Session 7 PD
Pricing Risk Management

Society of Actuaries Spring Meeting
Washington, DC
May 29, 2003
10:30 AM – 12 PM

Session 7 PD
Pricing Risk Management

Keith A. Dall
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Session 7 PD
Pricing Risk Management

RMTF Reflecting Risk in Pricing Survey

Todd Henderson

May 29, 2003


Western & Southern Financial Group

Reflecting Risk In Pricing Survey

- Fall 2002
- Determine Prevalence of Practices
  - Pricing Measures
  - Provisions for Risk
- Investment and ILA Product Development Sections
- Not yet published

Reflecting Risk In Pricing Survey

Survey Response

- 275 Responses
  - 235 US, 26 Canada
    - Australia, Asia, Europe, South America
- Broad Range of Employers and Practice Areas
  - Large, Medium and Small Companies
  - Mostly Life Insurers and Consultants
  - Mostly Individual Life, Health and Annuity
  - Mostly Pricing, Risk Management, Valuation

Reflecting Risk In Pricing Survey

Profit Measures

- Most use multiple profit measures
- Top responses were RO(I, E, C, A, etc) and Margin
  - Life – 35%, 20% (15% IRR)
  - Annuity – 50%, 15% (15% IRR)
  - A&H – 35%, 30% (15% Value Added)
  - Other – 45%, 25% (15% Value Added)
- Embedded Value
  - More important for Large Companies

Reflecting Risk In Pricing Survey

Reflecting Risk In General

- Capital Allocation
- Assumption Stress Testing
- Risk Adjusted Profit Target
- Stochastic Scenario Analysis
- Provision for Adverse Deviation

Reflecting Risk In Pricing Survey

Capital Allocation

- 55% use multiple of regulatory formula
- 25% use internal formula

Assumption Stress Testing

- 60% base stress testing parameters on judgment
- 20% develop confidence limits
- 20% look at historical worst case

Reflecting Risk In Pricing Survey

Risk Adjusted Profit Target

- 65% adjust target based on judgment
- 35% adjust target based on formula

Provisions for Adverse Deviation

- 50% base provision on recent historical experience
- 25% use an industry standard

Reflecting Risk In Pricing Survey

Stochastic Scenario Analysis

- 30% use percentiles
- 15% use mean-variance analysis
- 15% look at conditional tail expectation
- 15% analyze the problem scenarios

Reflecting Risk In Pricing Survey

Asset Default Risk
- 60% use a charge to yield
- 75% guided by investment area
- 50% use an internal model

Interest Rate and Equity Volatility Risk
- 30 % using stochastic scenario analysis
  - Historical, mean reversion
- 25 % stress test assumptions

Reflecting Risk In Pricing Survey

Adverse Claim Deviation Risk
- 40% stress test assumptions
- 25% use assumption PADs
- 10% use stochastic scenario analysis

Customer/Agent Behavior Risk
- 40% stress test assumptions
- 25% use a dynamic lapse formula

Reflecting Risk In Pricing Survey

Expense Risk

- 45% stress test assumptions
- 25% use assumption PADs
- 20% model inflation

Reflecting Risk In Pricing Survey

Risk Covariance

- 50% do no explicit additional work
- 15% have covariance component in capital formula
- 15% perform a multi-risk stochastic analysis
- 15% cited interest rate risk and dynamic lapses

Reflecting Risk In Pricing Survey

General Observation

- Asset related risks
  - default, volatility
  - have a higher tendency to be modeled
- Liability related risks
  - mortality, morbidity, lapse, expense
  - are more often stress tested or PADed
  - heavier reliance on judgment

Session 7 PD
Pricing Risk Management

Risk Management While Pricing Annuity Products

Douglas L. Robbins

May 29, 2003

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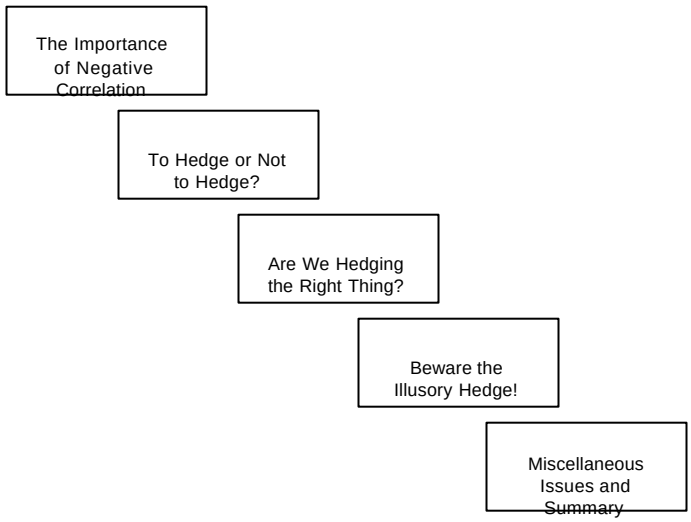

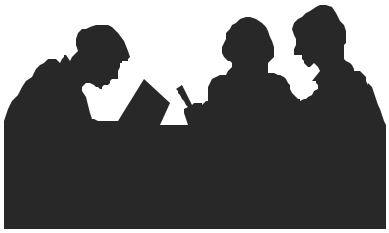

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- The Importance of Negative Correlation
- To Hedge or Not to Hedge?
- Are We Hedging the Right Thing?
- Beware the Illusory Hedge!
- Miscellaneous Issues and Summary

