Developing a reserve range, from theory to practice

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Motivation

- Practices for developing ranges vary widely, from the very simple to the very complex.
- Given a consistent dataset, how do the results of these different methods vary?
- Considering the results, and the input from a survey of actuaries, which methods are appropriate?

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Overview

- Conceptual introduction
- Guidance
- Comparison of alternative approaches
- Which approach makes sense?

Conceptual introduction

Purposes of ranges

- The purpose will vary depending on the type of range and the use of the range
- Two types of ranges are commonly discussed:
  - **Range of possible outcomes** — includes the full range of potential results of the claim process
  - **Range of reasonable estimates —** expresses the degree of uncertainty in an estimate
- Sometimes, both are referred to as "reserve ranges," but they have very different meanings

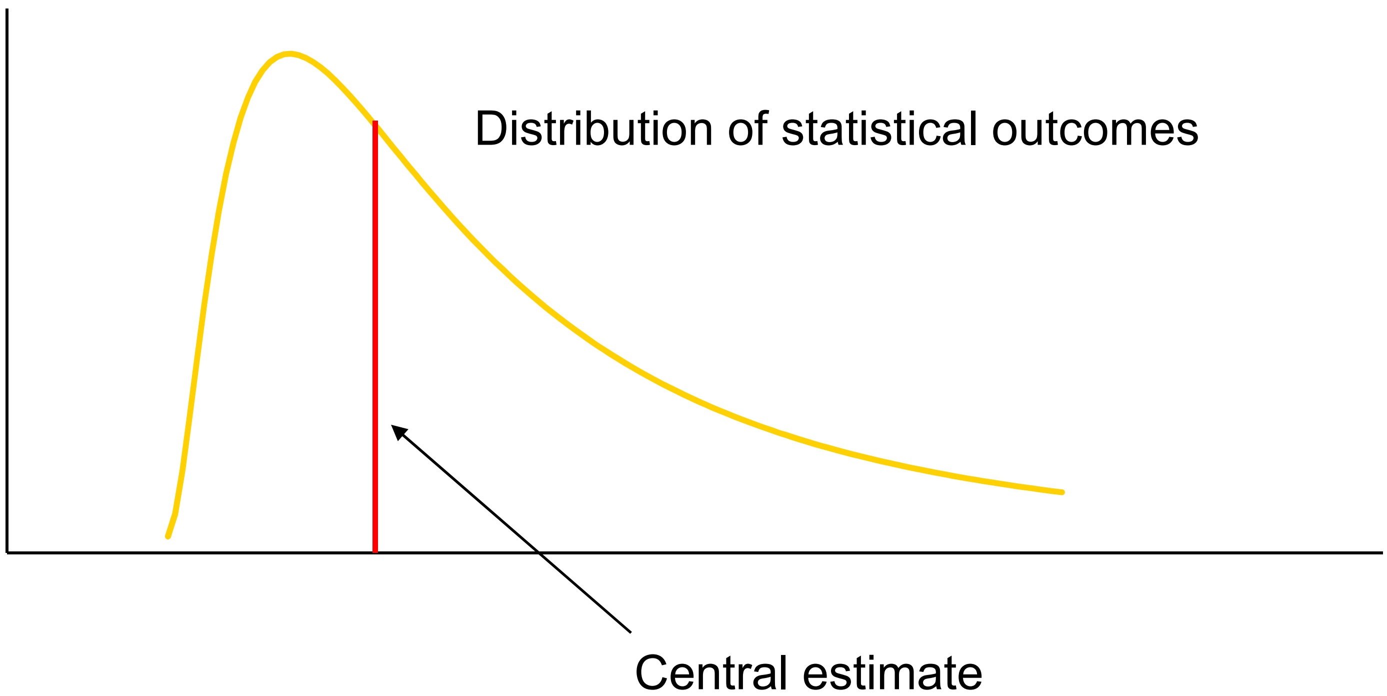
Uses of ranges

- Internal communications
  - As an aid to setting management's best estimate
- Risk management and capital modeling
  - Scenario testing and worst-case scenarios
- SEC filings
  - Reliability of current earnings
- Mergers and acquisitions
  - Profitability, ranges of future outcomes
- Audits and statutory examinations
  - Testing of management's best estimate
- Reports supporting the Statement of Actuarial Opinion (SAO) and Actuarial Opinion Summary (AOS)
  - Opinion on management's best estimate

