The Challenge of Categorizing, Characterizing, and Communicating Reserve Variability and Ranges

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Overview

- Categorizing/Characterizing "Risk" (sources of variability)
- Tools For Numerically Defining Ranges
- Standards of Practice (ASOP) Guidance
- On the Current CAS Exam Syllabus
- Some Highlights of Historical Research
- The Imperative of Communication and Consistency
- Summary

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Classic Categories of "Risk" (sources of variability)

- Process
  - Example: The true mean reserve is $1 billion but the actual reserve outcome will be lognormally distributed with coefficient of variation 30%.
- Parameter
  - Example: The mean reserve itself follows a lognormal distribution with coefficient of variation of 15%.
- Model
  - Example: The mean and actual reserves may be following either a lognormal distribution, an inverse gamma distribution, or unknown/undetermined.

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More Diverse Ways to Categorize/Characterize Reserve "Risk"

- Mass Latent
  - Example: Triangular methods generally cannot capture point or variability estimates for reserves when systematic liabilities, such as asbestos, are latent in runoff.
- Future Regime/Environmental Changes
  - Example: A big increase in future inflation poses potential risk generally not be reflected in past reserve development data.
- Discounted Risk
  - Example: A risk of a nominal $1 billion dollar change in reserves for quick paying Auto Physical Damage poses a far greater financial risk than it would for slow paying Excess Workers Compensation.

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More Diverse Ways to Categorize/Characterize Reserve "Risk" (cont.)

- Independent or Dependent Components
  - Example: Assuming independence between exposure years, development years, or calendar years will produce lower variability than allowing for positive correlations.
- Net, Gross, or Ceded Regarding Reinsurance
  - Example: Reinsurance is generally designed to lower net risk, including risk in net reserve development.
- Reasonable Provision or Actual Outcome
  - Example: The range of reasonable reserve estimates is generally much narrower than a reasonably probable range of possible actual reserve outcomes.

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More Diverse Ways to Categorize/Characterize Reserve "Risk" (cont.)

- Tail Factor
  - Example: Development to ultimate, beyond the triangle of historical data, is intrinsically very uncertain.
- Cyclical
  - Example: Cycles over time in case reserving practices and/or speed of payments contribute to reserve variability.
- Triangular
  - Example: Just a simple triangle of data with basic chain ladder assumptions as described for example by Mack.
- And So Many Others…..

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Tools For Numerically Defining Ranges

- Value At Risk (VAR) By Percentile
  - Example: The 90% VAR is $1.4 billion.
- Probable Maximum Loss (PML) By Return Period
  - Example: The 50 year return period loss is $1.75 billion.
- Tail Value At Risk (VAR) or Conditional Tail Expectation (CTE) By Percentile
  - Example: The 90% TVAR is $1.62 billion
- Standard Deviation
  - Example: Two standard deviations above the mean is $1.6 billion.
- Confidence Intervals
  - Example: The symmetric 90% confidence interval for the outcome around the mean is [$0.54 billion, $1.46 billion].
- And So Many Others…

Note: Examples use a lognormal distribution with mean $1 billion and coefficient of variation 30%.

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Standards of Practice (ASOP) Guidance

- ASOP 36
  - Consider range of estimates, may use range to evaluate reserve reasonableness
- ASOP 41
  - "…actuarial report…should …identify the methods, procedures, assumptions, and data … with sufficient clarity….that another actuary … could make an objective appraisal of the reasonableness…"
  - "Uncertainty or Risk—The actuary should consider what cautions regarding possible uncertainty or risk in any results should be included in the actuarial report."

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Standards of Practice (ASOP) Guidance (cont.)

ASOP 43

- “Actuarial Central Estimate—An estimate that represents an expected value over the range of reasonably possible”
- “..actuary may present the unpaid claim estimate in a variety of ways, such as a point estimate, a range of estimates, a point estimate with a margin for adverse deviation, or a probability distribution of the unpaid claim amount.”
- “In the case when the actuary specifies a range of estimates, the actuary should disclose the basis of the range provided, for example, a range of estimates of the intended measure (each of such estimates considered to be a reasonable estimate on a stand-alone basis); a range representing a confidence interval within the range of outcomes produced by a particular model or models; or a range representing a confidence interval reflecting certain risks, such as process risk and parameter risk.”

