Applications of Reserve Ranges and Variability in Practice

Casualty Loss Reserve Seminar
September 2016

Chicago, Illinois

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- Enjoy the exchange of information and ideas.
- Contribute.

Your Panelists

- Christopher Walker, FCAS, MAAA
  - Principal, PwC-Chicago
- Mark Littmann, FCAS, MAAA
  - Principal, PwC-Hartford

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Outline for our Discussion

- Distributions & Ranges
- Business Applications
- Concepts in the Literature
- Approaches in Practice
- Illustrations
- Aggregate Ranges
- Take-Away's

This presentation is based on the panelists' paper, *Applications of Reserve Ranges and Variability in Practice*, published by the CAS in the Casualty Actuarial Forum, Fall (Volume 1) 2013.

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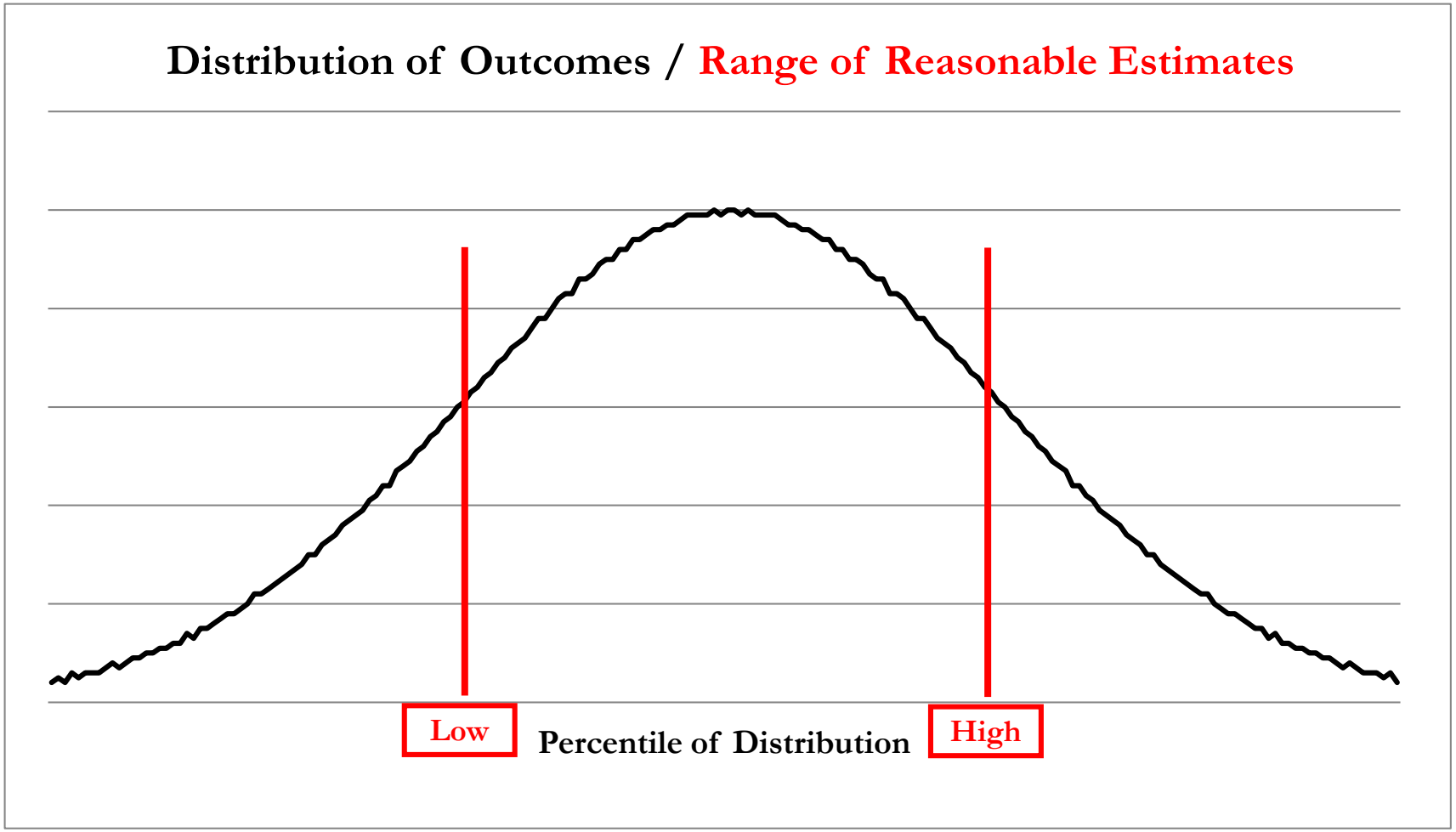
Distributions & Ranges



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Business Applications of Variability Concepts

- Statements of Actuarial Opinion and Actuarial Opinion Summary

  Discussions of the business and its qualities that may introduce variability; assessment of RMAD; optional in AOS

- Securities and Exchange Commission filings

  Discussion of analysis that developed the carried reserve and variability in that estimate; recently expanded disclosure by registrants.

- Financial Audits

  Even for non-insurance entities, "how much of a difference is too much" is a constant question in assessing self-insurance estimates

- Mergers and Acquisitions

  May affect subsequent year "true ups" or the decision to purchase third-party reinsurance, and how much.

