TOWERS PERRIN

Considerations Regarding Standards of Materiality in estimates of Outstanding Liabilities

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Agenda

- Why analyze reserve uncertainty
- Purpose of analysis
- Practical illustration of the theory
- Detailed illustration of the research
- Results and conclusions

Why analyze reserve uncertainty

Evaluating loss reserve uncertainty has many purposes

Compliance/Financial Reporting

- Regulators
  - NAIC
  - SEC
- Rating Agencies
  - AM Best
  - S&P
- Actuarial Profession
  - CAS
  - GRIT

Financial/Capital Management

- Anticipate potential for "bad news"
- Capital management
  - Evaluate "needed" surplus
- Allocation of capital
  - Reserve risk by line and branch
- Reinsurance terms
  - Consider impact over range of estimates

Operational/Strategic Excellence

- Monitor results
  - Early warning system
  - What deviations from plan are significant?
- Growth strategies
- Evaluate investments
  - Range of outcomes

Traditional applications

Value-added applications

Loss generation follows a “random” process

- The claim generation and emergence is a random process
  - Accidents happen
  - Claims are reported
  - Case reserves are set
  - Payments are made
- Stochastic reserving models formally recognize that claim generation and emergence is a random process

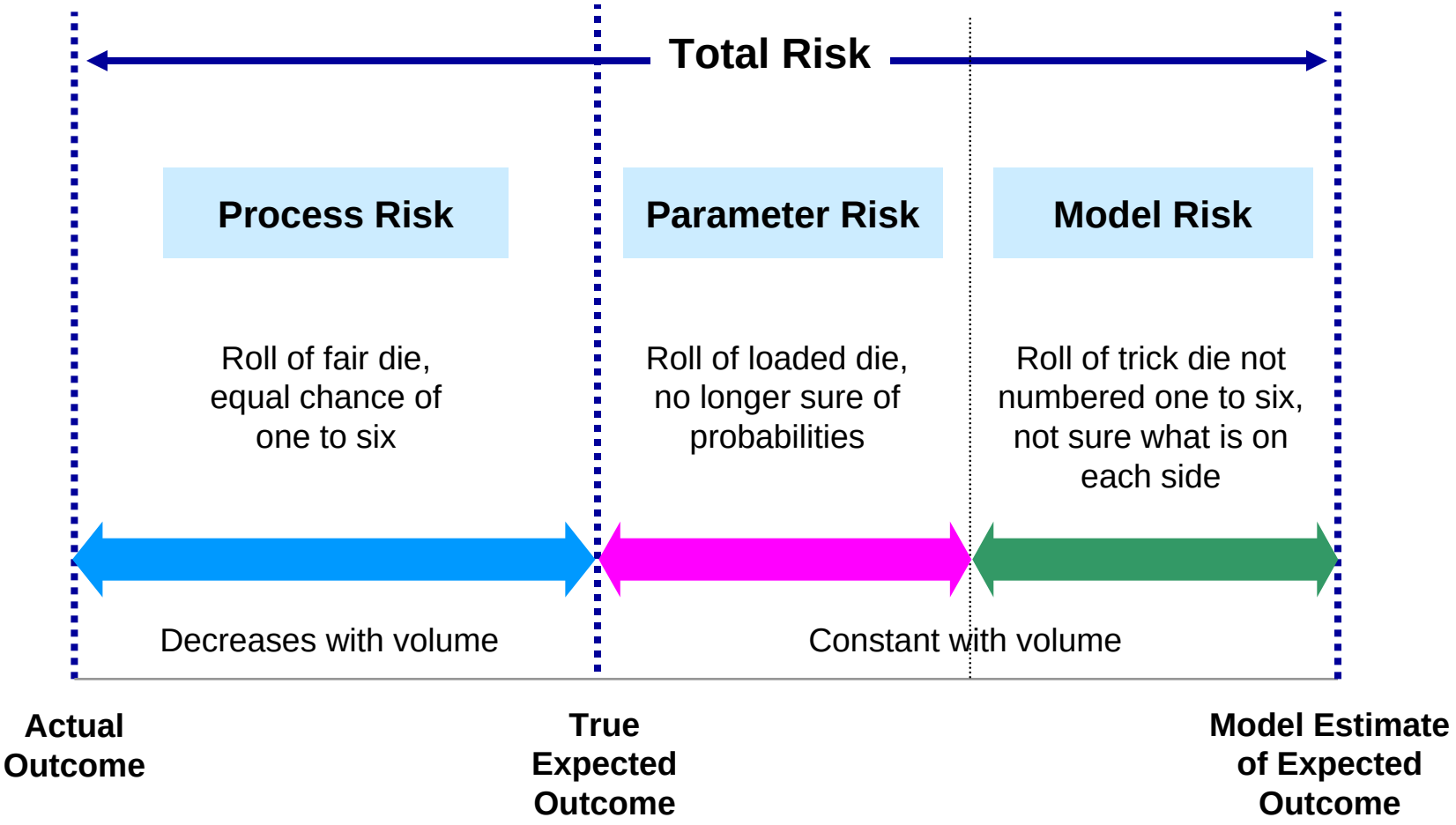
Purpose of analysis

Purpose of our intellectual capital efforts

Our research focused on the uncertainty of the claim liabilities. It tries to tackle two issues that arise from that uncertainty:

- By what amount must two estimates of claim liabilities differ to be considered materially different from each other?
  - Reserve adequacy in actuarial opinions
- What is the magnitude of the reasonable probable total deviation (adverse or favorable) in actual claim liabilities from the current estimate of expected claim liabilities?
  - Solvency/Financial impact on the company
- Materiality in the context of actuarial opinions is slightly different
  - Relates to adverse claim liability deviation that would significantly affect the viability of a company

Several distinct types of risks are inherent in the measurement of claim liabilities — the actuary and the audience need to be clear about which are relevant to a particular application



Three different perspectives of materiality

- ***Statistical perspective*:** relates to the uncertainty associated with the shape and parameters of the unknown claim liability distribution

- ***Financial perspective*:** relates to the question whether the users of the financial statements will draw different conclusions if the reported reserve figures were different
  - Balance Sheet and Income statement perspective

- ***Solvency perspective*:** links the uncertainty of the claim liabilities to the capital and claims-paying capacity of the company

