156 bp. However, we observe that the CLARA technique is vastly superior to the Chueh technique when conducting the CTE90. This is because the median CTE90 relative error for the Chueh algorithm is 134 bp with a range of 575 bp, which is unreasonable, whereas the CLARA algorithm has a median relative error of 51 bp and range of 237 bp.

Our recommendation is to use either representative scenario selection process when calculating reserves, but to limit the approach strictly to the CLARA technique for making capital CTE estimations.

APPENDICES

Projection Pursuit Regression (PPR)

In linear regression, one fits a response variable Y to a collection of n predictor variables X_i in the familiar form:

$$Y = \alpha + \sum_{i=1}^{n} \beta_i X_i + \varepsilon$$

In additive models, the $\beta_i X_i$ are replaced with various functions $f_i(X_i)$, with this form:

$$Y = \alpha + \sum_{i=1}^{n} f_i(X_i) + \varepsilon$$

Projection Pursuit Regression (PPR), introduced by Friedman and Stuetzle,[6] is a modification of this structure in that there are:

- M different f_i.
- Each f_i acts on a different linear combination of all n of the X_k.
- A specific coefficient of these linear combinations is denoted by α_{ik}.
- Each f_i is multiplied by a β_i.
- The constant term is the average of the response variable.

So PPR takes on the following form:

$$Y = \bar{y} + \sum_{i=1}^{M} \beta_i f_i\left(\sum_{k=1}^{n} \alpha_{ik} X_k\right) + \varepsilon$$

or in vector format:

$$Y = \bar{y} + \sum_{i=1}^{M} \beta_i f_i(\alpha_i \cdot X) + \varepsilon$$

where $X=(X_1, X_2, \ldots, X_n)$ is the predictor vector, and $\alpha_i=(\alpha_{i1}, \alpha_{i2}, \ldots, \alpha_{in})$.

The term "Projection" in PPR comes from the projection of X on to the directional vector α_i for each i.

The "Pursuit" arises from the algorithm that is used to determine optimal direction vectors $\alpha_1, \alpha_2, \ldots, \alpha_M$.

Each f_i is called a ridge function. This is because they only have values in the α_i direction and are considered constant elsewhere. Effectively, what occurs is that the overall PPR model is a linear combination (β_i are the coefficients) of the ridge functions. These functions only take on values that arise from the projection of the predictors against the direction vectors, and the functions are assumed to take on a constant value in any other direction. So, each ridge function is like the profile of a mountain range, and we linearly combine these functions along all different ridges (as pointed out by the α_i).

On a formal basis, Y and X are assumed to satisfy the following conditional expectation:

$$E[Y \mid X_1, X_2, \ldots, X_n] =$$

$$= \mu_y + \sum_{i=1}^{M} \beta_i f_i(\alpha_i \cdot X)$$

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PPR models can take extremely large amounts of data and create a very good model of the underlying data.

with $\mu_y = E[Y]$ and the f_i have been standardized to have zero mean and a unit variance. That is: $E[f_i(\alpha_i \cdot X)]=0$ and $E[f_i^2(\alpha_i \cdot X)]=1$, where i takes on values from 1 to M. We assume that the realized sample values for the random variables Y and $X=(X_1, X_2, \ldots, X_n)$ are independent and identically distributed to the distributions of Y and X, respectively.

The ppr algorithm in the R stats library[7] estimates the best β_i, f_i and the α_i by minimizing the following target function for the mean square error:

$$E\left[Y - \mu_y - \sum_{i=1}^{M} \beta_i f_i(\alpha_i \cdot X)\right]^2$$

across all the data samples for Y and X. Note: This expectation can be a weighted average.

A powerful trait of PPR models, since the predictor vector X is projected, is that interactions beween different X_j and X_k are included within the model, whereas other model algorithms cannot do this without user intervention.

We justify this by using an algebraic demonstration based on the S-Plus Guide to Statistics[8] recast into our notation as follows:

Suppose that the actual data model is $E[Y / X_1, X_2] = X_1 X_2$.

Let Y=Ø, M=2 , $\beta_1 = \beta_2 = .25$ and assume that $\alpha_1 = (1,1)$ and $\alpha_2 = (1,-1)$. Furthermore assume that $f_1(t)=t^2$ and $f_2(t)=-t^2$. Let $X=(X_1, X_2)$

Now

$$f_1(\alpha_1 \cdot X) = (X_1 + X_2)^2 = X_1^2 + 2X_1X_2 + X_2^2.$$

and similarly

$$f_2(\alpha_2 \cdot X) = -X_1^2 + 2X_1X_2 - X_2^2.$$

and finally,

$$\sum_{i=1}^{M} \beta_i f_i(\alpha_i \cdot X) = X_1X_2.$$

So, we can see that if the β_i, f_i and α_i are optimally selected and the underlying model has interactions between different predictors, PPR should capture this.

Advantages and Disadvantages of PPR

The following is a list of advantages of using PPR as a model:

- The model is a continuous function. According to Venables and Ripley,[9] they cite Diaconis and Shahshahani[10] and say that given a large enough number of ridge functions, PPR can approximate arbitrary continuous functions.
- It is the best possible fit since every component is solved for the minimization of the weighted least squares.
- Each ridge function does not extrapolate outside of its specific domain. If the specific $\alpha_i \cdot X$ is outside the domain, the relevant domain endpoint is used.
- The model handles the interactions between the different predictors as we saw in the last section.
- PPR models categorical predictors as easily as continuous predictors.
- PPR models can take extremely large amounts of data and create a very good model of the underlying data. One can also adjust the model to distinguish between model fit and model smoothness.
- PPR does not suffer from the curse of dimensionality (COD). COD arises from the increased complexity of a multi-dimensional surface. Since PPR optimally is solved one ridge function at a time, the difficulty of trying to locate global optimal values for model calibration is eliminated.