- Internal Revenue Service Considerations

  Supportable "reasonable ranges" may factor into IRS actions.

Business Applications of Variability Concepts

- Risk Transfer Assessments

  Analysis of the potential for variability of losses subject to a (re)insurance contract; affects the manner in which the transaction may be accounted and, potentially, whether premiums paid to a captive insurer may be tax deductible

- Own Risk and Solvency Assessment (ORSA)

  Analysis of reserve variability, whether through stochastic modeling or scenario testing, contributes to a company's view on appropriate capital levels

- Modeling individual excess claims

  Analysis of potential development for claims that have exceeded or may exceed a threshold.

Variability Concepts in the Literature

- Thomas Mack Method

  "Distribution free" technique using loss development; no guidance on what constitutes "reasonable range"

- Boot-Strapping

  Simulation process with observed development being one "observation"

- Sensitivity Testing

  Not explicitly described in literature, though widely used reflecting alternative high/low assumptions

Approaches in Practice

- Stochastic Modeling

  Assuming informed models with appropriate parameterization, these can provide outcome quantiles and other statistics.

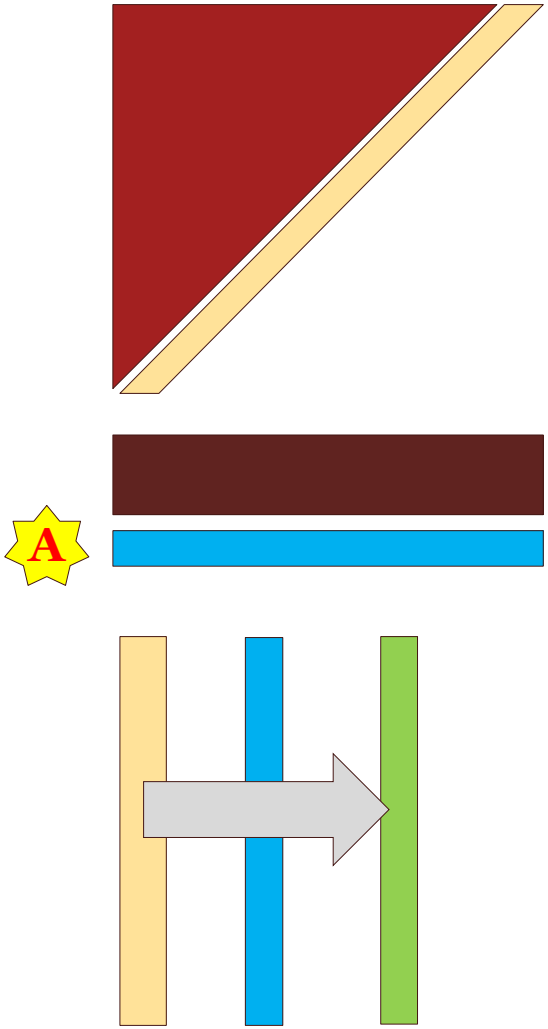
- Judgment

  Includes “rule of thumb”; lacks substantive analytical or qualitative evidence; increasingly ignored by regulators and other third parties

- Sensitivity-Testing

  Some commonalities, such as adjustment of tail factors; changes in severity assumptions; inflation; or inclusion/exclusive of large single events

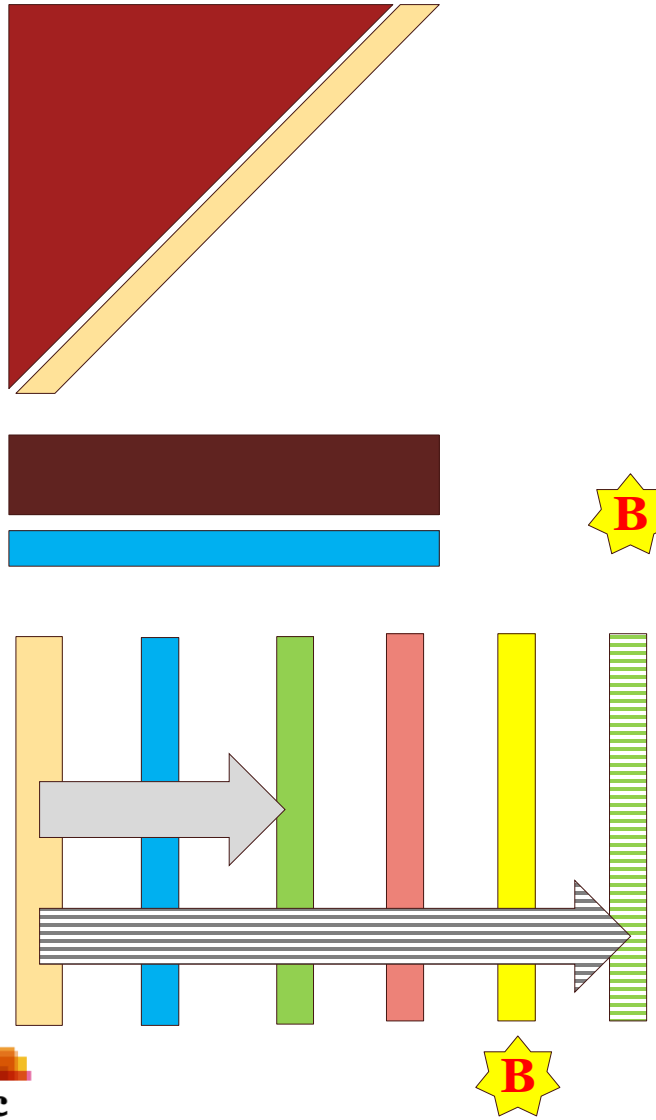
Sensitivity Testing – A Framework



Common loss development approach:

1. Gather historical development data
2. Evaluate development metrics by interval
3. Choose interval LDF's and accumulate them
4. Multiply latest data by the cumulative LDF's for a projection of ultimate

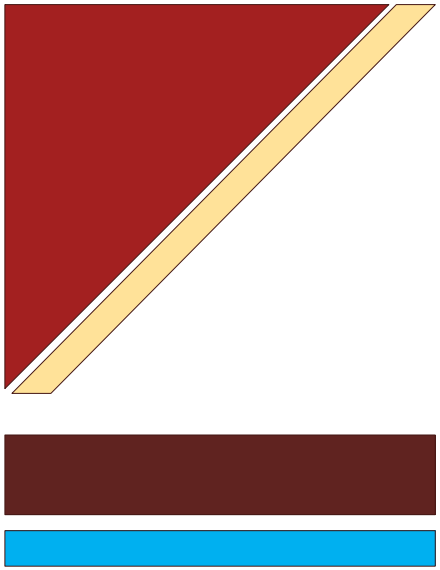
Sensitivity Testing – A Framework

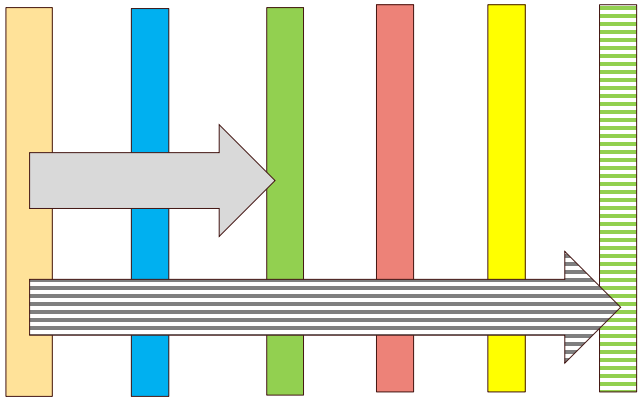


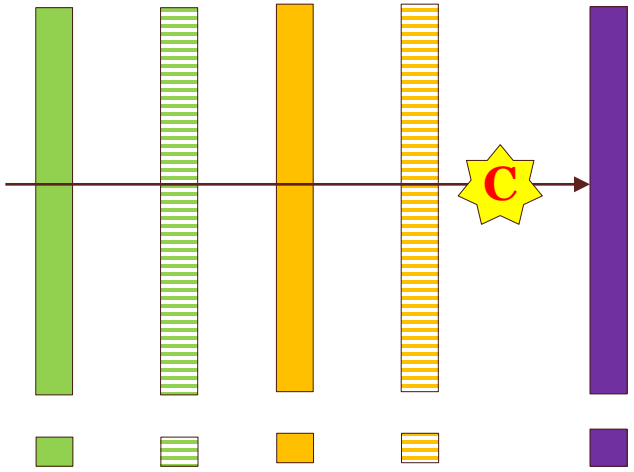
Common Bornhuetter-Ferguson approach:

1. Obtain proxy for exposure (for instance, premiums)
2. Prepare assumptions for expected loss rates
3. Along with latest data and LDF's, do the arithmetic for a projection of ultimate

