Session 62 PD, Simplified Methods for Determining Reserves Under VM-20

Moderator:
John K. McGarry, ASA, Ph.D.

Presenters:
Mark William Birdsall, FSA, FCA, MAAA, MBA
Brian Matthew Hartman, ASA, Ph.D.

SOA Antitrust Disclaimer
SOA Presentation Disclaimer
2017 Life & Annuity Symposium

Mark Birdsall, FSA, MAAA
Brian Hartman, PhD, ASA
SOA PBR Simplified Methods for VM-20 Project
May 9, 2017
SOCIETY OF ACTUARIES
Antitrust Notice for Meetings

Active participation in the Society of Actuaries is an important aspect of membership. However, any Society activity that arguably could be perceived as a restraint of trade exposes the SOA and its members to antitrust risk. Accordingly, meeting participants should refrain from any discussion which may provide the basis for an inference that they agreed to take any action relating to prices, services, production, allocation of markets or any other matter having a market effect. These discussions should be avoided both at official SOA meetings and informal gatherings and activities. In addition, meeting participants should be sensitive to other matters that may raise particular antitrust concern: membership restrictions, codes of ethics or other forms of self-regulation, product standardization or certification. The following are guidelines that should be followed at all SOA meetings, informal gatherings and activities:

- **DON’T** discuss your own, your firm’s, or others’ prices or fees for service, or anything that might affect prices or fees, such as costs, discounts, terms of sale, or profit margins.
- **DON’T** stay at a meeting where any such price talk occurs.
- **DON’T** make public announcements or statements about your own or your firm’s prices or fees, or those of competitors, at any SOA meeting or activity.
- **DON’T** talk about what other entities or their members or employees plan to do in particular geographic or product markets or with particular customers.
- **DON’T** speak or act on behalf of the SOA or any of its committees unless specifically authorized to do so.
- **DO** alert SOA staff or legal counsel about any concerns regarding proposed statements to be made by the association on behalf of a committee or section.
- **DO** consult with your own legal counsel or the SOA before raising any matter or making any statement that you think may involve competitively sensitive information.
- **DO** be alert to improper activities, and don’t participate if you think something is improper.
- If you have specific questions, seek guidance from your own legal counsel or from the SOA’s Executive Director or legal counsel.
Presentation Disclaimer

Presentations are intended for educational purposes only and do not replace independent professional judgment. Statements of fact and opinions expressed are those of the participants individually and, unless expressly stated to the contrary, are not the opinion or position of the Society of Actuaries, its cosponsors or its committees. The Society of Actuaries does not endorse or approve, and assumes no responsibility for, the content, accuracy or completeness of the information presented. Attendees should note that the sessions are audio-recorded and may be published in various media, including print, audio and video formats without further notice.
Session overview

• SOA research project on simplified methods (Mark Birdsall)
  • Project overview
  • Multi-Risk Scenario Generator
  • Assumption Objectivity Measures
  • Next Steps

• Assumption Objectivity Measure (Brian Hartman)
  • Input Method
VM-20 Section 2G under Minimum Reserves

“A company may use simplifications, approximations and modeling efficiency techniques to calculate the net premium reserve, the deterministic reserve and/or the stochastic reserve required by this section if the company can demonstrate that the use of such techniques does not understate the reserve by a material amount and the expected value of the reserve calculated using simplifications, approximations and modeling efficiency techniques is not less than the expected value of the reserve calculated that does not use them.”
Project Goal stated in RFP

“The goal of the project is to develop less intensive methodologies that are allowed under VM-20 and satisfies the specified demonstration requirement.”
Research Team Members

• Steve Strommen from Blufftop, LLC—Multi-Risk Scenario Generator
• Dr. Brian Hartman from Hartman Analytics, LLC—Assumption Objectivity Measures
• Mark Birdsall from Lewis & Ellis, Inc.
• Peer Reviewers
  • Two Regulatory Actuaries
  • John Manistre from GGY Axis (Moody’s)
Project Approach

• Develop Multi-Risk Scenario Generator
  • Set company best estimate assumptions for all material risks
  • Input company A/E ratios for each of those material assumptions
  • Input event and exposure counts of company experience for each material risk
  • Select distribution type for each material assumption
  • Scenarios will be generated for each material risk

• Develop objectivity measures for best estimate assumptions
  • Used in the regulatory demonstration

• Analyze level premium term, traditional whole life, accumulation universal life, UL with secondary guarantees
Project Approach