The disadvantages are:

- The range of a PPR model may be outside of the range of acceptable values. For instance, if one were using PPR to model mortality, model results could fall below zero or above one. However, PPR will not extrapolate outside the existing ridge functions, so if any predictor projects on a specific α with a value outside the

domain of a specific ridge function, the ridge function takes on the value either at the furthest point on the right hand side or left hand side. This no extrapolation rule can lead to biased results.

- All of the parameters are point estimates, and there is no distributional consideration given to the significance of a specific parameter. Because one is unable to create a confidence interval using the R ppr function around each of the α_{ik} or the β_i , one is not able to determine if a specific parameter is significant to the model. In fact, one is unable to test if the actual model is significant, other than the use of the goodness of fit statistic. There are complex methods that have been developed using spherical statistics to overcome this, but these require an understanding of advanced Banach Algebra in functional analysis and have not been included within the R ppr function.

- One can easily overfit or overexplain the data. See Venables and Ripley for a further discussion.

- The model can be *too flexible*, which can make interpretation of the PPR model difficult. Again, see Venables and Ripley.

Techniques and Diagnostics for PPR

The procedure when using the R ppr algorithm is as follows:

First, one specifies that M should range between M_{MIN}=1 and some positive integer M_{MAX} . The ppr algorithm then creates a PPR model for each M from M_{MAX} to M_{MIN} in a descending fashion, and at the same time produces a goodness of fit statistic for each value of M. Scanning this list of goodness of fit values should display a local minimum. If this local minimum is at M_{MAX} one should reprocess the experiment with a larger M_{MAX}. Once one determines the local minimum, say *s*, reset $M_{MIN} = s$ and reprocess the ppr algorithm with the same M_{MAX} as before. The resultant model arising from the backward iteration from M_{MAX} to M_{MIN} will then be the best PPR model.

Two other components that are implemented in ppr are the concept of "bass" and "optlevel." "Bass" is Friedman's super smoother bass tone control[11] that is used with automatic span selection. It is used in ppr to smooth the results. The range of values allowed with this component is from 0 to 10. To increase smoothing within the data, increase this value. The default is 0, and this setting gives the best fit to the underlying data. Bass is similar to the *h* smoothness parameter used within the Whitaker-Henderson graduation formula.

Two other components that are implemented in ppr are the concept of "bass" and "optlevel." "Bass" is Friedman's super smoother bass tone control that is used with automatic span selection.

"Optlevel" is an integer from zero to three, which determines the optimization thoroughness. The best models usually are obtained if this is set to three. At level zero, the ridge functions are not refitted. At level one, the projection directions are not refitted, but the ridge functions and the regression coefficients are. Levels two and three refit everything, but level three takes pains to re-balance each regressors' contribution at each step and so reduces the chance of converging to a saddle point in the sum of squares.

One diagnostic aid in PPR model building is to plot the ridge functions. If these ridge functions are very noisy or discontinuous, you should expect that the resultant PPR model will behave oddly.

Another effective diagnostic aid is to both plot the fitted $\hat{Y}$ against the actual Y and do a simple linear regression of Y against $\hat{Y}$, assuming no intercept. The scatterplot should display symmettry around the 45 degree line and the coefficient of the regression should be approximately one. These two diagnostics will indicate how well the PPR model will perform as a predictive model.

Note: A PPR model does not extrapolate outside of the sample data. So, frequently the resultant fitted values from PPR model will hit a maximum value and will not grow any larger no matter how one manipulates the predictors. This is not the case for linear regression models, where there are no natural limits placed on how one sets any respective X_i. However, one may revise the prediction object to conduct extrapolations. However, one must first feel comfortable with the continuity of the separate ridge

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functions. If these functions are very noisy or appear not to be differentiable, you might want to avoid all extrapolation.

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A Quarter Where "Nothing" Happened

by Henry Siegel

I finished my column for the March issue of the *Financial Reporter* and was concerned that I wouldn't be able to write a column for this issue because not much had been scheduled for the first quarter on the insurance project. I needn't have worried; stuff came up—small stuff like the future of FASB. But more on that later.

January

It was a slow start. There was a Financial Instruments Working Group (FIWG) meeting on January 18. A key question discussed was whether insurance is a financial instrument. If yes, is it a derivative? Some think so! The argument then proceeds: If that's all insurance is, why do we need special accounting for it? Since there are no insurance representatives on FIWG, the discussion of this issue was inconclusive. But the comparison came up again at the February IASB meeting.

The FIWG meeting also covered a discussion paper that the IASB issued later, in March, on how to simplify accounting for financial instruments. The paper is called *Reducing Complexity in Reporting Financial Instruments*, and runs 96 pages (including appendices).

Basically, it says that there are people who find the current accounting for financial instruments too complicated. There are options to use held to maturity, available for sale, trading (or fair value through the income statement) and a number of additional special methods such as for insurance contracts.

The IASB has concluded that a long-term solution is to hold everything at fair value. The logic for this can be simplified as follows: there are some things that clearly need to be held at fair value—derivatives and common stock are two that few would argue with. If that's the case, and you want a single measurement attribute to reduce complexity, then fair value is where you need to go. In the months to come, as we discuss insurance accounting, it's useful to keep this predilection in mind in thinking about the Board's positions. On the other hand, the Board is not unanimous on this position so commenting on whether a fair value approach makes sense now is very timely.