Sensitivity Testing – A Framework

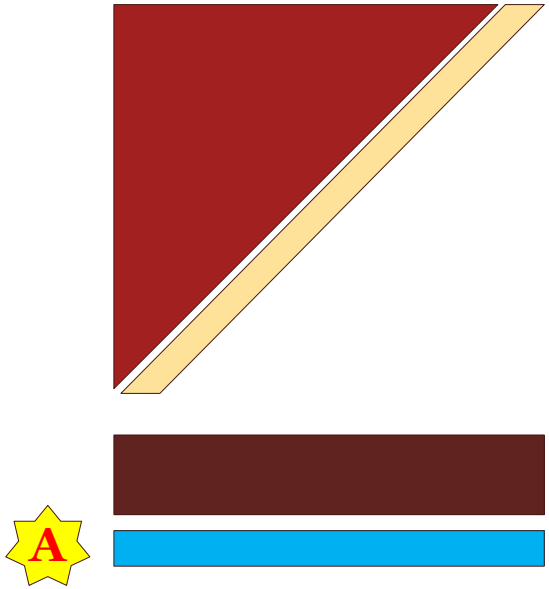


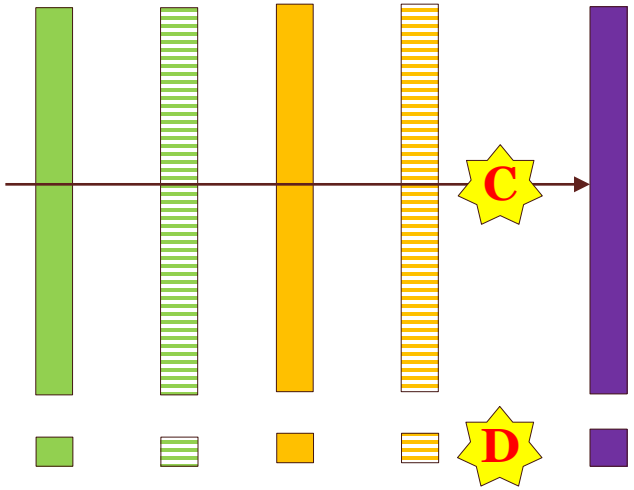


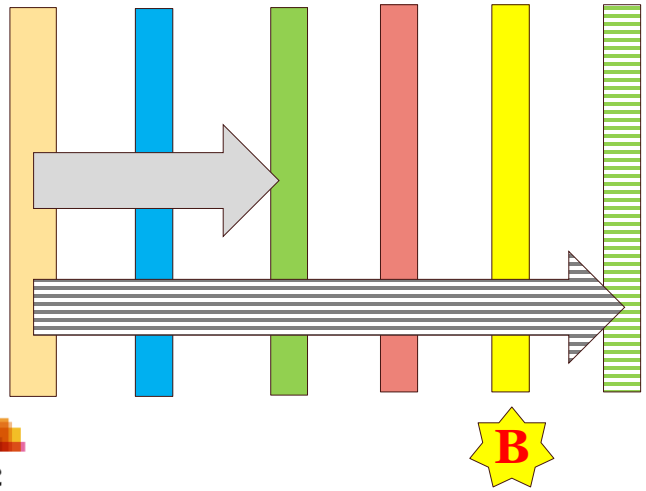


1. Prepare additional projections based on a different type of data
2. Form a view on weights (whether explicit or implicit) to select an estimate of ultimate loss for each period

Sensitivity Testing – At What Point(s)?







A – LDF's

B – ELR's

C – method, data type & period

D – method & data type (all periods)

Illustration: Sensitivity Testing

Accident Year (AY)	Preliminary Projections of Ultimate Losses: Loss Development on Paid (1)	Loss Development on Reported (2)	Bornhuetter-Ferguson on Paid (3)	Bornhuetter-Ferguson on Reported (4)	Selection (5)	Paid-to-date (6)	Estimated Unpaid (7)
1	1,127	1,157	1,127	1,157	1,147	1,127	20
2	1,179	1,193	1,179	1,193	1,188	1,178	11
3	1,089	1,119	1,090	1,119	1,109	1,086	23
4	1,128	1,169	1,129	1,169	1,155	1,120	35
5	1,608	1,634	1,603	1,634	1,626	1,584	41
6	1,418	1,466	1,416	1,465	1,451	1,358	92
7	1,430	1,463	1,430	1,463	1,453	1,291	162
8	1,440	1,473	1,456	1,476	1,464	1,177	286
9	1,800	1,782	1,693	1,739	1,778	1,198	580
10	1,597	1,565	1,574	1,564	1,570	569	1,000
Total	13,816	14,021	13,698	13,978	13,940	11,690	2,250

See Table 4 in the original paper for the set of weights applied to the four projections by year for determining the Selection (column 5).

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Illustration: Sensitivity Testing
Minimum & Maximum by Accident Year

AY	Minimum (1)	Selected (2)	Maximum (3)
1	1,127	1,147	1,157
2	1,179	1,188	1,193
3	1,089	1,109	1,119
4	1,128	1,155	1,169
5	1,603	1,626	1,634
6	1,416	1,451	1,466
7	1,430	1,453	1,463
8	1,440	1,464	1,476
9	1,693	1,778	1,800
10	1,564	1,570	1,597
Sum	13,669	13,940	14,074

	Minimum (4)	Selected (5)	Maximum (6)
Estimated Ultimate	13,669	13,669	13,669
Inception-to-date Paid	11,690	11,690	11,690
Unpaid Claim Estimate	1,979	2,250	2,385
Difference to Mean	(271)		135
Difference as % Mean	-12%		6%

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Illustration: Sensitivity Testing
Minimum & Maximum by Method

Accident Year (AY)	Preliminary Projections of Ultimate Losses: Loss Development on Paid (1)	Loss Development on Reported (2)	Bornhuetter-Ferguson on Paid (3)	Bornhuetter-Ferguson on Reported (4)	Selection (5)
Total	13,816	14,021	13,698	13,978	13,940

	Minimum (6)	Selection (7)	Maximum (8)
Ultimate Loss Projection	13,698	13,940	14,021
Paid-to-date	11,690	11,690	11,690
Unpaid Claims Estimate	2,008	2,250	2,331
Difference to Selection	(242)		81
Difference as % Selection	-11%		4%

Illustration: Sensitivity Testing

Alternate (High) Assumptions for LDF's & ELR's

AY	Estimates of Ultimate Losses			
	Baseline		Alternate (High)	
	Amount	% EP	Amount	% EP
	(1)	(2)	(3)	(4)
1	1,147	64.8%	1,147	64.8%
2	1,188	59.1%	1,188	59.1%
3	1,109	53.4%	1,109	53.4%
4	1,155	52.3%	1,155	52.3%
5	1,626	71.0%	1,628	71.1%
6	1,451	62.7%	1,457	63.0%
7	1,453	62.8%	1,467	63.4%
8	1,464	62.6%	1,487	63.6%
9	1,778	75.1%	1,824	77.0%
10	1,570	67.2%	1,646	70.5%
Sum	13,940		14,108	

See Tables 5 & 6 in the original paper for the complete set of alternate LDF's and ELR's.