• Test four different approaches
  • 1. Generate various numbers of fully stochastic scenarios with adjustment for the standard deviation of the CTE estimator--show trade-off in reserves vs. number of scenarios
  • 2. Generate deterministic scenarios at specified probability levels calibrated to represent the distribution of the worst 30% of the fully stochastic scenarios, averaging the results to estimate the CTE 70 reserve
Project Approach

• Test four different approaches
  • 3. Use predictive modeling tools to estimate the fully stochastic distribution based on results from 1 and 2, then run a large number of fully stochastic inputs through the predictive model(s) to estimate the CTE 70 reserve
  • 4. Use scenario reduction techniques to select a small number of scenarios from a larger universe of fully stochastic scenarios to estimate the CTE 70 reserve
Project Approach

• Compare results of four methods to Net Premium Reserve, Deterministic Reserve, and Stochastic Reserve (where applicable)

• Mortality improvement will be treated as a material assumption, but the simplified reserve calculations will reflect the regulatory guardrail of no future mortality improvement
Project Deliverables

• Multi-Risk Scenario Generator
  • Open source
  • Deliverable before project completion

• Definition of Objectivity Measures for Best Estimate Assumptions
  • Input Method (Brian Hartman)
  • Output Method
Project Deliverables

• Actuarial Report will include:
  • Descriptions of simplification methods tested
  • Recommendations for the probability distribution type for each material assumption
  • Comparisons to NPR, DR, and SR (where applicable)
  • Analysis of margins, including ranking of material risks by product type
  • Estimates of target capital by product type
  • Impact of the credibility of company experience for material assumptions
  • Summary of how well the tested techniques satisfy the regulatory demonstration requirement

• Sample regulatory demonstrations by product type
Other Uses of Project Deliverables

• Developing Total Asset Requirement (e.g., 99th percentile) leads to other key measures
  • Calculate Target Capital = Total Asset Requirement – Statutory Reserve
  • Calculate Free Surplus = Total Adjusted Capital – Target Capital

• Developing Target Capital factors for pricing and valuing New Business Written and the Value of In force Business based on Distributable Earnings, components of Company Value

• Providing projections of cash flows for optimizing investment strategies

• Developing PADs for GAAP Reserves (where applicable)
Other Uses of Project Deliverables

• Quantifying and ranking risk margins and testing risk mitigation strategies for company risk management program and ORSA (where applicable)
• Developing margins for “full” PBR calculations
• Quantifying the benefits of product mix (“natural hedging”)
• Submitting assumption objectivity measures with other regulatory submissions, including Asset Adequacy Analysis and LTC rate reviews
• Enhancing communications with rating agencies, auditors, and regulators
Multi-Risk Scenario Generator

• Create Risk Definition File
Multi-Risk Scenario Generator

- Define scenarios to generate

![Multi-risk Scenario Generator](image-url)
Using “Relevant” Experience

The ASOP Exposure Draft on setting assumptions indicates that the actuary should consider using “available” and “relevant” data and information to set assumptions and refers to ASOP 25, Credibility Procedures.

The PBR Valuation Manual Section 20 (VM-20) uses the word “relevant” together with “available” and “credible” for using both company and industry experience in setting anticipated experience assumptions.
Demonstrating relevance and reducing margins

Traditional experience studies may not have identified all significant predictors, such as:

- Product design elements
- Distribution characteristics
- Target markets
- Dynamic policyholder behavior functions, reflecting in-the-moneyness of benefits

Both data aggregators and companies can use statistical tools to enhance experience studies by identifying additional significant predictors.

Align significant predictors of company and industry experience to increase the credibility of the experience used for setting material assumptions, providing the basis for lower margins.
Assumption Objectivity Measures

• Output Objectivity Measures 1, 2, 3
  • Central estimate assumptions = credibility blending relevant company experience with relevant industry experience for material risks, updated annually
  • Calculate Actual to Expected Ratios of the actual modeling assumptions to the central estimate assumptions
  • Calculate a gross premium reserve based on actual modeling assumptions
  • Calculate a gross premium reserve based on central estimate assumptions
  • Margin Impact = Actual Modeling Assumption Reserve – Central Estimate Assumption Reserve (could be + or -)
  • Percent Statutory Margin Impact = Margin Impact/(Statutory Reserve – Actual Modeling Assumption Reserve)
Assumption Objectivity Measures