February

All this was prologue to February's IASB meeting. At this meeting, Peter Clark, the project leader for the insurance project, presented his analysis of the comments on the IASB's *Discussion Paper on Insurance Contracts* (the DP). (All the discussion papers for the meeting can be found on the IASB Web site, *http://www.iasb.org/Meetings/IASB+Board+Meeting+19+February+2008.htm*.) If you read my comments from last month, you already know what he said and I won't repeat it all here. Suffice it to say that the comments were not very supportive of most of the DP's tentative conclusions.

A lively discussion ensued at the board meeting. Clark presented three papers for discussion. The first was a project planning paper. It contained a plan for discussing the various issues contained in the DP at upcoming board meetings. The plan called for completing the task in eight "meetings" but some board members observed that some of those meetings would need to be several weeks long in order to reach conclusions.

The most interesting part of the project schedule is that it did not state clearly that the IASB would wait for FASB to join in the project before re-deliberating the issues. This was surprising since almost everyone I have spoken to has assumed all along that the two boards would work together on the next phase of the project. Clark later stated that it was not unprecedented for one board to move ahead on

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a proposal and the other board would then catch up. There would be more on the FASB to follow later in the quarter.

The paper also noted that it didn't provide any time for field testing of proposals. This was also a surprise since almost everyone who commented on the DP called for careful testing of ideas. It was clear that the IASB staff did not want to do any testing, viewing it as unnecessary. Whether anything will eventually be done remains to be seen. In the meanwhile, the SOA research project on the effects of the DP should be seen as the first example of such testing.

The second paper discussed was the concept of the "contract as a whole." Several commentators on the DP stated that the insurance contract should be evaluated as a whole rather than broken up into pieces with certain premiums being recognized or certain parts being valued separately. In part, these comments were alternatives to the Board's proposal to only recognize renewal premium when it was required for insurability and to only recognize dividend payments when they were a legal obligation. After a brief discussion, the staff agreed to study the idea further.

The third paper dealt with the measurement attribute of "settlement value." Again, many of the commentators had suggested replacing current exit value with settlement value as the measurement attribute for insurance contracts. This proposal dealt with perceived flaws in the DP, particularly the requirement to use market-driven assumptions where none exist. I'll have more on this paper in a moment.

March

The most interesting meeting this month was of the Financial Accounting Standards Advisory Council (FASAC). This group provides advice to FASB on a broad range of activities.

At the meeting there was considerable discussion of the sub-prime crisis. Eventually discussion moved to how convergence between US GAAP and IFRS would work. An SEC representative reported that in February the chairman of the SEC, Christopher Cox, had directed staff to develop a plan on how to transition U.S. entities to IFRS. This could be done either as an option, as proposed in a paper issued by the SEC in February, or as a requirement as of a specific date (the Big Bang method). The Big Bang method would be similar to the approach taken by Europe in 2005 when all public companies were required to report on IFRS. Before setting a date for the Big Bang, the SEC will need to decide if certain progress on convergence between IFRS and US GAAP is required first.

The bottom line is that FASB is going to largely disappear within the next five years unless a major change of direction takes place. Of course, no one knows whether the Presidential Election will cause a change in the SEC's direction, but by the time it happens, there may be no turning back.

The final event of the first quarter actually took place April 1 and 2. This was a meeting of the IASB's Insurance Working Group. For a report on the discussions at that meeting, see the Breaking News section. However, the discussion papers for the meeting are of interest.

One of the discussion papers concerned the same settlement value issue that was discussed at the February board meeting. Again, the goal here is to see if there is a better phrase for describing the value of the liability than the current exit value measurement attribute that is in the DP, FAS 157 and Solvency II. The concern expressed by those who commented was that current exit value was impossible to calibrate to the real market when there are no real transfers of policies between companies. Reinsurance and acquisitions don't really apply since they are all one-off negotiations and, further, they typically will use expense assumptions that are not typical of a going concern.

A key concern, however, is that the term "settlement value" may refer, for some people, to a deal in which the liability is specially settled, such as for a lawsuit, and not settled in the normal course of business, which is the intent of the commentators. Accordingly, a new term may be needed to describe this measurement attribute.

The IAA has also just, at this writing, published its *Second Exposure Draft on Measurement of Liabilities for Insurance Contracts: Current Estimates and Risk Margins*. This paper may provide important input into the process for setting risk margins for insurance liabilities. The Academy will again be commenting on this paper.

The IAA also published two preliminary exposure drafts of potential IAA standards regarding International Financial Reporting Standards: Business Combinations and Disclosure of Information about

Insurance Risk. Neither, at first reading, appears controversial. It is expected they will be approved at the upcoming IAA Council and Committee meeting June 11–14 in Quebec City.

The upcoming quarter promises to be even more interesting. Not only will the Insurance Working Group be meeting, but in May there will be the FASB Insurance Forum. This is an annual meeting between representatives of the industry and FASB. Our hope is that we will get a better understanding at that meeting of what FASB's plan for the insurance project is likely to be.

As noted above, the IAA will have its twice-annual committee meetings in Quebec City in June, and there will also be a number of informational meetings on international accounting and solvency sponsored by accounting and consulting firms as well as the Geneva Association.

So stay tuned. Remember…

Insurance accounting is too important to be left to the accountants!