Alternate (High) Estimate reflects alternate judgments for development factors and expected loss ratios:

- Incremental LDF's:
  - 1st interval: 1.38 vs. 1.35
  - 2nd interval: 1.11 vs. 1.10
  - Similar for next 4 intervals
- Expected Loss Ratios
  - Higher by 3, 2, & 1 point for the latest three periods

The same weights (as in Baseline) are used among the 4 projections.

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Illustration: Sensitivity Testing

Alternate (High) Assumptions for LDF's & ELR's

	Estimates of Ultimate Losses						
	Baseline		Alternate (High)			Unpaid Claims Estimate	
AY	Amount	% EP	Amount	% EP	**Paid-to-date**	Baseline	Alternate (High)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	1,147	64.8%	1,147	64.8%	1,127	20	20
2	1,188	59.1%	1,188	59.1%	1,178	11	11
3	1,109	53.4%	1,109	53.4%	1,086	23	23
4	1,155	52.3%	1,155	52.3%	1,120	35	35
5	1,626	71.0%	1,628	71.1%	1,584	41	44
6	1,451	62.7%	1,457	63.0%	1,358	92	99
7	1,453	62.8%	1,467	63.4%	1,291	162	176
8	1,464	62.6%	1,487	63.6%	1,177	286	309
9	1,778	75.1%	1,824	77.0%	1,198	580	626
10	1,570	67.2%	1,646	70.5%	569	1,000	1,076
Sum	13,940		14,108		11,690	2,250	2,418
						Difference	168
						Difference as % Baseline Unpaid Claims Estimate	7.5%

Illustration: Stochastic Approach – Thomas Mack Technique

	Estimated Standard Error	
AY	Paid Data	Reported Data
1		
2	1	1
3	1	1
4	1	2
5	2	2
6	21	23
7	30	33
8	31	33
9	109	76
10	166	132
All Years	219	175

Choose ESE of $197

The chosen ESE of $197 is 9% of the mean unpaid claim estimate of $2,250.

Based on the assumed distribution, the High estimate (from sensitivity testing) of $2,418 corresponds with the 80th percentile of the distribution.

Percentiles of Distribution		Unpaid Claim Estimate	
Low	High	Low	High
20%	**80%**	2,082	2,418

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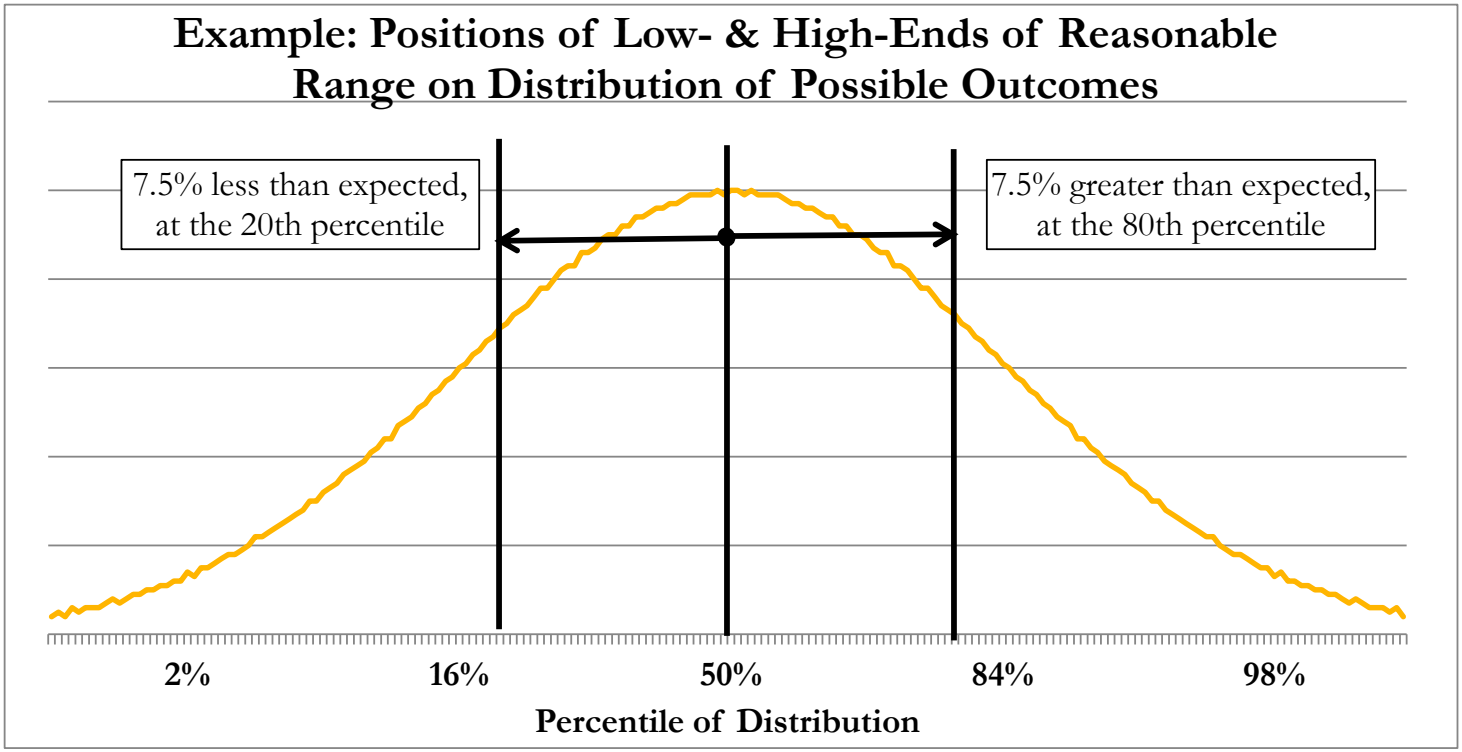
Illustration: Building a Bridge