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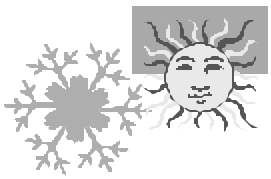
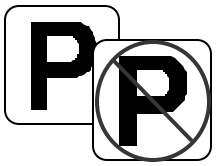
A Discussion of Opposites

- Risk management typically involves attempting to control volatility. “Pricing risk management” would imply that that volatility is of profit measures.
- This involves efficiently combining elements with opposing characteristics. The central element of this is negative correlation.
- Since deferred annuities are investment-oriented products, this next negative correlation example will focus on investment fund choices.





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Importance of Negative Correlation: Example #1

- Say you buy a 50/50 mix of two mutual funds, with expected returns of 6% and 10%. Your expected total return is then 8%, assuming a time horizon of a year. Say the annual volatility of the first fund is 10%, and that of the second is 20%.
- If they are 100% positively correlated, the volatility of a 50/50 mix will be 0.5 * 10% + 0.5 * 20% = 15%.
- If they are independent, the volatility of a 50/50 mix will be ((0.5 * 10%)^2 + (0.5 * 20%)^2)^0.5 = 11.2%, a pretty nice savings in volatility.
- If they are 100% negatively correlated, the volatility of a 50/50 mix will be only 5%!

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8% expected return with 5% volatility? Not bad!

- Perhaps hard to believe? But the mathematical derivation is straightforward enough:

$$\sigma_{xy} = ((Wx\,\sigma_x)^2 + 2rWxWy\,\sigma_x\,\sigma_y + (Wy\,\sigma_y)^2)^{0.5}$$

(Where W represents a weight, and Wx = 1 - Wy)

- When r = 1 or -1, the formula collapses familiarly into a squared sum or difference, respectively. (The square root leaves you just the sum or difference.)
- When r = 0, the middle term just disappears, leaving the sum of squares implied on the previous slide.

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The Difficult part is finding those two funds

- Actually, a *volatility of 5%* would not even be the lowest possibility, given these fund parameters.
- With these two imaginary funds, a mix of 2/3 of the first fund, and 1/3 of the second would give you an expected return of 7.33%, with a volatility of 0%.
- This becomes clear after sufficient consideration:
  - 100% negative correlation implies that the two funds always counteract exactly, directionally.
  - With the second fund having double the first fund's volatility, the absolute value of changes in the second fund must be twice those of the first.

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Realistically, we are lucky to find “risky” funds with “r” as negative as -0.2 or more.

- Nonetheless, mixes of independent and slightly negatively correlated funds are the basis for efficient frontier analysis, and other such methods.
- In this instance, our true goal has just been to illustrate in a familiar setting the effect on volatility of negative correlation.

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Applicable Dictionary Definition of “Hedge”

- Webster: “To try to avoid or lessen loss by making counterbalancing bets, investments, etc.”
- Sounds like an attempt at true 100% negative correlation. But correlation of what?

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What do we want to hedge?

- If you want a hedge for a single value or cash flow, finding a true hedge can be straightforward.
  - Determine the possible characteristics of that single entity.
  - Determine what you want the outcome to be.
  - Find an item (or items) that, together with the item you hold, produces a certain or nearly certain outcome equal to your desired outcome.
- Obtaining that hedge may carry a substantial cost. Or if your desired outcome is quite unambitious, it could have a zero or negative cost. (Most attempts to eliminate tail risk carry a substantial cost.)

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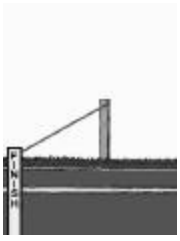
Initial variable annuity ("VA") example: GMAB

- Let's say you want to hedge a 10-year Guaranteed Minimum Accumulation Benefit ("GMAB").
- If you only allow investment in an S&P 500-oriented fund, and you are only concerned with hedging away exposure under this benefit, it is simple:
  - Determine required strike, based on product loads and other reductions to gross S&P return.
  - Buy the put option.
  - Any questions?



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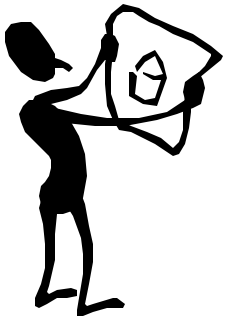
Fixed Annuity Example: Disintermediation Risk

- What if I decide my worst case is a spike upward in interest rates during the surrender charge period?
- Like the previous example, you know what you are hedging against. There are a few instruments out there you might use, the only question is timing.



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What if I want to hedge losses under a VA's GMDB? Or worse yet, a GMIB?

- Under the Guaranteed Minimum Death Benefit ("GMDB"), you can buy a series of put options, but they are only as good as your mortality assumption.
- Under a Guaranteed Minimum Income Benefit ("GMIB"), you are much *less* certain on utilization.
- And both of these benefits, along with a substantial number of GMABs we have seen, typically fail to restrict fund choices, so it's hard to know what asset class to hedge against.

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Could reinsurance be the answer?

- Maybe -
  - IF YOU CAN GET IT!!