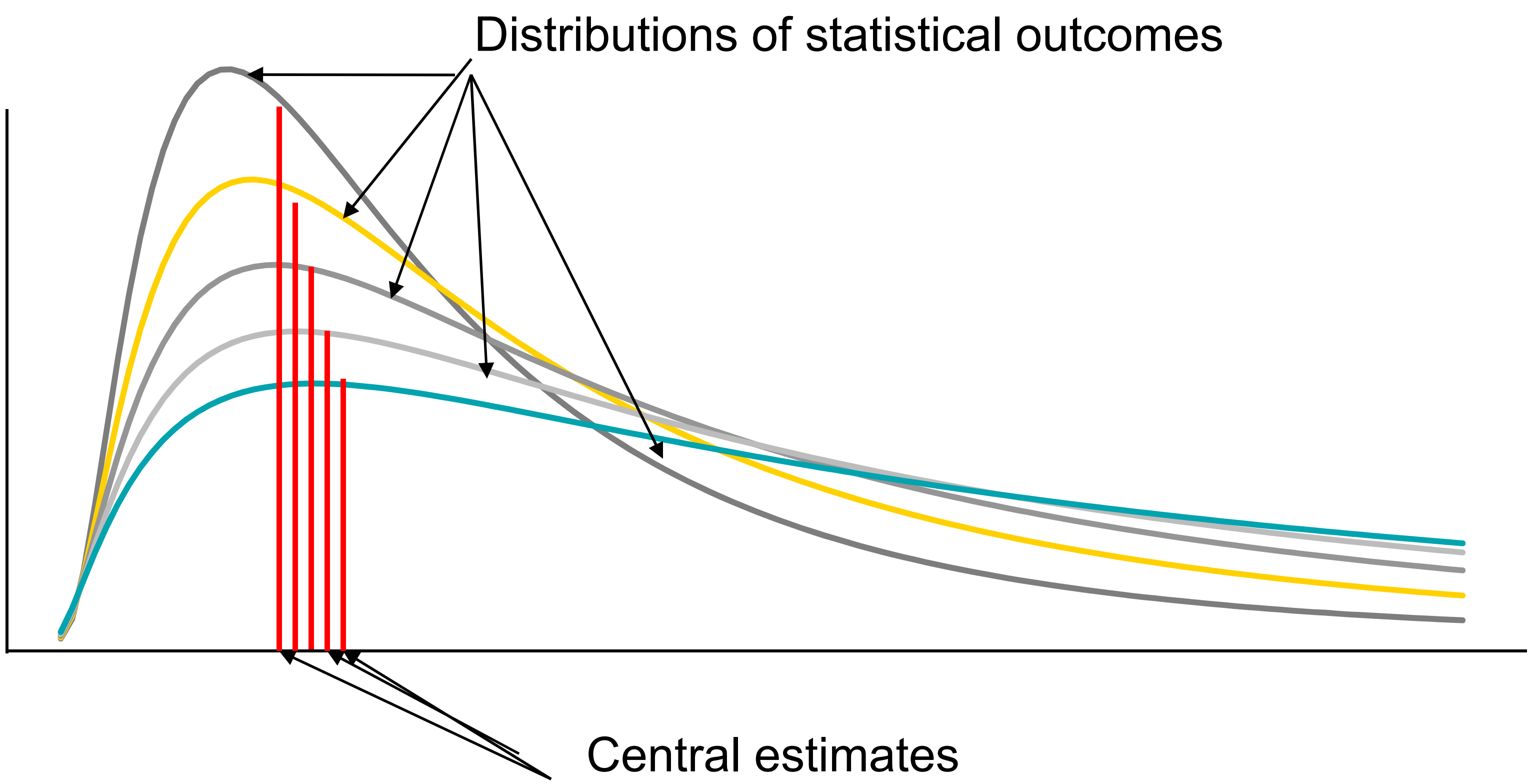
Estimates vs. outcomes

- A range of reasonable estimates is not the same as a range of possible outcomes.
- A range of possible outcomes or *distribution* is a statistical function that attempts to quantify the probabilities of all possible outcomes, including those that are very unlikely.
- *A range of reasonable estimates* is produced by evaluating different actuarial methods or alternative sets of assumptions that the actuary judges to be reasonable.
- *A range of reasonable estimates* is a range of the reasonable values that an actuary could produce as an actuarial central estimate.
- *A range of reasonable estimates considers primarily parameter and model risk, not process risk.*

What is a reserve range?