Overlaying the Reasonable Range on the Distribution of Outcomes



2nd & 16th percentiles	amounts that are 2 & 1 standard deviations less than the mean
50th percentile	the mean amount
84th & 98th percentiles	amounts that are 1 & 2 standard deviation greater than the mean

The low/high differential from sensitivity testing ($168, 7.5%) is about 0.85 of the estimated standard error ($197, 9%) based on the Mack technique.

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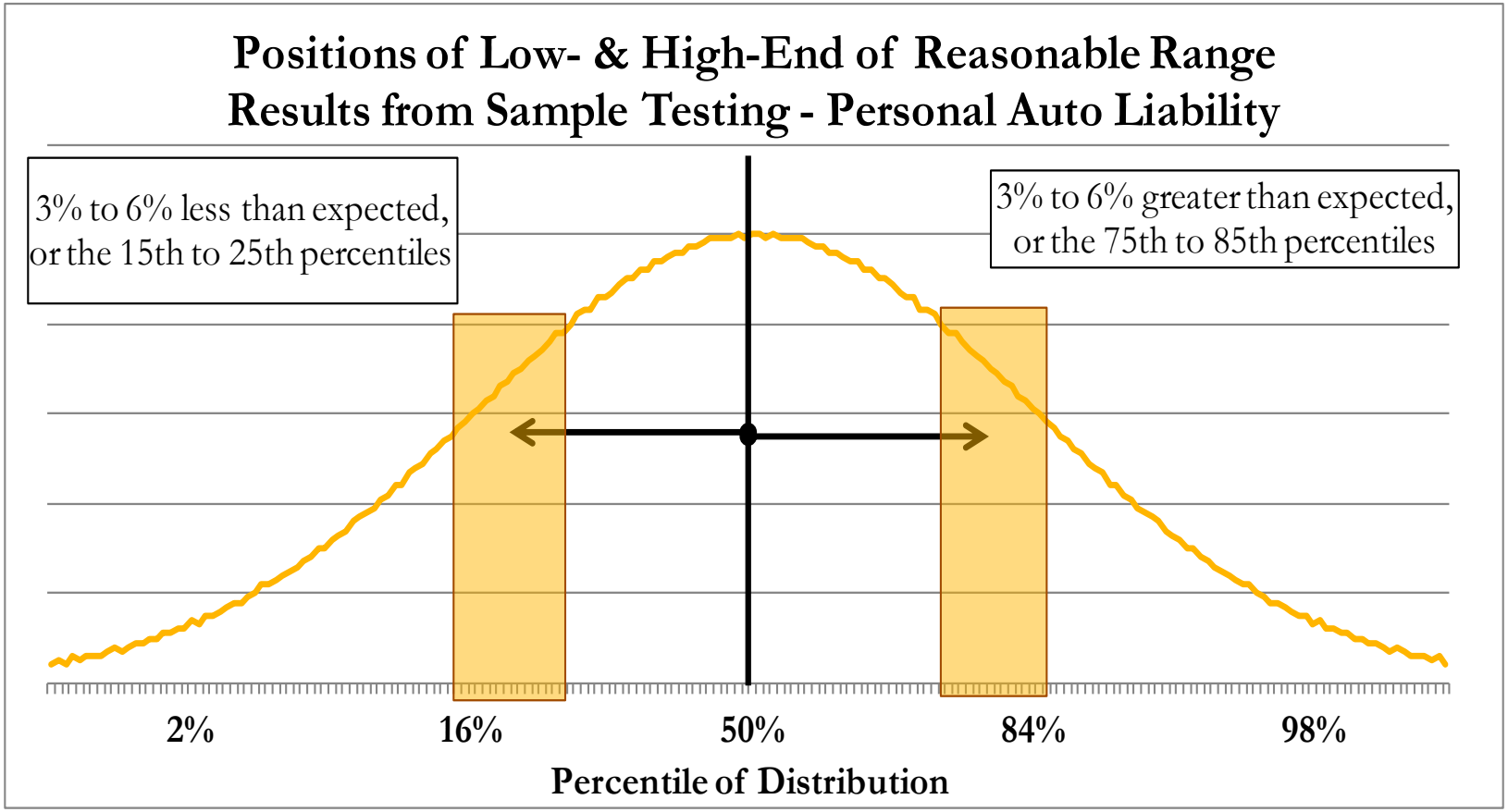
Sample Testing: Background

- Perform the sensitivity testing (varying LDF's and ELR's) and apply the Mack technique to a sample of publicly-available data
- 10 companies
- 3 lines
  - Personal Auto Liability
  - Homeowners
  - General Liability - Occurrence

Our intention was to assess a potential relationship between a sensitivity-based range of reasonable estimates with a distribution of outcomes based on a Mack approach.