- Two reinsurance issues, counterparty risk aside:
  - Availability, at a price that works for the direct writer.
  - Tail coverage. This is the big one, in terms of Pricing Risk Management. If you don't cover the tail, the real driver of volatility is still "on you."
- If you can get low-cost, full coverage reinsurance, it can certainly be a very effective hedge.

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What if I can't get reinsurance, and static hedging is not an option (or is impractical)?

- You could run your risks naked:
  - (No clip art here, for obvious reasons . . . . DLR)
  - Accept the risk, and hope for the best!
- You can opt for a dynamic hedging program.
  - Attempt, through a sophisticated backing portfolio (instead of static option purchases), to achieve the desired hedging position.
  - Often involves trading of futures, which are relatively inexpensive to trade actively.
  - Can be expensive (or fail altogether) if market is or becomes highly volatile.
- BIG NOTE: in any hedging or non-hedging format, there is one more *key thing* to consider!

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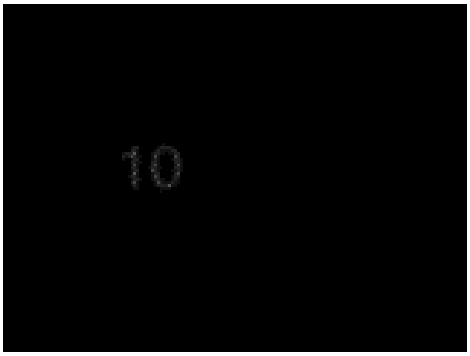

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The Importance of Negative Correlation

To Hedge or Not to Hedge?

Are We Hedging the Right Thing?

Beware the Illusory Hedge!

Miscellaneous Issues and Summary

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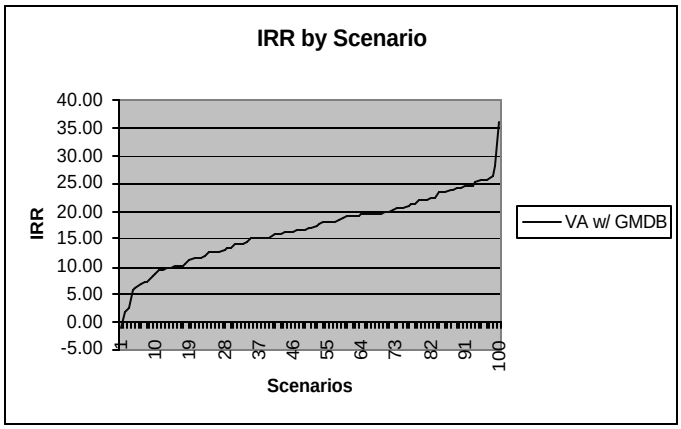
Here is the profit pattern for a typical B-Share VA over 100 “realistic” equity scenarios.

- This VA has an annual ratchet GMDB included.



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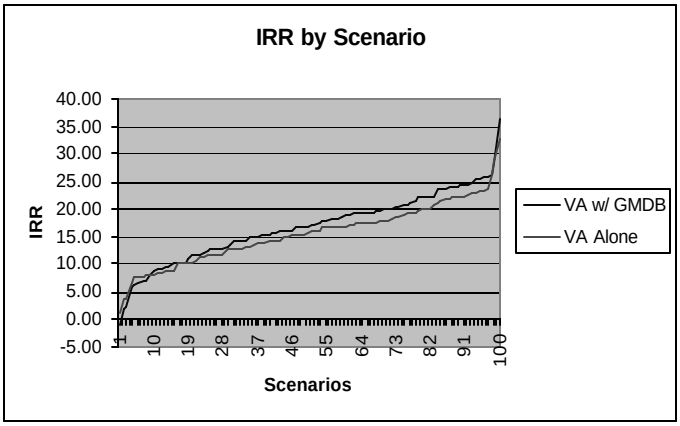
Here is what you get if you remove the GMDB.

- Clearly, the lion's share of the tail risk comes from something other than the GMDB.



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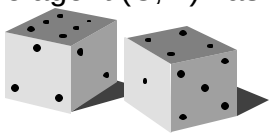
When we sell a back-end loaded ("B-Share") VA, we effectively make a bet on the market!

- This was not true for fixed annuities, the prototype for our pricing methods. There, we mostly just made a persistency bet.
- Of course, most of the riders we have added to VAs over the years act to make things worse – not better.
- Interestingly, either A-Share ("front-ended") or C-Share annuities ("no-load") mitigate both bets, whether on a fixed or variable product.
  - L-Shares are of course somewhere in between.
  - Either the policyholder (A) or the agent (C, L) has allotted us a "hedge."



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The key issue is one of Holistic Pricing

- Before we decide on any kind of hedging strategy, we really need to look at the product as a whole.
- This includes base profitability, rider impacts, and sales mix between various products and versions.
  - By doing so, we may find features within product structures, or between product lines, that are "self-hedging."
  - In any case, we get a better picture of our overall risk exposure, before making a hedging decision.

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In one sense, we've all done Holistic Pricing of offsetting positions at one time or another.

- Take an MVA on a fixed multi-year guaranteed rate:
  - You would never price an MVA stand-alone.
  - You would look at the combined portfolio (perhaps including assets), and assess overall risk.
- Generally, those of you who price Equity-Indexed Annuities ("EIAs") don't price the cost of the minimum guarantee on a stand-alone basis.