What is a reserve range? (cont'd)



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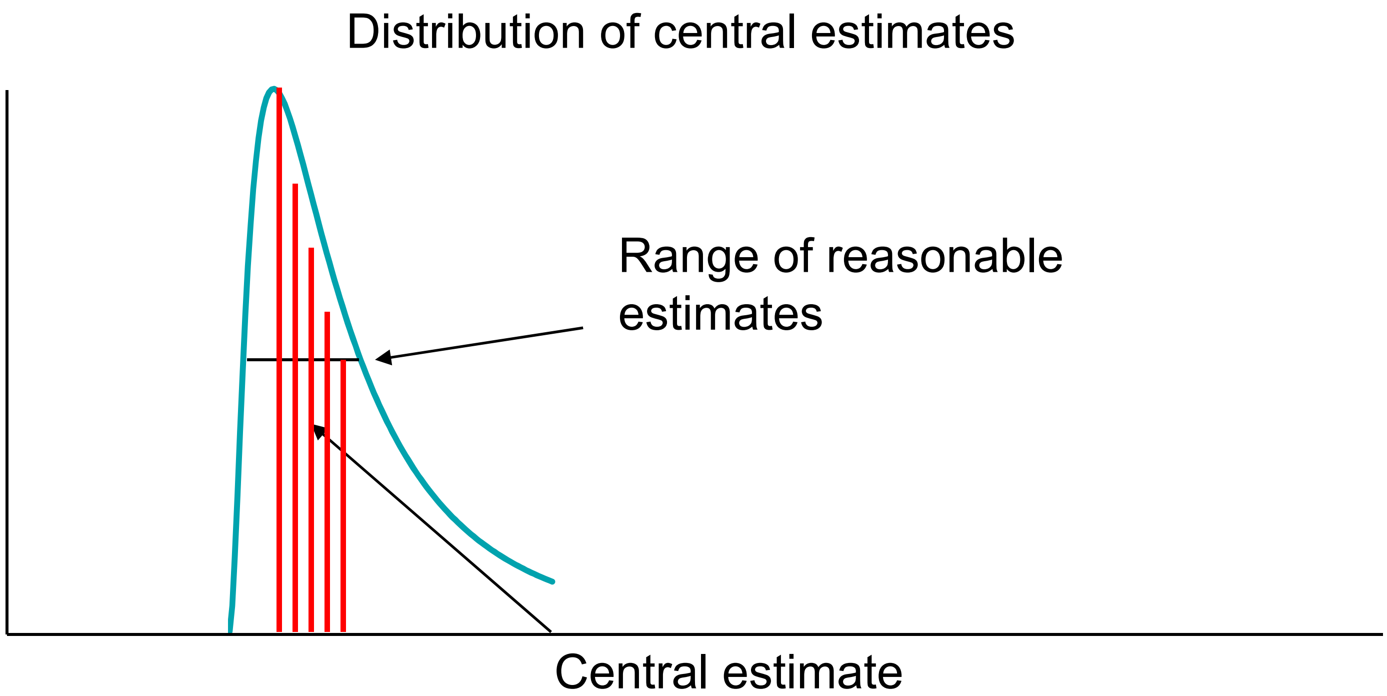
What is a reserve range? (cont'd)



Guidance

Two types of guidance on ranges

- ASOPs 36 and 43[1] provide high-level guidance on development of ranges.
  - However, this guidance is vague.
- Actuarial literature (Mack [1993][2], England and Verrall[3] [2002, 2007]) describes advanced techniques on range variability.
  - Use of these methods for ranges may or may not be appropriate.

[1] ASOP No 36 references are to the official released revision of the original ASOP No 36 (http://www.actuarialstandardsboard.org/pdf/asops/asop036_153.pdf), adopted December 2010, and the ASOP No 43 references are to the official release adopted June 2007 (http://www.actuarialstandardsboard.org/pdf/asops/asop043_106.pdf)

[2] All mentions of Mack refer to Mack, T., *Distribution-free calculation of the standard error of chain ladder reserves estimates, ASTIN Bulletin 23/2, 213-225, 1993.*

[3] All mentions of England and Verrall refer to England, P.D. and Verrall, R.J., *Stochastic claims reserving in general insurance, British Actuarial Journal 8/3, 443-518, 2002.*