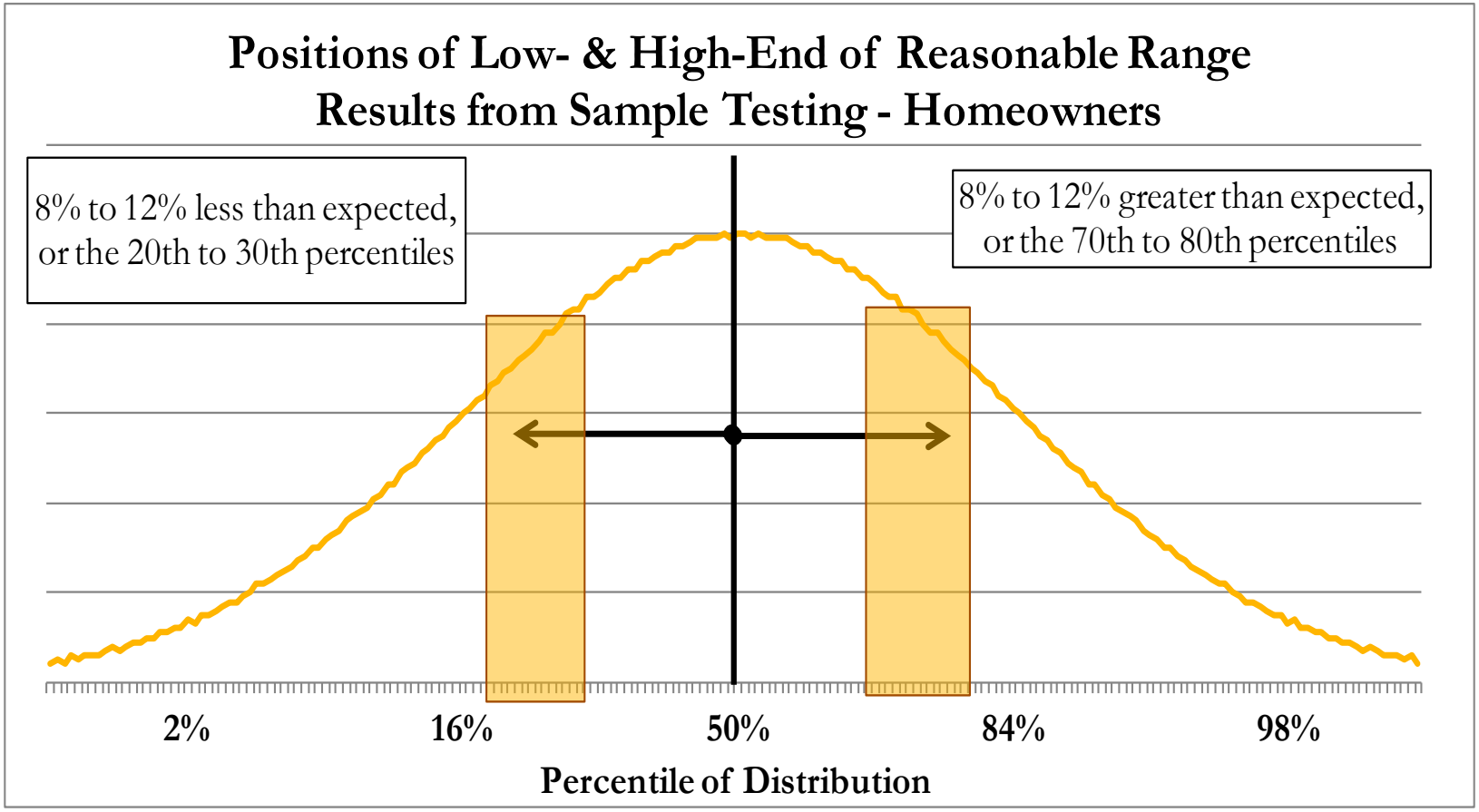
See accompanying commentary on the sample testing in Section 5.3 of the paper.