* * *

Breaking News—Insurance Working Group

The Insurance Working Group (IWG) meeting on April 1–2 was most notable for the comments made by the IASB members. In particular, Sir David Tweedie, chair of the IASB, stated that two things won't happen. One—there will be no deferred profit liability on the balance sheet. (This was the CFO Forum's proposal). Two—no situation where changes in liability won't go into income. (This can cause a problem where assets are held at available for sale.) He also stated that since a day 1 profit isn't allowed in IAS 39, it would be permitted in insurance accounting only if you have information from other transactions that would justify it. Of course, Sir David is speaking only for himself; nevertheless his comments do have considerable weight.

Otherwise, there was considerable discussion on the concept of a settlement value as proposed by various commentators on the DP as well as on the general topic of risk margins. The FASB staff representative, Jeffrey Cropsey, was asked if FASB would be joining the project, but he was unable to give an answer since FASB hasn't discussed it yet.

Three new members of the IWG from the user community—William Witt (FCAS) of Morgan Stanley; Maurizio Lualdi of Capital Research Global Investors; and Andrew Crean of Citigroup Global Markets—made presentations on their respective views of insurance accounting. For those interested in communicating better with their analysts, I recommend their presentations (found on the IASB Web site) for reading.

Another IWG meeting was scheduled for September 9–10.

Revisiting FAS 97's Management Potential

by Steve Malerich

In the 1999 *Financial Reporting Section Monograph* article, "Unlocking FAS 97's Management Potential," Bruce R. Darling presented ways to understand and explain the effects of Statement of Financial Accounting Standard (FAS) 97.

Since 1999, we've seen the adoption of AICPA Statement of Position (SOP) 03-1, which altered the way earnings emerge under certain circumstances. We've also seen the enactment of Sarbanes-Oxley (SOX) control requirements and are seeing increased interest in sensitivities to variances in current experience and to possible changes in assumptions.

New Problems

SOP 03-1 complicates the analysis from what was presented in 1999. The formulas given then may be inadequate if a cohort requires accruing and amortizing costs against assessments. If we are to explain current results, we need to know the combined effects.

SOX also challenges the utility of the 1999 article. Darling's focus was on understanding FAS 97 effects after they happen. SOX requires testing of results against various controls to ensure that they are reasonable.

Management and shareholder interest in sensitivities can be satisfied by inserting hypothetical variances and assumption changes into our existing valuation, but at a cost. As we add sensitivities, the cost compounds.

There are also situations when updates to amortization rates are performed less frequently than financial reporting. In these situations, we estimate the effects of variances from expected experience. The better the estimation, the lower the earnings volatility we'll see from the less frequent true-up or unlocking.

A New Solution

It is possible to satisfy many of these needs and wants without running new models or inserting hypothetical variances into our valuation systems. Some situations may still require new models, but the results need not be inserted into the valuation system. To do this, we must capture sufficient information from our existing valuation. In this article, we'll see what's needed, how to measure the effects, what the measures mean and some examples.

We apply, here, the concepts presented by Mike A. Lesar in the 2004 *Financial Reporter* article, "Resolution of Circularity Issues in SOP 03-1." Tentative gross profits and tentative assessments exclude changes in the mortality and unearned revenue reserves, respectively. And, interest on these reserves is excluded from final gross profits and assessments.

In this article, we do not deal with constraints, such as a floor on the mortality reserve or a cap on the DAC asset. When breached, such constraints would alter results.

What's Needed

The following values are already calculated in the valuation of FAS 97 assets and liabilities. For this article, I've treated any deferrable sales inducements as a part of deferred acquisition costs. This does not impair our ability to calculate the net effect of an assumption change or a variance. All of these are measured before any current variance or change in assumption:

^{c}k = the expense amortization rate

^{r}k = the revenue amortization rate

b = the mortality benefit accrual rate (the benefit ratio)

DAC = deferred acquisition cost asset

URR = unearned revenue reserve

MR = mortality reserve

The following amounts are easily calculated from the existing valuation, again before any current variance or assumption change.

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A( ) = accumulated value, at the valuation date, accrued at the valuation interest rate:

A(GP) = accumulated value of actual *tentative* gross profits

A(TA) = accumulated value of actual *tentative* assessments

A(DE) = accumulated value of actual deferred expenses

A(DR) = accumulated value of actual deferred revenue

A(CM) = accumulated value of actual deferred mortality costs

P( ) = present value, at the valuation date, discounted at the valuation interest rate:

P(GP) = present value of expected *tentative* gross profits

P(TA) = present value of expected *tentative* assessments

P(DE) = present value of expected deferrable expenses

P(DR) = present value of expected deferrable revenue

P(CM) = present value of expected deferrable mortality costs

k = the net amortization rate (the net k-factor)
$= {}^{c}k - {}^{r}k$

F( ) = future proportion of gross profits and assessments:

$$F(GP) = \frac{P(GP) + MR}{A(GP) + P(GP)}$$

$$F(TA) = \frac{P(TA) + URR}{A(TA) + P(TA)}$$

H( ) = historic proportion of gross profits and assessments:

$$H(GP) = \frac{A(GP) - MR}{A(GP) + P(GP)} = 1 - F(GP)$$

$$H(TA) = \frac{A(TA) - URR}{A(TA) + P(TA)} = 1 - F(TA)$$

Calculating Marginal Effects

From the above values, we can calculate the marginal effects of a current variance and of a change in present value. We define these as:

m = marginal effect of a current variance on *net amortization*

p = marginal effect of a present value change on the *net intangible asset*

Note the different focus—m on income and p on the balance sheet. Other than the convenience of making both positive, this is consistent with a common focus on income during a regular reporting period and on the balance sheet during unlocking.