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Standards of Practice (ASOP) Guidance (cont.)

ASOP 43 (cont.)

- "Uncertainty—The actuary should consider the uncertainty associated with the unpaid claim estimate analysis. This standard does not require or prohibit the actuary from measuring this uncertainty. The actuary should consider the purpose and use of the unpaid claim estimate in deciding whether or not to measure this uncertainty. When the actuary is measuring uncertainty, the actuary should consider the types and sources of uncertainty being measured and choose the methods, models, and assumptions that are appropriate for the measurement of such uncertainty. For example, when measuring the variability of an unpaid claim estimate covering multiple components, consideration should be given to whether the components are independent of each other or whether they are correlated. Such types and sources of uncertainty surrounding unpaid claim estimates may include uncertainty due to model risk, parameter risk, and process risk."

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On the Current CAS Exam Syllabus

Exam 7 Learning Objectives

- "Calculate the moments and percentiles of unpaid claim distributions implied by the (reserve) models"
- "Describe the various sources of risk and uncertainty that are associated with the determination of reserves. Calculate risk margins that consider these sources of risk and uncertainty."
- "Calculate the mean and prediction error of a reserve given an underlying statistical (reserve) model."
- "Derive predictive distributions using bootstrapping and simulation techniques."
- "Develop a distribution of reserves using weights and multiple stochastic models."

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1994 Call Paper

- The Committee on Theory of Risk sponsored a Variability in Reserves Prize Program.
- Important milestone, before relatively little in literature on estimating reserve variability.
- An introduction and 10 papers were published in the two volumes of the Spring 1994 *CAS Forum*.
- Included key papers by Mack, Murphy, Verrall, Zehnwirth, and others.
- Mostly focused on basic triangular risk models.

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2004 Working Party

- CAS Working Party on Quantifying Variability in Reserve
- "The Analysis and Estimation of Loss & ALAE Variability: A Summary Report," Fall 2005 *CAS Forum*.
- "Conclusions. The actuarial profession does not yet have a single, all-inclusive method for estimating the distribution of future payments for property and casualty liabilities. Much work is yet to be done on the issue."

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Circa 2010-Present Retrospective Testing

- "The Retrospective Testing of Stochastic Loss Reserve Models," Meyers and Shi, , Summer 2011 *CAS E-Forum*.
  - "…study suggests that there might be environmental changes that no single model can identify…cannot rely solely on stochastic loss reserve models…"
- "Back-Testing the ODP Bootstrap of the Paid Chain-Ladder Model with Actual Historical Claims Data," Leong, Wang, and Chen, Summer 2012 *CAS E-Forum*.
  - Retrospective testing suggests a ODP (over-dispersed Poisson) bootstrapping underestimates reserve variability for homeowners.
  - May indicate systematic risk, not captured model.

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2012 Khury

"Empirical Method-Based Aggregate Loss Distributions," Khury, Volume 1 of 2012 *Variance*

- A numerical method is shown to tractably estimate to any precision the distribution of ultimate losses assuming observed loss development factors are the population of possible future loss development factors.
- Example: If 1.05, 1.07, 1.13, and 1.25 are the observed development factors for 6^{th} to 7^{th}, then 6^{th} to 7^{th} development factors for future exposure years are randomly and uniformly distributed among these 4 values.
- Very appealing and compelling due to simplicity of assumptions and complete grounding in empirical data.
- Produces somewhat lower variability estimates than other triangular methods, such as the Mack Method, as the variability of observed samples –particularly the small samples involved - is generally lower than true population variability. Also, assumes no parameter estimation risk and complete independence of development factors.

The Imperative of Communication and Consistency

- Intended Use
  - Example: A Mack Method derived basic triangular range is not very relevant to the asbestos runoff of an excess reinsurer.
- Consistent Comparisons
  - Example: A Mack Method derived range for one company is not comparable with a Khury Method derived range for another company.
  - Obviously, an issue for comparisons between companies, between business plans, over time, etc.
- High Risk of Misunderstanding In Communicating Range

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Summary

- Characterizing the risk assumptions behind a range is key.
- ASOPs and CAS Syllabus already contain a good amount of material about reserve ranges, risk, variability, and uncertainty.
- Research and practice has focused on basic triangular development risk.
- Reserve range estimation is for the most part unstandardized for practice, making communication clarity all the more important.

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