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But do we really use all potential aspects of this type of analysis?

- For non-registered MVAs, do we look sufficiently at the residual risk from the book value guarantees?
- For EIAs, we typically hedge the equity piece by rote (typically static), but the minimum guarantee not at all. Are there ways (probably dynamic) that we might do so at little cost to our overall profitability?
- In summary, only by carefully looking at product lines as a whole can we get a handle for our overall risks, and react appropriately.

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The Importance of Negative Correlation

To Hedge or Not to Hedge?

Are We Hedging the Right Thing?

Beware the Illusory Hedge!

Miscellaneous Issues and Summary

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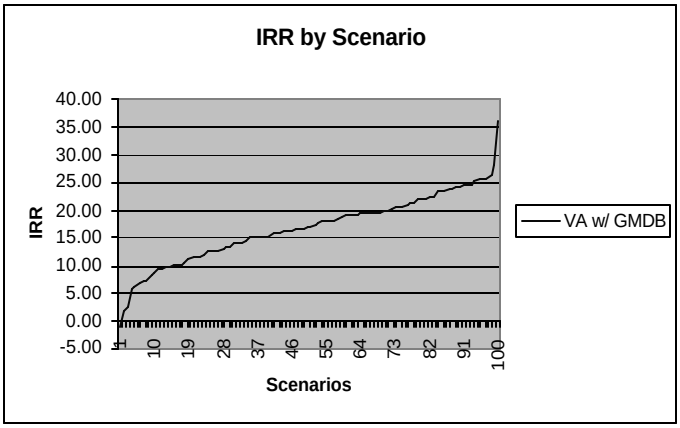
Let's go back to our VA w/ GMDB example:

- With GMDB on, our IRR distribution looked like this:



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What happens when we add an EEDB?

- When this benefit hit the market, it was in some ways seen as the potential silver bullet.
- Since the benefit is an added proportion of contract "gains," paid upon death, it would seem to directly offset GMDB costs, and other VA risks.
- Does this work out in practice?

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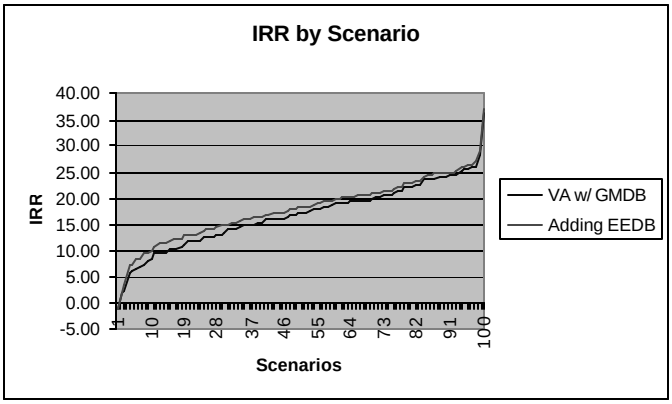
Here's what happens when we add an EEDB.

- Pretty close to nothing, at least in the tails!



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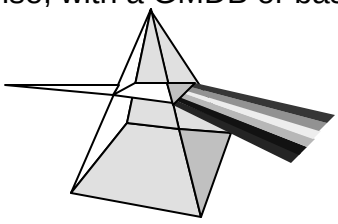
How can that be?

- Let's think about the basic structure of most EEDBs:
  - The policyholder pays an additional asset fee.
  - The policyholder gets nothing if the fund is below his premium(s) when he dies.
  - If the fund is above his premium(s), he gets a bonus, but it is capped.
- When we break it down, is this benefit negatively correlated, profit-wise, with a GMDB or base VA?



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Breaking it Down:

- If a product with an EEDB has fund value equal to net premiums paid equal to $10,000, the company has nothing at risk on policyholder death, but will get an asset fee of about $20 this year.
- If the fund goes up 50% within the year, then the company is now at risk for $2,000 on death, but the potential annual asset fee has only gone up to $30.
- Clearly, given reasonably high mortality, this is bad for the company, at least in the short run. So for this market move, the EEDB *is negatively correlated* with most GMDBs and with base VA profitability.

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Continuing:

- Now let's say that the fund has moved to the EEDB benefit cap, which is at $20,000. The company is at risk for $4,000 on death, and the asset fee is $40.
- If the fund value grows, the asset fee grows with it, but the amount at risk (being capped) does not.
- Similarly, recall that when fund equaled $10,000, we had nothing immediately at risk, and a $20 asset fee.
- If the fund falls at that point, we still have nothing at risk, but our asset fee falls.
- In both cases, the EEDB profit patter is *positively correlated* with GMDB and VA base profitability!!

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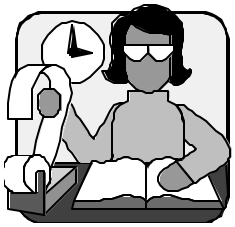
In fact, EEDB is negatively correlated with other VA benefits, only within a fairly narrow range.

- Are there potential solutions to this?
  - Could raise or eliminate the cap, and raise fees.
  - Could make the bonus be based on fund value, not "gains." (This would eliminate the income tax marketing play.)
- These are just partial solutions, since everything we add to a VA, and charge for, just makes the situation even worse in the tail scenarios.