If there is a mortality reserve, the marginal effects depend on the type of variance or assumption change. Three possible situations are changes in deferrable mortality costs, in other costs and in tentative assessments. Since current variances can also affect what's left in force, it also helps to look at a proportionate change in all present values.

For a change in deferrable mortality costs:

(1)
$${}^{1}m = \frac{F(GP) \times (k + {}^{r}k \times b) + F(TA) \times (1 - k)}{1 + {}^{r}k \times b}$$

(2)
$${}^{1}p = \frac{H(GP) \times (k + {}^{r}k \times b) + H(TA) \times (1 - k)}{1 + {}^{r}k \times b}$$

For a change in other costs:

(3)
$${}^{2}m = \frac{F(GP) \times (k + {}^{r}k \times b)}{1 + {}^{r}k \times b}$$

(4)
$${}^{2}p = \frac{H(GP) \times (k + {}^{r}k \times b)}{1 + {}^{r}k \times b}$$

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For a change in tentative assessments:
(5)

$$^{3}m = \frac{F(GP)\times(k+{}^{r}k\times b)+F(TA)\times b\times(1-k)}{1+{}^{r}k\times b}$$

(6)

$$^{3}p = \frac{H(GP)\times(k+{}^{r}k\times b)+H(TA)\times b\times(1-k)}{1+{}^{r}k\times b}$$

For a change affecting everything proportionately:
(7)

$$^{4}p = \frac{\begin{array}{l}H(GP)\times(DAC-URR-k\times MR)\\ +H(GP)\times b\times\{{}^{r}k\times[P(GP)-P(DE)]-P(DR)\times(1-{}^{e}k)\}\\ -H(TA)\times(1-k)\times(MR+b\times URR)\end{array}}{P(GP)\times(1+{}^{r}k\times b)}$$

If there is no deferrable revenue, the same formulas apply, but deferrable revenue and the revenue amortization rate are both zero. Substituting into formula (7), for example, leaves:

$$^{4}p = \frac{H(GP)\times(DAC-k\times MR)-H(TA)\times(1-k)\times MR}{P(GP)}$$

The same formulas also apply if mortality costs are not deferrable. Here, the first situation doesn't exist. Deferrable mortality is zero by definition, so there can be no variance or change in deferrable mortality costs. Putting a benefit ratio of zero into formula (5), for example, leaves:

$$^{3}m = F(GP)\times k$$

Understanding the Results

Even a glance at the marginal rates shows a clear symmetry between m and p. For each type of change, the formulas are identical except that m is a function of future ratios F(GP) and F(TA), and p is a function of historic ratios H(GP) and H(TA). This symmetry is more than just a nice coincidence.

If we add m and p, we get formulas that are independent of time:

$$^{1}m+{}^{1}p = 1$$

$$^{2}m+{}^{2}p = \frac{k+{}^{r}k\times b}{1+{}^{r}k\times b}$$

$$^{3}m+{}^{3}p = \frac{k+{}^{r}k\times b+b\times(1-k)}{1+{}^{r}k\times b}$$

Each is an average net amortization rate, including the mortality reserve and applicable to the three different components of tentative gross profits: 1) deferrable mortality; 2) other costs; and 3) tentative assessments.

In practice, we may want to express amortization in two pieces. The first piece, average amortization against actual gross profits, might already be built into routine reporting processes. The second piece is a true-up associated with any variance from expected gross profits. Even before revised amortization rates are known, the true-up can be estimated as the product of the variances and the difference between average and marginal rates. Given the symmetry, we know that difference is equal to p.

Now let's look at the average amortization rates to see what else they tell us.

In retrospect, $^{1}m + {}^{1}p = 1$ seems obvious. It tells us that deferrable mortality costs have no effect on current earnings as long as they remain as expected.

The average amortization rate for other costs is equal to or a little greater than the net k-factor. How much greater depends on the significance of deferrable revenue. This, too, is intuitive. We know that other costs affect the mortality reserve only as a residual of their effect on unearned revenue.

Average amortization for assessments is more complex, but still understandable. Their effect on DAC and unearned revenue is muted by their effect on the mortality reserve, but their total effect is greater because it includes the mortality reserve.

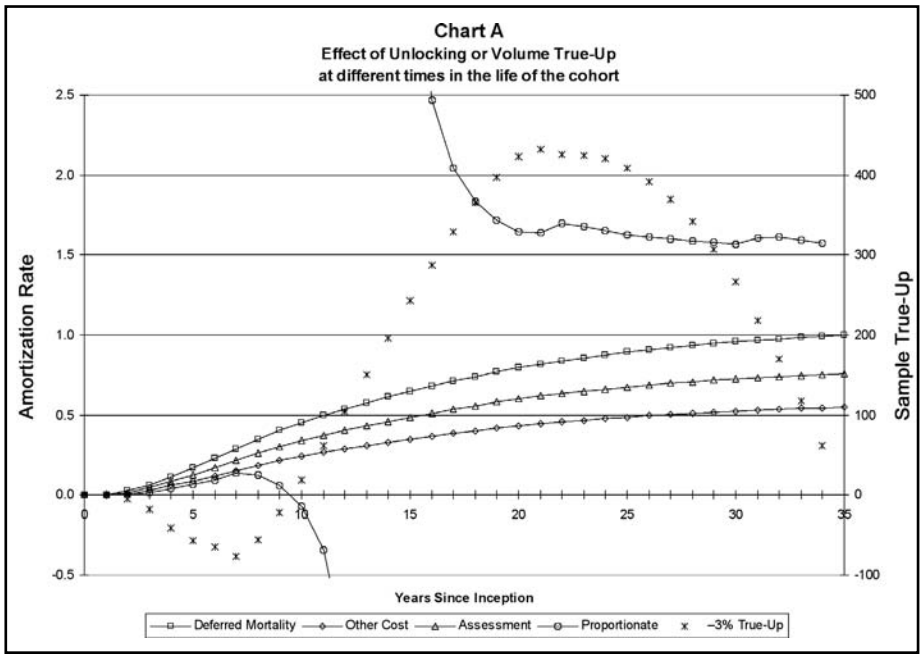
Next, a look at the two pieces, m and p, helps us to understand how time alters the effect of variances