• Output Objectivity Measure 4
  • Using the multi-risk scenario generator and central estimate assumptions, produce an 84th percentile (moderately adverse) scenario reserve for each material risk
  • Calculate the difference between the scenario reserve and the central estimate reserve for each material risk
  • Use square root formula (like Life RBC covariance adjustment) to calculate an Aggregate Reserve Margin
  • **Percent Aggregate Margin Impact** = Margin Impact/Aggregate Reserve Margin (could be + or -)
  • Could also calculate: Statutory Reserve Excess = Statutory Reserve – (Central Estimate Assumption Reserve + Aggregate Reserve Margin)
Next Steps—Modeling

- Cash flow projection models for traditional whole life, term, accumulation UL, and ULSG
- Software reads the multi-risk scenarios
- Run Stochastic Exclusion Tests (SETs)
- Calculate Deterministic and Stochastic Reserves as indicated by the SETs
- Develop modeled reserves and implicit percentile levels in the Deterministic and Stochastic Reserves for different credibility levels
Input Objectivity Measure
Modeling the Uncertainty in the Actual/Tabular Ratio

• We could add a prior distribution directly to the actual/tabular ratio:

\[ Y_a \sim Bin(N_a, \theta T_a) \]

\[ \theta \sim N(1, 0.2^2) \]
Impact of Company Data Size

ACTUAL-TO-TABULAR RATIO 95% CREDIBLE INTERVALS AS A FUNCTION OF SAMPLE SIZE
Regulatory Example

• We will compare the observed data to the 2012 IAM female table.
• 2600 exposures, 100 deaths, ages 65+
• MLE of actual/tabular ratio is 0.7452
• Using our method, we can find the uncertainty around that estimate.
Regulatory Example
Regulatory Example

• From that posterior distribution, we can calculate any desired credible interval. In this example, a few reasonable credible intervals are:

<table>
<thead>
<tr>
<th></th>
<th>80%</th>
<th>90%</th>
<th>95%</th>
<th>99%</th>
<th>99.9%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Limit</td>
<td>0.67</td>
<td>0.64</td>
<td>0.62</td>
<td>0.58</td>
<td>0.54</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>0.84</td>
<td>0.87</td>
<td>0.89</td>
<td>0.93</td>
<td>0.98</td>
</tr>
</tbody>
</table>

• Regulators could determine reasonableness
  • Whether in the range
  • Percentile of assumption
Possible Extensions

• Our current model is (with hyperpriors removed)

\[ Y_a \sim Bin(N_a, \theta T_a) \]
\[ \theta \sim N(\mu, 0.02^2) \]

• To allow \( \theta \) to vary by a subgroup (e.g. gender and age) the model can be adjusted as follows:

\[ Y_{ag} \sim Bin(N_{ag}, \theta_{ag} T_{ag}) \]
\[ \theta_{ag} \sim N(\mu + \tau_g + \nu_a, 0.02^2) \]
Incorporating Both Parameter and Process Uncertainty
Types of Uncertainty

• In almost all random events, there are two types of uncertainty:

  • Parameter uncertainty – “Are we sure that the true survival probability for a 65-year-old annuitant is 0.99?”

  • Process uncertainty – “Even if the true survival probability is 0.99, if we have 1,000 exposures, we may have 10 deaths, or 15, or 5.”
One way to incorporate both

1. Draw random parameter values from their posterior distributions
2. Given the parameters in (1), draw the responses from their likelihood
3. Repeat until satisfied

For example, it you are simulating the number of deaths from 100 lives,

1. Draw the survival probability \((p_x)\) from the posterior
2. Draw the number of deaths from \(Bin(100,1 - p_x)\)
Software constraints

• What if you are using software which will take draws of the A/T ratio and multiplies them by the number of exposures to get the number of deaths?
• It takes a little more statistics, but we can incorporate both types of uncertainty in this case as well.
Our Model

\[ X \sim Bin(E, \theta T) \]
\[ \theta T \sim Beta(\alpha, \beta) \]
\[ \theta T | X \sim Beta(\alpha + X, \beta + E - X) \]

- \( X \) is the number of deaths in the company experience
- \( E \) is the number of exposures
- \( \theta \) is the Actual/Tabular ratio
- \( T \) is the tabular mortality rate
- \( \alpha \) and \( \beta \) are hyperparameters
How to draw $\theta$

• Using the CLT, we can draw $\theta$ from a normal distribution with the following mean and variance:

\[
E(\theta) = \frac{1}{T} \cdot \frac{T/3+X}{1/3+E}
\]

\[
Var(\theta) = \frac{1}{T^2} \left( \frac{1}{n} \left( \frac{T/3+X}{1/3+E} - \frac{(T/3+X)^2 + T/3+X}{(1/3+E)(1/3+E+1)} \right) \right) +
\]