ASOP No. 43: *Property/Casualty Unpaid Claim Estimates*

- Introduces the concept of a "central estimate"
- 2.1 "*Actuarial Central Estimate* — An estimate that represents an expected value **over the range of reasonably possible outcomes** …"
- 3.3.a.1 "… Such range of reasonably possible outcomes may not include all conceivable outcomes, as, for example, it would not include conceivable extreme events where the contribution of such events to an expected value is not reliably estimable. An actuarial central estimate may or may not be the result of the use of a probability distribution or a statistical analysis. This description is intended to clarify the concept rather than assign a precise statistical measure, as commonly used actuarial methods typically do not result in a statistical mean …"

ASOP No. 43: *Property/Casualty Unpaid Claim Estimates* (cont'd)

- 4.2.a "*Additional Disclosures* — 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."

ASOP No. 43: *Property/Casualty Unpaid Claim Estimates* (cont'd)

- 3.6.8 "*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."

ASOP No. 36: *SAOs regarding Property/ Casualty Loss and Loss Adjustment Expense (LAE) Reserves*

- 3.7 "*Reserve Evaluation* — The actuary **should consider a reserve to be reasonable if it is within a range of estimates that could be produced by an unpaid claim estimate analysis …"** that is, in the actuary's professional judgment, consistent with both ASOP No. 43, *Property/Casualty Unpaid Claim Estimates,* and the identified stated basis of reserve presentation.
- 3.7.1 "*Evaluation Based on Actuary's Unpaid Claim Estimates* — When developing unpaid claim estimates to evaluate the reasonableness of a reserve, the actuary may develop a point estimate, a range of estimates, or both. **The actuary should be guided by ASOP No. 43 for the development of these unpaid claim estimates."**

Mack (1993)

Distribution-free Calculation of the Standard Error of Chain Ladder Reserve Estimates

- Formula to calculate the standard error of the chain ladder reserve estimates
- Works with almost no assumptions
- Reflects both the parameter variance and the process variance
- A template for the method is available for free download on the CAS website

England and Verrall (2002, 2007)

Stochastic Claims Reserving in General Insurance

- Discussed a wide range of stochastic reserving models, including bootstrapping
  - Powerful, yet simple, technique to obtain information from a single sample of data
  - Achieved by repeated re-sampling of data with replacement
  - Sampled data must be independent and identically distributed (residuals in most cases)
  - Estimates the full distribution of the sampled data

Comparison of alternative approaches

Approach to analysis

- Motivation
  - There are a number of different methods currently being used to develop ranges of reasonable actuarial central estimates.
  - What are these methods and how do they differ?
- Approach
  - Apply some of these commonly used methods to a sample dataset to understand how the methods differ and interpret the results.
  - Provide a working example of the various methods and calculations.

List of methods considered

1. Flat percentage adjustment
2. Function of results from different methods
3. Sensitivity testing of key assumptions
4. Low and high reasonable assumption sets
5. Mack method
6. Bootstrap chain ladder

Dataset

- A mid-sized insurance company's workers' compensation loss data
- NAIC annual statement Schedule P
  - Paid and reported loss and defense and cost containment (DCC) triangles
  - Reported claims triangle
  - Earned premiums by accident year

Best estimate actuarial assumptions

- Selection of development factors, loss ratios and ultimate losses
- Tail development factor based on an inverse power curve fit
- Generally accepted actuarial methods were calculated, including the paid and reported development methods and Bornhuetter-Ferguson method
- Ultimate loss and DCC were selected using a combination of reported loss development method and Bornhuetter-Ferguson method
- Selected reserve for loss and DCC of US$288.8 million

Best estimate calculation

December 31, 2011 (dollar amounts are in US$000s)

Accident period ending 12/31	Reported LDF method	Reported B-F method	Selected ultimate	Total paid as of 12/31	Selected reserve
2002	**106,646**	106,606	106,646	100,679	5,967
2003	**116,440**	116,322	116,440	108,231	8,209
2004	**119,214**	119,505	119,214	110,545	8,669
2005	**122,562**	123,790	122,562	111,615	10,947
2006	**146,202**	146,571	146,202	129,254	16,948
2007	**150,765**	**150,279**	150,522	129,664	20,858
2008	**159,250**	**159,756**	159,503	133,013	26,490
2009	**148,644**	**148,136**	148,390	111,574	36,816
2010	154,941	**151,668**	151,668	90,499	61,169
2011	140,032	**133,665**	133,665	40,972	92,693
Total	1,364,695	1,356,298	1,354,813	1,066,046	288,767