and assumption changes. Early in the life of a cohort, a variance in deferrable mortality cost has almost no effect on current earnings. The variance is almost entirely offset by a change in the benefit reserve. Offsets to other cost and assessment variances are also most significant early in the life of a cohort. The effect is lowest for an other cost variance, where most of the effect is in amortization, with a small effect on the mortality reserve. The offset for an assessment variance lies in between—it has a significant effect on the mortality reserve, but not dollar-for-dollar. As time passes, history grows and the offset to a variance declines until, late in the life of the cohort, there is little offset to a current variance.

Similarly, assumption changes have little effect on earnings early in the life of a cohort. As time passes, a growing share of the change in expected gross profits passes through into current earnings. For a change in a deferrable mortality assumption, the earnings effect eventually approaches 100 percent of the present value change. The effect of a change in other costs approaches something a little greater than the net k-factor times the present value change. And, the effect of a change in assessments approaches something a little greater than the present value change times the sum of the net k-factor and the portion of the benefit ratio not offset by amortization.

Finally, a proportionate change in all expected values does not lend to such a simple understanding as the other changes. However, we can observe that this marginal effect, in contrast to the others, is dampened by the mortality reserve, not magnified. For example, a lower than expected volume would mean a write-off of DAC because expected gross profits are now lower. The same condition would also result in a lower present value of future mortality losses. In effect, the reduction in volume creates a redundancy in the reserve, which is released at the same time as the DAC write-off.

Chart A shows the progression of marginal rates 1p to 4p over the life of a sample cohort. For mortality, other costs and assessments, we can see the smooth progression from zero to the average net amortization rates. The proportionate change needs a little more thought.



In this example, the marginal rate for a proportionate change starts positive but smaller than the other rates. It declines after seven years, falling below zero when the marginal effect on MR exceeds the net effect on DAC and URR. For the sample cohort, expected negative margins on mortality eventually lead to negative tentative gross profits. As the present value of tentative gross profits approaches zero, the marginal effect approaches negative infinity. Once the present value turns negative, the marginal effect changes sign, jumping to positive infinity but then rapidly declines as the present value moves further into the negative range.

The net effect of this discontinuity is not as confusing as we might guess from the infinities. Again looking at Chart A, we can see that the dollar value of a hypothetical true-up forms a smooth curve through the life of the cohort.

Improving the Estimate

Although these are all precise marginal effects, they become approximations in any practical application. Four key reasons are: (1) variances do not occur precisely on a valuation date; (2) the effects are not linear; (3) variances and assumption changes have secondary effects; and (4) multiple variances and assumption changes occur simultaneously.

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In contrast, the effect of a lapse variance on expected gross profits may be as significant as its effect on current gross profits.

Timing

Addressing the first difference is simple; we already know how to account for time. For example, if my valuation assumes simple interest for fractional periods and that gross profits occur mid-quarter, my adjustment for a current quarter variance is to multiply by:

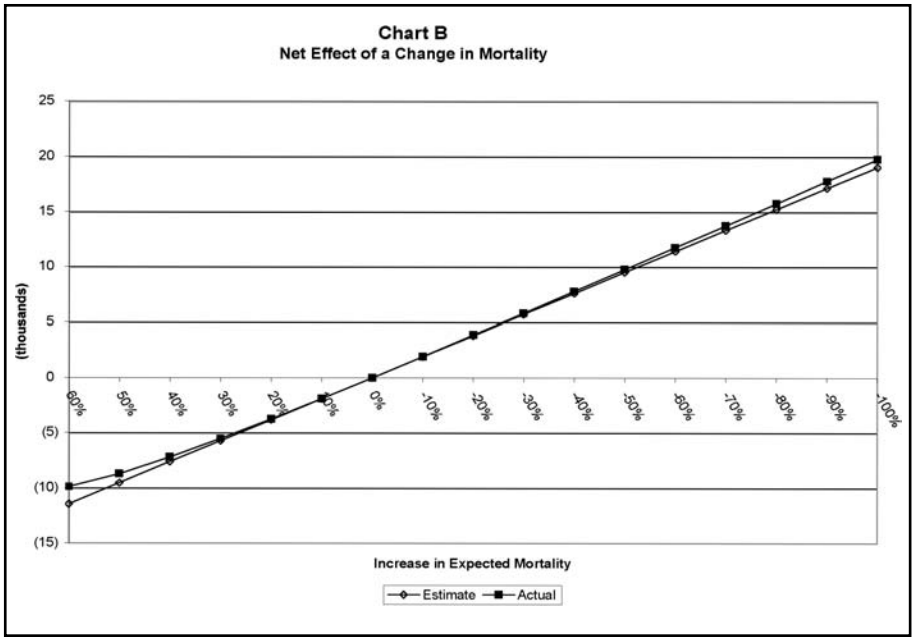
1+⅛×valuation interest rate

Nonlinearity

If we think of net effects as a function of the change in tentative gross profits, we can envision a curve with the gross profits change on the X-axis and the net effect on the Y-axis. Formulas (1) through (7) all represent the exact slope of the curve at the point where X equals zero.