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Tail Risk & Hedge Effectiveness: Bottom Line

- Especially for VAs, but in some ways for other products as well, it is hard to attack the tail risk internally (from within the product, or riders).
- There are possibilities on the asset side, either by motivating policyholders to invest in a way that helps you, or by static or dynamic hedging.
- There are also possibilities via other product lines.
- The main message of this sub-section: only by examining your strategy over a broad enough range of possible scenarios, can you adequately test it.
  - "Measure first. Then implement."

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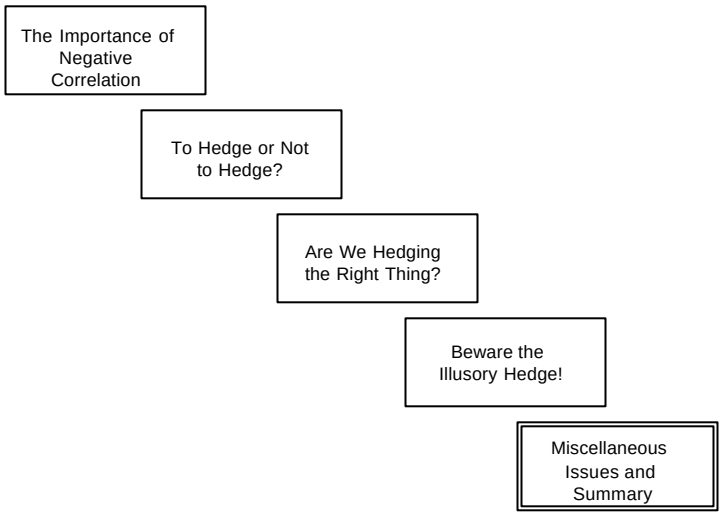

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Appropriateness of Different Types of Scenario Sets for Hedging Analysis

- If you are attempting to put a market-based cost on a hedging strategy, you really need to use risk-neutral scenarios to analyze option costs.
- Once a hedging strategy is established, and you want to "run it through the wringer," a realistic set may be more appropriate.
- I can discuss the difference during Q&A if anyone wishes to ask.

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Hedging Between Product Lines or "Risk Management through Product Balancing"

- A couple of strong possibilities exist:
  - Fixed SPDAs versus fixed SPIAs
  - VAs versus EIAs
  - SPIAs vs. life products vis-à-vis mortality
- These offer the potential for lively discussion, but would be slightly off-topic here.

- Note that things are not as they always have been, and at least one of the above may not work as well as it used to!

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Summary

- Risk management often involves attempting to establish positions that are negatively correlated.
- Risk management at the annuity product pricing level can often involve discussion of possible hedging strategies and associated costs.
- This discussion, at a minimum, should cover:
  - the subject of Holistic pricing,
  - overall hedging position desired, and
  - Testing/measuring your hedge strategy, before implementation, to ensure it fulfils your objective.

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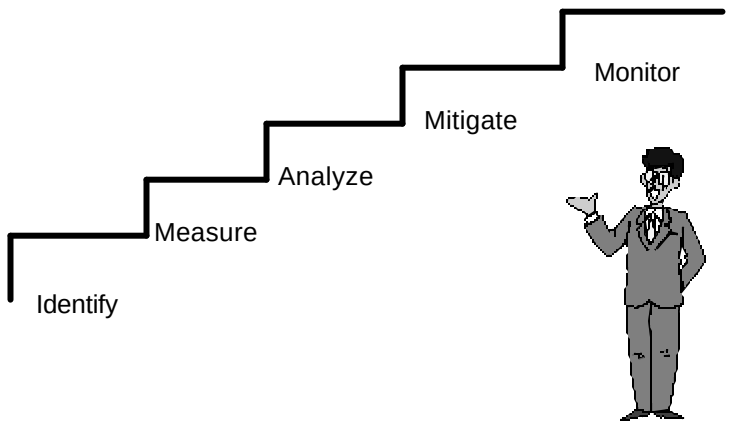
SOA Spring Meeting

May 29, 2003

Pricing Risk Management
Case Study: Pricing a UL Secondary Guarantee Product
Session 7PD

Keith Dall, FSA
Milliman USA

Risk Management



Identifying Risks

- Regulatory
- Expense
- Mortality
- Interest Rate
- Lapse
- Internal Replacement

Pricing Risk Management: Regulatory

- How to Manage Unknown?
- XXX Model Regulation
- AXXX Model Regulation
- SNFL
- 2001 CSO Table
- What's Next?