Flat percentage adjustment

- Often based on the actuary's experience with a certain line of business and the perceived variability in the estimation of loss and loss adjustment expense liabilities for the given line
- Example
  - Personal lines
    - Auto, homeowners +/-5%
  - Commercial lines:
    - Auto, workers' compensation +/-7.5%
    - General liability +/-10%
    - Products liability, medical malpractice +/-15%
    - Construction defect, asbestos and environmental exposures +/-25%

Flat percentage adjustment (cont'd)

- +/- 10% reserve from best estimate
- Judgmental selection

Accident period ending 12/31	Selected best estimate	Low estimate	High estimate	Low %	High %
2002	5,967	5,370	6,563	-10.0%	10.0%
2003	8,209	7,389	9,030	-10.0%	10.0%
2004	8,669	7,802	9,536	-10.0%	10.0%
2005	10,947	9,852	12,041	-10.0%	10.0%
2006	16,948	15,253	18,643	-10.0%	10.0%
2007	20,858	18,772	22,944	-10.0%	10.0%
2008	26,490	23,841	29,139	-10.0%	10.0%
2009	36,816	33,135	40,498	-10.0%	10.0%
2010	61,169	55,052	67,286	-10.0%	10.0%
2011	92,693	83,424	101,963	-10.0%	10.0%
Total	288,767	259,890	317,644	-10.0%	10.0%

Function of results from different methods

- Used standard deviation as an example
- For each accident period:
  - Assumed reserve follows normal distribution
  - Mean = best estimate
  - Standard deviation = standard deviation between paid/report LDF/BF methods
  - Used 25th and 75th percentile of the distribution as the range
- Sum ranges over all accident periods

Function of results from different methods (cont'd)

Accident period ending 12/31	Selected best estimate	SD of diff. methods	Low estimate	High estimate	Low %	High %
2002	5,967	2,201	4,484	7,450	-24.9%	24.9%
2003	8,209	3,079	6,134	10,285	-25.3%	25.3%
2004	8,669	2,687	6,858	10,480	-20.9%	20.9%
2005	10,947	2,915	8,982	12,911	-17.9%	17.9%
2006	16,948	4,041	14,225	19,672	-16.1%	16.1%
2007	20,858	4,268	17,982	23,734	-13.8%	13.8%
2008	26,490	1,690	25,351	27,629	-4.3%	4.3%
2009	36,816	1,389	35,880	37,753	-2.5%	2.5%
2010	61,169	5,903	57,191	65,148	-6.5%	6.5%
2011	92,693	9,059	86,588	98,799	-6.6%	6.6%
Total	288,767		263,673	313,860	-8.7%	8.7%

Sensitivity testing of key assumptions

- Recalculation of point estimates using alternative key assumptions
- Alternative selection of tail development factors and initial expected loss ratios
- Low: combination of optimistic assumptions
- High: combination of pessimistic assumptions
- Otherwise, same methodology as the best estimate

Sensitivity testing of key assumptions (cont'd)

Accident period ending 12/31	Selected best estimate	Low estimate	High estimate	Low %	High %
2002	5,967	5,478	6,450	-8.2%	8.1%
2003	8,209	7,676	8,737	-6.5%	6.4%
2004	8,669	8,123	9,209	-6.3%	6.2%
2005	10,947	10,385	11,502	-5.1%	5.1%
2006	16,948	16,278	17,611	-4.0%	3.9%
2007	20,858	20,155	21,604	-3.4%	3.6%
2008	26,490	25,570	27,484	-3.5%	3.8%
2009	36,816	35,945	37,763	-2.4%	2.6%
2010	61,169	59,879	62,671	-2.1%	2.5%
2011	92,693	90,642	95,111	-2.2%	2.6%
Total	288,767	280,130	298,142	-3.0%	3.2%

Low and high reasonable assumption sets

- Recalculation of point estimates using alternative sets of assumptions
- Reselection of lower and higher reasonable loss development factors for every development age; tail factors are based on inverse power curve fit of selected development factors
- Alternative selections of initial expected loss ratios
- Low: combination of optimistic assumptions
- High: combination of pessimistic assumptions
- Otherwise, same methodology as the best estimate

Low and high reasonable assumption sets (cont'd)