Using these formulas, the net effect is approximated by the product of the factor and the change in gross profits. The difference between this and the actual effect is the difference between the tangent of the curve and the curve itself. For most effects, this will be a suitable approximation.

Chart B compares the approximate formula with the exact formula over a range of possible changes in the mortality assumption of our sample cohort, at a particular point in time.



The range in this chart is broad—from 60 percent increase in mortality to 100 percent decrease. These are extremes for this cohort. A little past 60 percent increase, the cohort would go into loss recognition. Anything greater than 100 percent decrease would imply negative mortality rates. As you can see here, the gap between the two curves is hardly noticeable until we approach the extremes. Even at the extremes, it remains small.

When greater precision is needed, refer to the appendix for the more complex formulas that account for this effect. For example, if SOX controls are based on marginal rates, a large variance or assumption change might trigger an exception to the control. The exact formulas can be used to determine if the observed effect is appropriate for this extreme event.

Secondary Effects

Secondary effects can usually be identified as significant or insignificant without any mathematical analysis.

For example, a mortality variance will have an effect on expected gross profits. That effect, however, should be very small compared to the variance itself and can normally be ignored without concern.

In contrast, the effect of a lapse variance on expected gross profits may be as significant as its effect on current gross profits.

When a secondary effect cannot be ignored, it may be practical to estimate its effect on gross profits and apply the appropriate marginal rate.

Whether secondary effects are ignored or approximated, they will cause these calculations to result in approximations, even if exact adjustments are made for timing and nonlinearity.

Simultaneous Events

Simultaneous events do not introduce any new error into the calculations. They do present the problem, however, of attributing a total effect to each of the separate events.

The traditional approach to handling simultaneous assumption changes is to make one change at a time and revalue the asset after each change. The same

approach can be used here, except that each step changes the most recent valuation. Recalculating marginal rates after each step would add significantly to this effort.

A problem with the traditional approach is that the effect of each change depends on the order the changes are made. With these formulas, that can be avoided at the same time we simplify the effort. To do this, we apply the formulas using the results from the most recent valuation preceding the assumption changes.

When considering multiple variances in actual experience, it is not possible to determine the order in which they occurred. With this technique, that is not necessary. As with multiple assumption changes, these formulas can be applied independently to each variance.

In both situations, there will be an unexplained residual difference, but it will normally be small enough for crude allocation.

Examples

These examples are from a flexible premium universal life contract. It has front end loads and is expected to have positive mortality margins followed by negative mortality margins. In each case, I assume the changes occur exactly on the valuation date.

The following amounts are taken from the most recent valuation:

$^{c}k = 1.015$

$^{r}k = 0.587$

b = 0.461

DAC = 28,596

URR = 6,013

MR = 12,365

A(GP) = 23,721

A(TA) = 56,657

A(DE) = 40,120

A(DR) = 12,676

A(CM) = 11,004

P(GP) = 19,029

P(TA) = 115,346

P(DE) = 3,265

P(DR) = 12,406

P(CM) = 68,366

From these, we can calculate:

k = 1.015–0.587 = 0.428

F(GP) = [19,029+12,365]÷[23,721+19,029] = 0.734

F(TA) = [115,346+6,013]÷[56,657+115,346] = 0.706

H(GP) = 1–0.734 = 0.266

H(TA) = 1–0.706 = 0.294

Asset Default Variance

Asset default is an assessment. It has no direct effect on any other component of gross profits or on future gross profits. Any residual effect from replacing the asset with something that yields a different rate of return is assumed to be insignificant.

We'll estimate the offset to an additional $100 of asset default over the expected level.

This is a –100 variance in the current assessment. The marginal effect of a current assessment variance is:

$^{3}m =$
$[0.734\times(0.428+0.587\times0.461)+0.706\times$
$0.461\times(1–0.428)]\div(1+0.587\times0.461) = 0.550$

Current amortization on a –100 default variance is then $–100\times0.550 = –55$. Subtracting this from the –100 variance, we see a net effect on earnings of –45.

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To estimate the first effect, we start with the expected surrender gain in the next year.

Mortality Assumption Change

We want to test the sensitivity of our valuation to a change in the mortality assumption. This would be a change in the expected deferrable cost of mortality. Such a change would affect the projection of insurance in force and, consequently, expected gross profits in general. That effect, however, is assumed to be insignificant compared to the direct effect on mortality costs.

We'll estimate the current effect of a 10 percent increase in the assumed mortality rates.

We've already captured the present value of the expected cost of mortality, P(CM) = 68,366. A 10 percent increase would be a –6,837 change in the present value of gross profits. The marginal effect of a change in the mortality assumption is:

$^{1}p =$
$[0.266\times(0.428+0.587\times0.461)+0.294\times(1–0.428)]\div(1+0.587\times0.461) = 0.279$

The net effect of a 10 percent increase in the mortality assumption is then $–6,837\times0.279 = –1,905$.

Lapse Variance

A current lapse variance has two significant effects: (1) an immediate variance in the surrender gain; and (2) a change in the amount of business remaining in force. For this test, we assume a one-year, 50 percent shock to lapse rates.