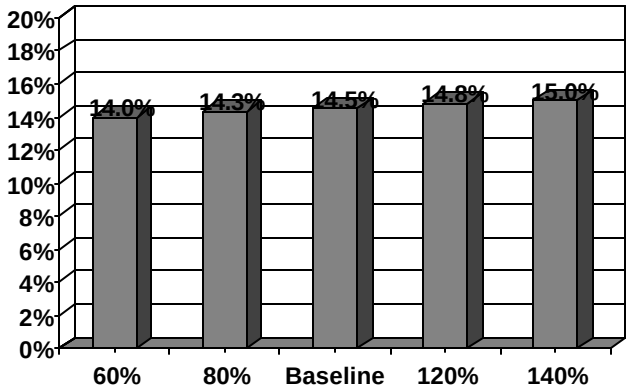
Pricing Risk Management: Regulatory

- Mitigate
  - Reinsurance
  - Change Product Design
- Monitor
  - SOA Meetings
  - NAIC Meetings
  - Trade Publications
  - Network

Pricing Risk Management: Expense

- Micro versus Macro Pricing
- Marginal versus Fully Allocated
- Unit Expenses
  - % of premium
  - Per thousand
  - Per policy
- Inflation
- Actual to Expected
- Mitigation: TPA, Joint Venture
- Monitoring: Actual to Expected

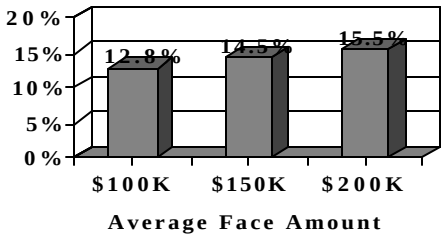
Pricing Risk Management: Expense



Pricing Risk Management: Expense

Unit Expenses ⇒ Introduce Additional Risk?

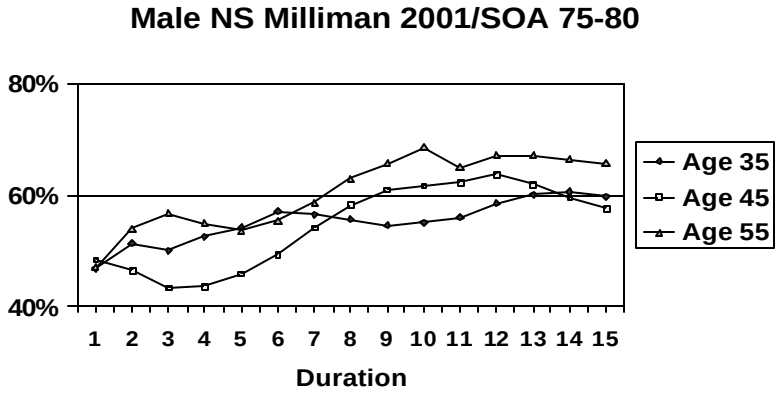
Per Policy



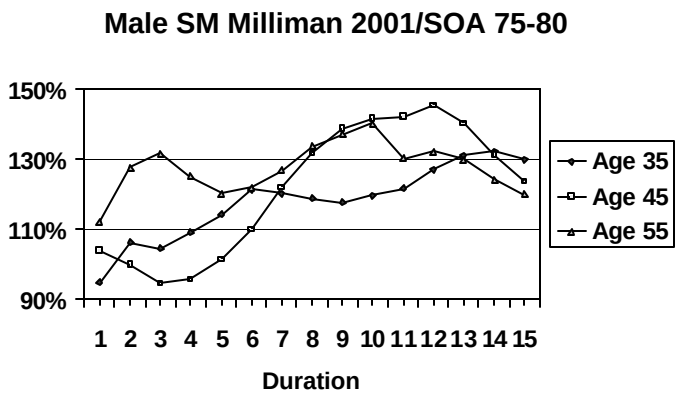
Pricing Risk Management: Mortality

- Base Table
- Select and Ultimate
  - Slope
  - Length
- UW Classes
- Mortality Improvement

Milliman 2001 Table



Milliman 2001 Table



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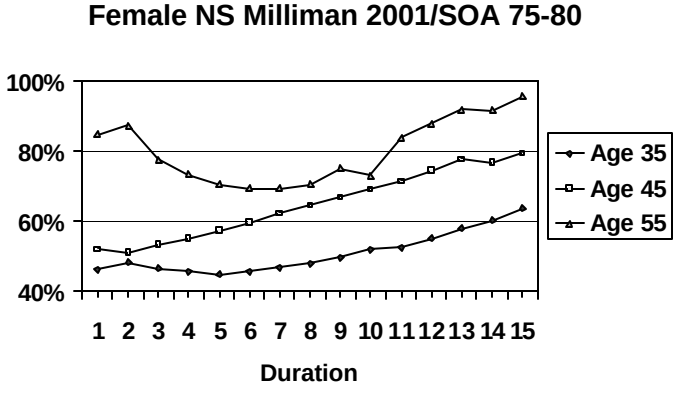

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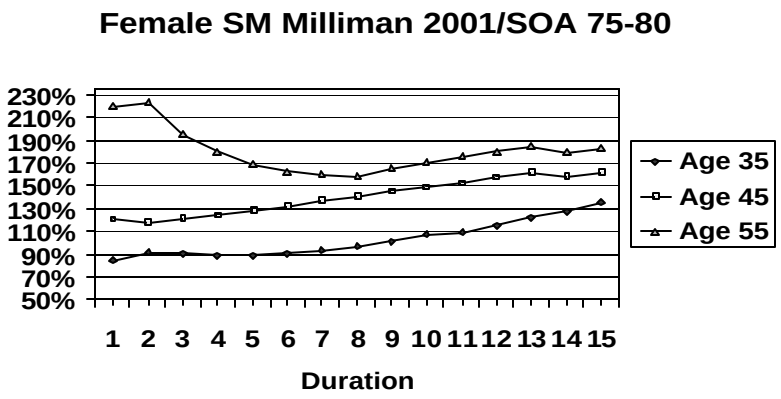