Accident period ending 12/31	Selected best estimate	Low estimate	High estimate	Low %	High %
2002	5,967	5,478	6,450	-8.2%	8.1%
2003	8,209	7,618	8,795	-7.2%	7.1%
2004	8,669	7,957	9,377	-8.2%	8.2%
2005	10,947	10,103	11,787	-7.7%	7.7%
2006	16,948	15,722	18,173	-7.2%	7.2%
2007	20,858	19,350	22,458	-7.2%	7.7%
2008	26,490	24,104	29,046	-9.0%	9.6%
2009	36,816	34,281	39,210	-6.9%	6.5%
2010	61,169	57,887	63,998	-5.4%	4.6%
2011	92,693	88,425	96,867	-4.6%	4.5%
Total	288,767	270,923	306,162	-6.2%	6.0%

Mack method

- “Distribution-free” chain ladder (loss development) method
- Thomas Mack (1993) provided formula for reserve variances under this method
- Used Mack method template from CAS website
- Assumed same CV percentages by accident period apply to our best estimate reserves
- For each accident period:
  - Assume reserve follows normal distribution
  - Mean = best estimate
  - Standard deviation = Mack CV * best estimate
  - Used 25th and 75th percentiles as ranges
- Sum ranges over all accident periods

Mack method (cont'd)

December 31, 2011 (dollar amounts are in US$000s)

Accident period ending 12/31	Selected best estimate	CV %	Low estimate	High estimate	Low %	High %
2002	5,967	25%	4,971	6,962	-16.7%	16.7%
2003	8,209	25%	6,840	9,579	-16.7%	16.7%
2004	8,669	58%	5,291	12,047	-39.0%	39.0%
2005	10,947	27%	8,987	12,906	-17.9%	17.9%
2006	16,948	18%	14,897	18,999	-12.1%	12.1%
2007	20,858	13%	19,075	22,641	-8.5%	8.5%
2008	26,490	10%	24,744	28,236	-6.6%	6.6%
2009	36,816	7%	34,996	38,636	-4.9%	4.9%
2010	61,169	6%	58,837	63,502	-3.8%	3.8%
2011	92,693	7%	88,506	96,881	-4.5%	4.5%
Total	288,767		267,144	310,390	-7.5%	7.5%

Bootstrap chain ladder

- Developed full distribution of outcomes
- Used chain ladder on a paid-loss basis as underlying model
- Re-sampled Pearson Residuals for each simulation
- Tail factors fitted with inverse power curve for each simulation
- Assumed tail factor to have the same variability as the last development factor where variance can be calculated
- Assumed age-to-age development to follow normal distribution
- Took the 5th and 95th percentiles from the simulated results

Bootstrap chain ladder (cont'd)

- Take weighted average of loss development factors from loss data
- Calculate Pearson Residuals for individual factors in the triangle
- Re-sample with replacement from the triangle of residuals
- Perform reverse calculation to obtain re-sampled development factors
- Simulate loss development one step at a time following normal distribution to obtain the ultimate losses
- Repeat 1,000 times

Bootstrap chain ladder (cont'd)

Accident period ending 12/31	Selected best estimate	Low estimate	High estimate	Low %	High %
2002	5,967	5,182	6,926	-13.1%	16.1%
2003	8,209	7,345	9,267	-10.5%	12.9%
2004	8,669	7,321	10,134	-15.5%	16.9%
2005	10,947	9,758	12,257	-10.9%	12.0%
2006	16,948	15,635	18,438	-7.7%	8.8%
2007	20,858	19,696	22,163	-5.6%	6.3%
2008	26,490	25,414	27,595	-4.1%	4.2%
2009	36,816	35,832	37,853	-2.7%	2.8%
2010	61,169	60,060	62,307	-1.8%	1.9%
2011	92,693	90,863	94,621	-2.0%	2.1%
Total	288,767	277,107	301,564	-4.0%	4.4%

Summary of results

Range method	Low estimate	High estimate	Low %	High %
Flat percentage adjustment	259,890	317,644	-10.0%	10.0%
Function of different methods	263,673	313,860	-8.7%	8.7%
Sensitivity testing of key assumptions	280,130	298,142	-3.0%	3.2%
Low/high reasonable assumption sets	270,923	306,162	-6.2%	6.0%
Mack method	267,144	310,390	-7.5%	7.5%
Bootstrap chain ladder	277,107	301,564	-4.0%	4.4%

Aggregated reserve ranges

- ASOP 43 states that:

  "… consideration should be given to whether the components are independent of each other or whether they are correlated"