Current Variance

To estimate the first effect, we start with the expected surrender gain in the next year. Returning to my most recent valuation, I see an expected surrender gain of 1,370. A 50 percent increase would then be 685 of assessment variance. The marginal effect of a current assessment variance is, again:

$^{3}m =$
$[0.734\times(0.428+0.587\times0.461)+0.706\times0.461\times(1–0.428)]\div(1+0.587\times0.461) = 0.550$

The current offset to a 50 percent shock lapse is then $685\times0.550 = 377$.

Present Value Effect

Returning to my existing valuation, I estimate that this shock would reduce the amount of business remaining in force by 3 percent. I assume that all components of expected gross profits are reduced proportionately. With the present value of expected tentative gross profits at 19,029, this would be a –571 change in expected gross profits.

The marginal effect of such a change is:

$^{4}p =$
$\{0.266\times(28,596–6,013–0.428\times12,365)+0.266\times0.461\times[0.587\times(19,029–3,265)–12,406\times(1–1.015)]–0.294\times(1–0.428)\times(12,365+0.461\times6,013)\}\div[19,029\times(1+0.587\times0.461)] = 0.132$

The net secondary effect of the shock lapse is then $–571\times0.132 = –76$.

Altogether, the shock lapse results in an immediate gain of 685, an immediate amortization of 377 and a present value adjustment of –76, for a net gain of 232.

Expense Assumption Change

We also want to test the sensitivity of our valuation to a change in the maintenance expense assumption. This would be a change in expected other costs.

We'll estimate the current effect of a 5 percent increase in the maintenance expense assumption.

We return again to our current valuation, to find the present value of a 5 percent increase in expected maintenance expenses equal to –518. The marginal effect of a change in an other cost assumption is:

$^{2}p =$
$0.266\times(0.428+0.587\times0.461)\div(1+0.587\times0.461) = 0.146$

The net effect of a 5 percent maintenance expense assumption change is then $–518\times0.146 = –76$.

Variance Analysis

Our final example looks at variances in current income and their effect on amortization. The table, to the right, shows only those components that affect gross profits. Other variances would not affect amortization.

	Earnings Variance	Marginal Factor		Amort-ization	Net Variance
Mortality charges	–189	^{3}m	0.550	–104	–85
Surrender charges	–100	^{3}m	0.550	–55	–45
Policy charges	–198	^{3}m	0.550	–109	–89
Gross investment income	168	^{3}m	0.550	93	76
Revenues	**–319**			**–175**	**–143**
Interest credited	12	^{3}m	0.550	7	5
Assessments	**–331**			**–182**	**–149**
Death benefits	27	^{1}m	0.721	20	8
Commissions not deferred	56	^{2}m	0.404	23	34
Expenses not deferred	–6	^{2}m	0.404	–2	–4
Premium taxes	–0	^{2}m	0.404	–0	–0
Gross profit	**–408**			**–222**	**–186**
Volume in force	+0.9%				
ΔGP = 167		^{4}p	0.132	–22	22
Total	**–408**			**–244**	**–164**

Appendix—Adjusting for Nonlinearity

Where greater precision is needed or desired, our formulas can reflect nonlinearity. To precisely measure the effects of simultaneous changes, we would have to apply these formulas step-by-step, adjusting A( ) and P( ) after each step, as is often done in unlocking of multiple assumptions. But even here, such a precise application should not be necessary for most events.

To simplify these formulas, it helps to define a new function, Y( ), which is the ratio of a new total amount to the previous total amount, Y( ) = [A( ) + P( ) + Δ] ÷ [A( ) + P( )] = 1 + Δ ÷ [A( ) + P( )], where Δ is the change in a total amount—either a current variance from expected or a change in the present value. For example:

$$Y(TA) = 1 + \frac{\Delta TA}{A(TA) + P(TA)}$$

Then:

(1E)

$$^{1}m = \frac{F(GP) \times [k + {}^{r}k \times b \times Y(CM)] + F(TA) \times [Y(GP) - k]}{Y(GP) + {}^{r}k \times b \times Y(CM)}$$

(2E)

$$^{1}p = \frac{H(GP) \times [k + {}^{r}k \times b \times Y(CM)] + H(TA) \times [Y(GP) - k]}{Y(GP) + {}^{r}k \times b \times Y(CM)}$$

(3E)

$$^{2}m = \frac{F(GP) \times (k + {}^{r}k \times b)}{Y(GP) + {}^{r}k \times b}$$

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(4E)

$$^{2}p = \frac{H(GP)\times(k+{}^{r}k\times b)}{Y(GP)+{}^{r}k\times b}$$

(5E)

$$^{3}m = \frac{F(GP)\times[k\times Y(TA)+{}^{r}k\times b]+F(TA)\times b\times[Y(GP)-k]}{Y(GP)\times Y(TA)+{}^{r}k\times b}$$

(6E)

$$^{3}p = \frac{H(GP)\times[k\times Y(TA)+{}^{r}k\times b]+H(TA)\times b\times[Y(GP)-k]}{Y(GP)\times Y(TA)+{}^{r}k\times b}$$

(7E)

$$^{4}p = \frac{\begin{array}{l}H(GP)\times Y(TA)\times(DAC-URR-k\times MR)\\ +H(GP)\times b\times Y(CM)\times\{{}^{r}k\times[P(GP)-P(DE)]-P(DR)\times(1-{}^{e}k)\}\\ -H(TA)\times[Y(GP)-{}^{e}k\times Y(DE)+{}^{r}k\times Y(DR)]\times(MR+b\times URR)\end{array}}{P(GP)\times[Y(GP)\times Y(TA)+{}^{r}k\times Y(DR)\times b\times Y(CM)]}$$

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