Pricing Risk Management: Mortality

IRR Comparison

	75-80 SOA		90-95 SOA
Male	15.0%	⇨	15.3%
Female	14.3%	⇨	12.9%
Age 35	14.5%	⇨	14.9%
Age 55	15.1%	⇨	14.2%

Pricing Risk Management: Mortality

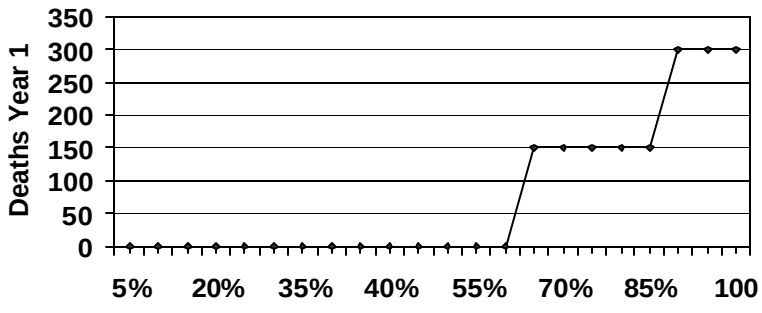
IRR Comparison

Female 55, Smoker

75-80 SOA	90-95 SOA
12.1%	6.4%

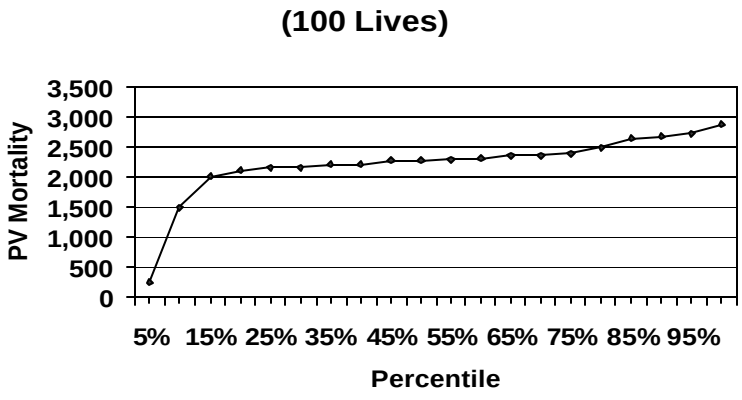
Pricing Risk Management: Mortality

(100 Lives)



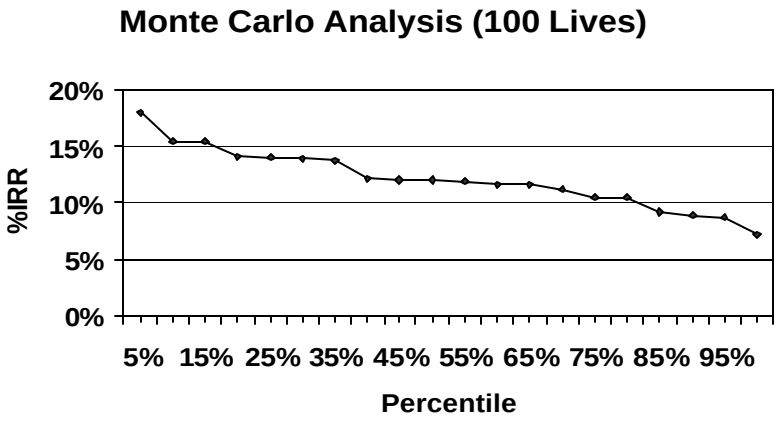
Avg $82.5 Min $0.0 Max $300.0 SD $113.9

Pricing Risk Management: Mortality



Avg $2,210 Min $253 Max $2,869 SD $547

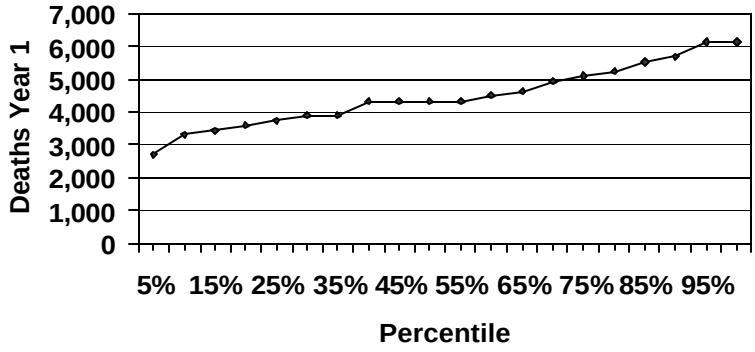
Pricing Risk Management: Mortality



Avg 12.1% Min 7.1% Max 18.0% SD 2.6%

Pricing Risk Management: Mortality

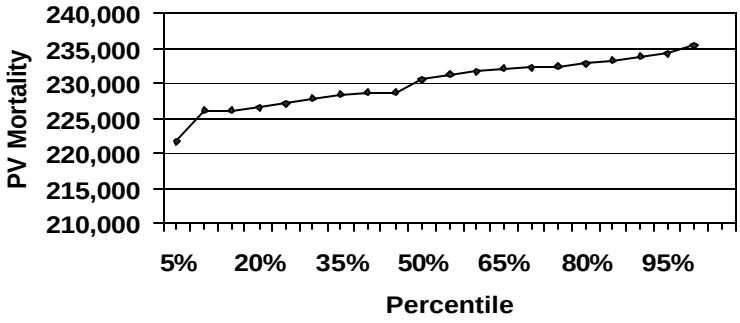
(10,000 Lives)