- "Components" could be interpreted as different lines of business, accident years and so forth.
- Correlation between these components would imply a decreased width of the aggregated range
- Two examples presented in following slides:
  - Covariance adjustment
  - Simulation using correlation matrix

Covariance adjustment

- Uses a formula similar to a variance calculation
  - Perfectly correlated risks: $\sigma_{x+y} = \sigma_x + \sigma_y$
  - Independent risks: $\sigma_{x+y} = (\sigma_x^2 + \sigma_y^2)^{1/2}$
  - Generalized formula: $\sigma_{x+y} = (\sigma_x^\alpha + \sigma_y^\alpha)^{1/\alpha}$
  - α = 1 implies perfect correlation between years (or lines)
  - α = 2 implies independence between years (or lines)
  - α between 1 and 2 implies imperfect correlation
- Standard deviation is then defined as the difference between the point estimate and the low estimate for a given year (or line) or, similarly, the difference between the point and high

Covariance adjustment (cont'd)

Accident year	Point estimate	Low estimate	α =	Low 1.00	Low 1.25	Low 1.50	Low 1.75	Low 2.00
2009	100	95	(Point-low)^α	5	7	11	17	25
2010	100	90	(Point-low)^α	10	18	32	56	100
2011	100	80	(Point-low)^α	20	42	89	189	400
			[Σ (Point-low)^α] $^{(1/\alpha)}$	35	29	26	24	23
Total	300	265	Aggregate range	**265**	**271**	**274**	**276**	**277**
Range width		-12%	Range width	**-12%**	**-10%**	**-9%**	**-8%**	**-8%**

- Aggregate standard deviation = [Σ (Point-low)^α]$^{1/\alpha}$
- Aggregate range = Point – Aggregate standard deviation

Covariance adjustment (cont'd)

Adjustment factor	Low estimate	High estimate	Low %	High %
1.00	262,575	311,274	-9%	8%
1.25	271,613	303,607	-6%	5%
1.50	275,676	300,173	-5%	4%
1.75	277,870	298,330	-4%	3%
2.00	279,194	297,226	-3%	3%

Best estimate 288,767

Simulation using correlation matrix

- Select a distribution for each line of business (e.g. lognormal)
  - Determine the parameters for each selected distribution
    - E.g. σ and μ can be solved for by assigning:

      Low estimate -> 35^{th} percentile

      Select estimate -> Mean

      High estimate -> 85^{th} percentile
- Select a correlation matrix
  - Determine correlation factors for each pair
  - Consider common factors that may produce correlated estimation errors
    - Model and parameter risk
    - Tail factor
    - Trend factors
    - Market cycle

Simulation using correlation matrix (cont'd)

Examples of a Correlation Matrix:

- Straight Sum (Perfectly Correlated)

	Line 1	Line 2	Line 3	Line 4	Line 5
Line 1	**1**	1	1	1	1
Line 2	1	**1**	1	1	1
Line 3	1	1	**1**	1	1
Line 4	1	1	1	**1**	1
Line 5	1	1	1	1	**1**

- Independence (Zero Correlation)

	Line 1	Line 2	Line 3	Line 4	Line 5
Line 1	**1**	0	0	0	0
Line 2	0	**1**	0	0	0
Line 3	0	0	**1**	0	0
Line 4	0	0	0	**1**	0
Line 5	0	0	0	0	**1**

- Partial Correlation

	Line 1	Line 2	Line 3	Line 4	Line 5
Line 1	**1**	1	0.25	0.5	0.5
Line 2	1	**1**	0.25	0.5	0.5
Line 3	0.25	0.25	**1**	0.25	0.25
Line 4	0.5	0.5	0.25	**1**	0.25
Line 5	0.5	0.5	0.25	0.25	**1**

- Apply a simulation
- Aggregate the results
- Select the low & high endpoints
  - E.g. Lognormal distribution

    Low Point = 35th %-ile

    Select = Mean

    High = 85th %-ile

Which approach makes sense?

Survey – overview

- Goal:

  To determine how actuaries are actually developing a range of reasonable actuarial central estimates (ACEs) in practice

- Approach:

  Informal discussions with various reserving actuaries regarding the methods they use to develop a range of reasonable ACEs and some of their key considerations when developing that range

- Participants:

  Primarily consulting actuaries

Survey – approach

Discussion of methods and key considerations

- What methods do you typically use to develop a range of reasonable actuarial central estimates?
  - Does your approach vary by LOB, company size and such?
  - How does your range width vary by LOB, company size and such?
  - Are your ranges typically symmetric or skewed?
  - What diagnostics do you look at to determine range reasonability?
- What methods do you see other actuaries using?
- How do you feel about the stochastic methods? Do you use them? If not, why not?
- How do you typically develop an aggregate range based on the range of the various accident years or lines of business?