Sample Testing: Personal Auto Liability

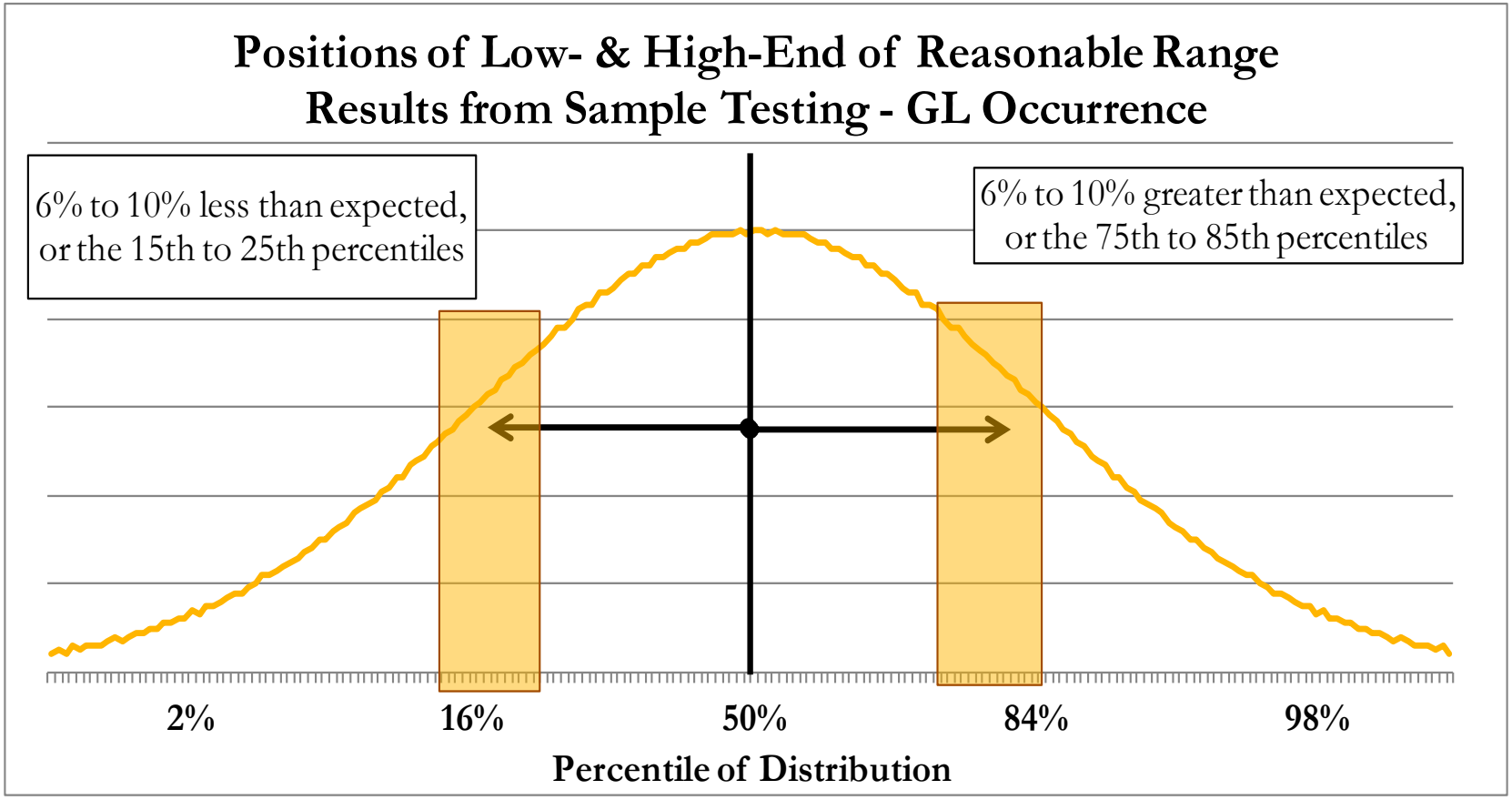


The low/high differentials from sensitivity testing tended to be about 3% to 6% of the selected estimates of unpaid claims liabilities, corresponding roughly with the 15th to 25th (and 75th to 85th) percentiles of the distribution.

Sample Testing: Homeowners



Sample Testing: GL Occurrence



Summary of Sample Testing

	High-End of Reasonable Range as % Reserves	Percentiles of Distribution aligning with High-End of Reasonable Range	# Std Dev's from Mean to High-End of Reasonable Range	Estimated Standard Deviation of Distribution as % Mean Reserve Estimate
Personal Auto Liability	3% to 6%	75th to 85th	0.7 to 1.0	3% to 7%
Homeowners	8% to 12%	70th to 80th	0.6 to 0.9	12% to 16%
GL Occurrence	6% to 10%	75th to 85th	0.7 to 1.0	6% to 12%

See accompanying commentary on the sample testing in Section 5.3 of the paper.

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Consideration of Ranges on an Aggregate Basis

Bottom-Up Approach

- Evaluate individual segments
- Aggregate segment results, considering correlations
- Aggregations at 0% correlation and at 100% correlation may be helpful
- In practice, actuaries often sum the low and high ends to develop a range of unpaid claim estimates in the aggregate.

Consideration of Ranges on an Aggregate Basis

Top-Down Approach

- Evaluate range at an aggregate level, by applying a technique (for instance, sensitivity testing or the Mack approach) to the aggregated data*

- A primary advantage is to implicitly address correlation among individual segments.

* We do not generally advocate an analysis of aggregated data for evaluating a point estimate, but consider it potentially useful to perform sensitivity testing or stochastic analysis in order to assess and inform a view on an aggregate range of reasonable estimates. The mix of underlying coverages should be relatively stable over the experience period for such an analysis of aggregate data; to the extent that there are substantial shifts of the mix of business (for instance, relative proportion of long and short tail business), we would caution against this approach.

Take-Away's

- Applications of variability of unpaid claim estimates arise in a variety of business settings; the approach must reflect the situation with appropriate disclosure regarding the type of finding being expressed.

- We believe that the days of expressions of reasonable ranges based solely on judgment or rules of thumb are over, as stakeholders seek a more-reasoned response to questions regarding the basis of a stated range.

- We believe the framework described herein is practical and can be reasonably explained to the variety of stakeholders who seek insights and points of view from actuaries on point-estimates and the associated uncertainty.

- We identified an apparent relationship between the sample ranges of reasonable estimates based on sensitivity testing and a consistent interval on the Mack-based distributions of outcomes (e.g., extending from the 20th to 30th to the 70th to 80th percentiles). This may be an area of further research.

Thank you