Avg $4,500 Min $2,700 Max $6,150 SD $949

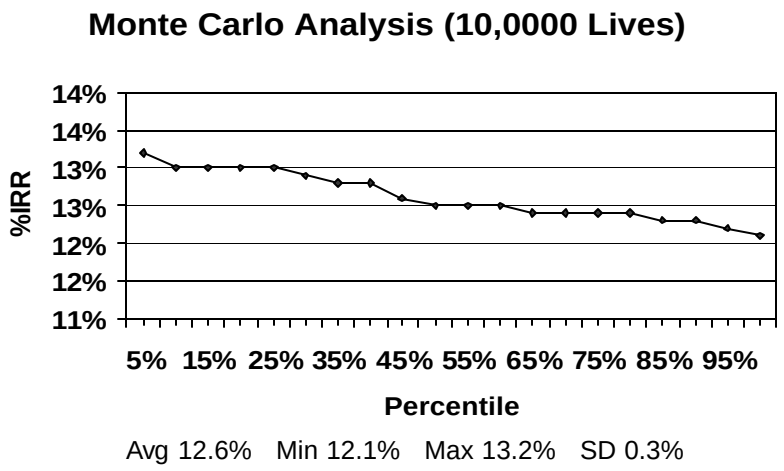
Pricing Risk Management: Mortality

(10,000 Lives)



Avg $230,080 Min $221,720 Max $235,393 SD $3,477

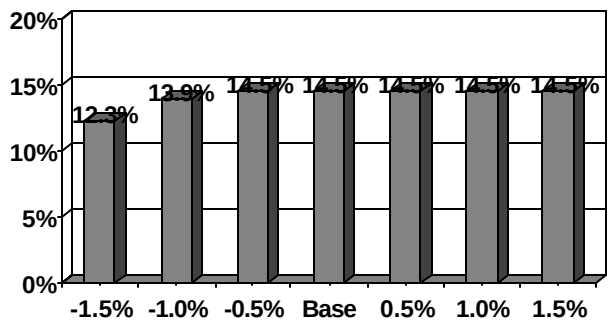
Pricing Risk Management: Mortality



Avg 12.6% Min 12.1% Max 13.2% SD 0.3%

Pricing Risk Management: Interest Rate

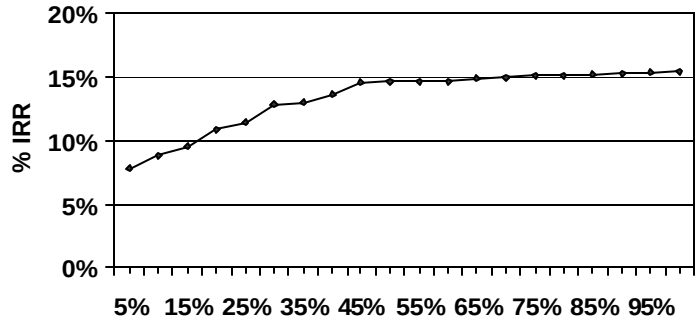
Change in NIER



Pricing Risk Management: Interest Rate

Stochastic Analysis

4% Interest Rate Guarantee

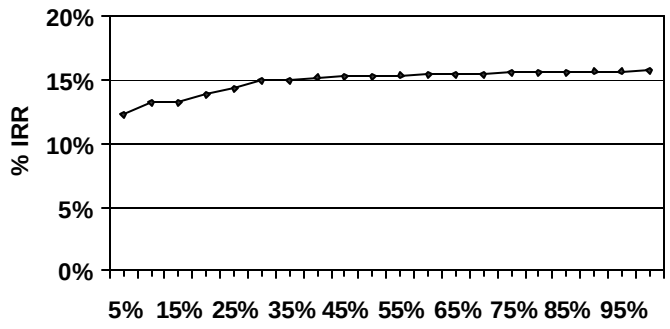


Avg 13.4% Min 7.8% Max 15.5% SD 2.4%

Pricing Risk Management: Interest Rate

Stochastic Analysis

3% Interest Rate Guarantee



Avg 14.9% Min 12.3% Max 15.8% SD 1.0%

Pricing Risk Management: Lapse

- Sensitivity Test
- High-Medium-Low Funding
- Dynamic Lapse
- Spike Lapses
- Mitigate
  - New Money Rate/Portfolio Rate
  - Commission Chargebacks
  - Higher Renewal Commissions

Pricing Risk Management: Internal Replacement

- Compared to Like Company Product
  - Rates
  - Commissions
- Compared to Other Company Products
  - Mortality Arbitrage
  - Commissions
- Strict Guidelines
- Monitor

Pricing Risk Management: Sign Off

- Pricing Actuary
  - Profit Targets
  - Proper Assumptions
  - Illustration Testing
- Marketing Director
  - Sales Projections
  - Meet Product Strategies
- Appointed Actuary
  - Statutory Reserve Methodology
  - GAAP Reserve Assumptions