Survey of methods

Selected percentage

- Often used at audit or consulting firms despite lack of direct support in the analysis
- Based on “inherent uncertainty in the data.” What does this mean?
  - Experienced reserving actuaries tend to have a benchmark range width in mind akin to a B-F a priori
    - Initially based on line of business
    - Adjusted for size of company and volume of data
  - The a priori is then tested using diagnostics
    - In the aggregate, what is the spread in method estimates?
    - Are there methods that are not reliable based on the data?
    - Often combined with sensitivity testing of key assumptions

Survey of methods (cont'd)

Variability in method estimates

- Often used as a mechanical way to get a starting point range by accident year
- Combined with "does this make sense" diagnostics
  - Are the answers logical and consistent by accident year?
    - The percentage reserve range width should get wider for earlier years
    - The dollar range width should get smaller for earlier accident years
  - Does the low estimate imply negative IBNR reserves?
  - Consider extreme boundaries
    - Look at the maximum and minimum of the method estimates by year
  - Should methods be excluded from the variability calculation?

Survey of methods (cont’d)

Sensitivity test of key assumptions

- Typically used in combination with the other range methods
- Significant differences between two actuarial analyses can often be traced to the incurred loss development tail factor
- Some statistical models, such as Ben Zenwirth’s ICRFS software, allow sensitivity testing of macroeconomic trends, such as workers’ compensation medical inflation

Survey of methods (cont'd)

Low and high assumption sets

- Used by some companies for all lines of business
  - Reasonably optimistic actuary vs. conservative actuary
- Often used for highly variable loss exposures or lines of business
  - Actuary can get comfortable with a set of low assumptions and a set of high assumptions, but may not be able to get comfortable with a point estimate (i.e., flatter distribution of ACEs)
  - Asbestos and environmental, medical malpractice, construction defect
- Be careful of compounding effect of extreme assumptions
- Cost must be considered as it creates twice or three times the amount of work

Survey of methods (cont'd)

Stochastic methods — Mack, bootstrapping

- Seem to be used more at insurance companies with large actuarial departments
- Actuaries inherently want to use statistical methods, but they are hard to validate for reasonability
- Can be tested against history and recent studies
- With Solvency II and other capital modeling regimes gaining traction, actuaries may be moving toward more stochastic methods but will need to distinguish between ranges of ACEs vs. outcomes

Survey of methods (cont'd)

Stochastic methods — Mack, bootstrapping (cont'd)

- Why not?
  - Still has a black box feel and would only be considered in combination with other approaches
  - Macroeconomic factors are not reflected in these methods, which could have a large impact on certain lines of business
  - Bootstrapping does not help you understand the distribution of the mean, but gives you variability around the mean; i.e., uncertainty in the ACE implies uncertainty in the outcomes, but not necessarily the other way around
  - Aggregate modeling still misses out on variability (process risk) that can only be captured by modeling individual claim data

Survey of methods (cont'd)

Aggregate ranges

- Rarely used in ranges of ACEs whereas capital models tend to require correlation assumptions
  - Adding up lows and adding up highs assumes 100% correlation; if one year or line of business goes bad, they will all go bad. Is this reasonable?
- Two methods were brought up in discussion
  - Both consider the extreme cases of 100% correlated vs. 100% independent with the general consensus that a reasonable estimate is probably somewhere in between
  - Accident years will be more correlated than lines of business; i.e., a conservative tail factor will impact all years

Survey – key considerations

- Are the end points of your range supportable by your analysis? They are ACEs as well
  - Range will be scrutinized in more detail if management's best estimate falls near one of the end points
  - Reconciliations between the actuarial range and management's best estimate need to be documented
- Most actuaries have an a priori benchmark range width in mind – challenge these assumptions
  - Use multiple range methods, if possible
- Consider stakeholders
  - Management – support for carried reserve
  - Auditors – reasonableness

Conclusions

- Define and consider the purpose and context of your range (estimates vs. outcomes)
- Be aware that different approaches can produce very different results
- Consider multiple methods and challenge them for reasonability
- Consider correlations when developing aggregate ranges

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