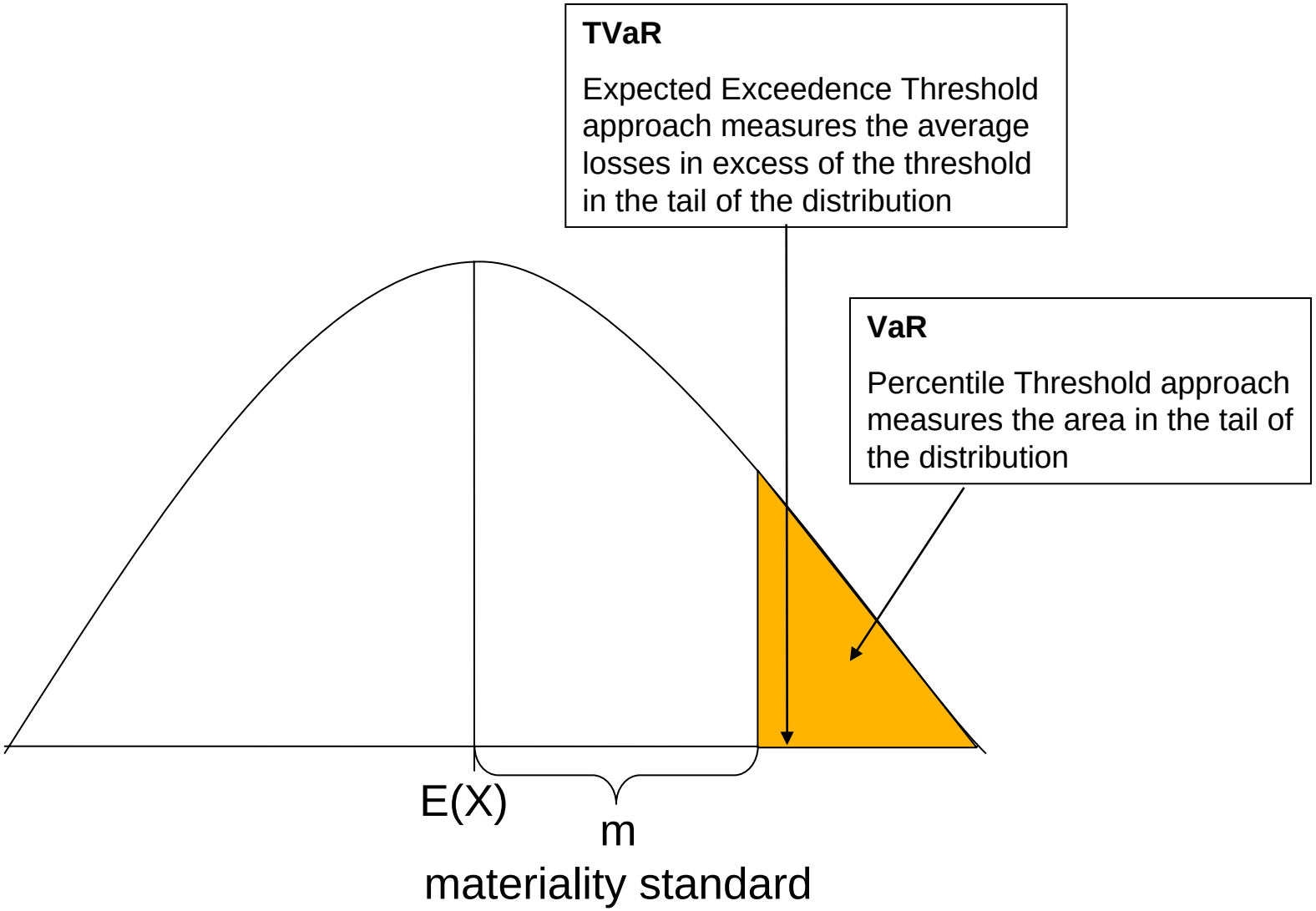
Two appropriate ranges are measured

- ***Range of Reasonable Estimates*:** range within which alternative estimates of the expected claim liabilities would deem to be immaterial
  - Difference of two reserve estimates is not **statistically** significant
  - Difference of two reserve estimates is not **financially** significant
    - Only parameter and model risk are relevant here
    - Produces Estimation materiality standards
- ***Range of Reasonable Probable Outcomes*:** range within which the alternative actual claim liabilities outcomes are expected to fall with reasonable confidence
  - Outcomes outside the range are possible but not probable
  - Outcomes within the range will not threaten the solvency of a well capitalized company
    - All types of risk are relevant here
    - Produces outcome materiality standards

Measurement of standards of materiality

- Calculate the appropriate claim liability distributions
- Appropriate materiality standards can be calculated based on the selection of a significance level threshold
- Thresholds are based on two measures of risk:
  - Percentile threshold approach (VaR): measures the probability of an outcome being worse than a given monetary threshold
  - Expected exceedence threshold approach (TVaR): measures the expected value of the amount in excess of a given monetary threshold, i.e., the expected material adverse deviation
- The TVaR approach assumes higher risk compared to the VaR approach since it is influenced by the outcomes of remote values

Two measures of risk:
Percentile Threshold (VaR)
Expected Exceedence Threshold (TVaR)



We employ the framework of a statistical hypothesis testing

- ***H_0 (Null Hypothesis):*** the two estimates of claim liabilities are not materially different from each other, i.e. $\mu_0 = \mu_1$
- ***H_1 (Alternative Hypothesis):*** the two estimates of claim liabilities are materially different from each other, i.e. $\mu_0 \neq \mu_1$
- The resulting standard of materiality m can be interpreted as a function of two primary variables among others:

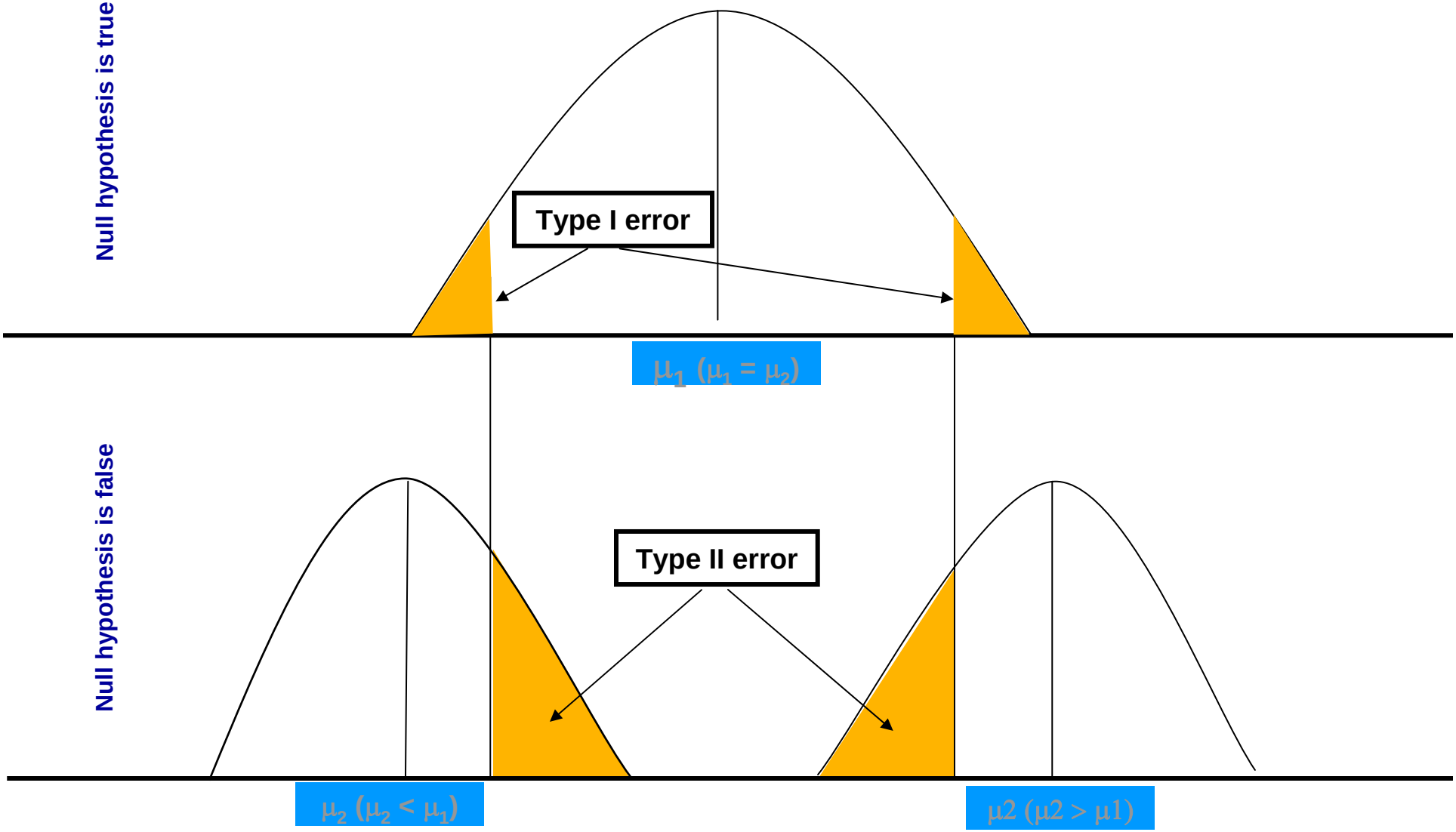
  m = f(σ,r); where

  σ: the implied volatility of the claim liability distribution in question

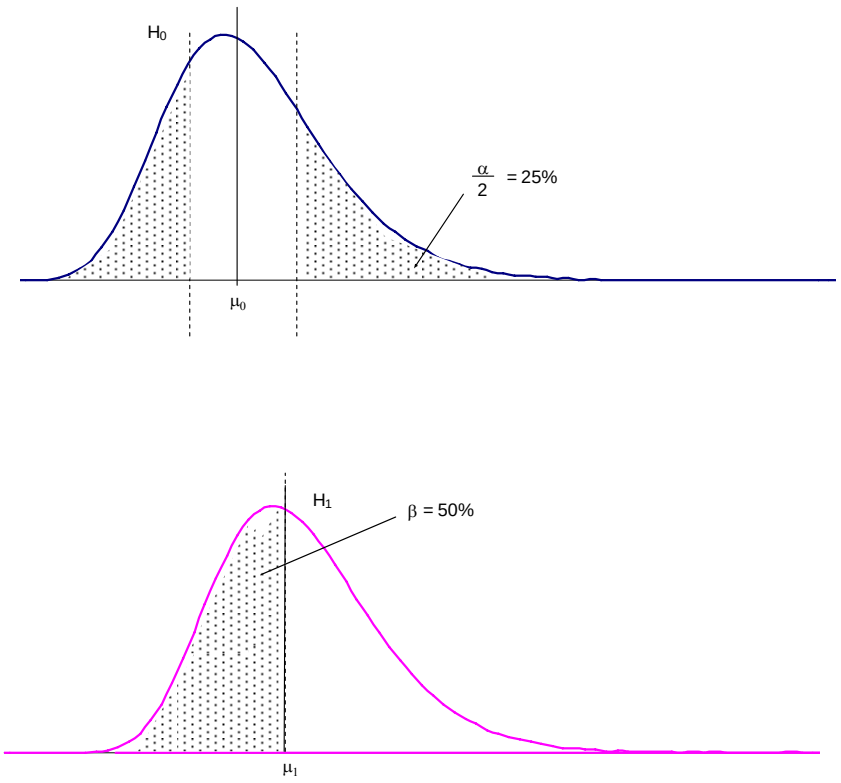
  r: the significance level threshold (the type I error under the null hypothesis approach). Facts:

- m is directly proportional to σ
  - There is a greater uncertainty associated with the claim liability estimate
  - A more volatile line will require a larger surplus allocation
- m is inversely proportional to r
  - A higher significance level implies a higher level of conservatism

Null hypothesis framework



In the context of reserve opinions, we need to know when one estimate of the liabilities is significantly different from another



- Distribution reflects the inherent uncertainty associated with any estimate of ultimate claim liabilities
- Hypothesis testing focuses on the probability of drawing the wrong conclusion
  - α = the probability of selecting the alternative estimate when the original estimate is correct
  - β = the probability of staying with the original estimate when the alternative estimate is correct
- Range of Insignificance $\alpha = \beta = 50\%$
- Significance levels defined in terms of lower value of α
- In this illustration, there is significant overlap between management's view and the external actuary's view of the underlying distribution
- Differences in estimates of ultimate liabilities are likely to represent "noise"

Other examples yield different scenarios:

Hierarchy of Difference	Test Result	Opinion Implications
Insignificant In the acceptance range defined by α = .50	Accept H_0	"Reasonable" opinion; No qualification or disclosure
Potentially Significant Outside the acceptance range defined by α = .50 In the acceptance range defined by α = .30	Accept H_0	"Reasonable" opinion; Disclosure
Significant In the rejection range defined by α = .30	Reject H_0	Adverse opinion

α for illustrative purposes only

A practical illustration of the theory

A practical illustration of the theory

- Company X carried reserve = $395 M
- Opining Actuary's mean indicated = $390 Million as follows:

Line of Business	Company X Carried Reserve ($Millions)	Opining Actuary's Indicated Reserve ($Millions)
Personal Auto Liability	$65	$55
Workers Compensation	$175	$185
Other Liability-Occurrence	$155	$150
Total	$395	$390

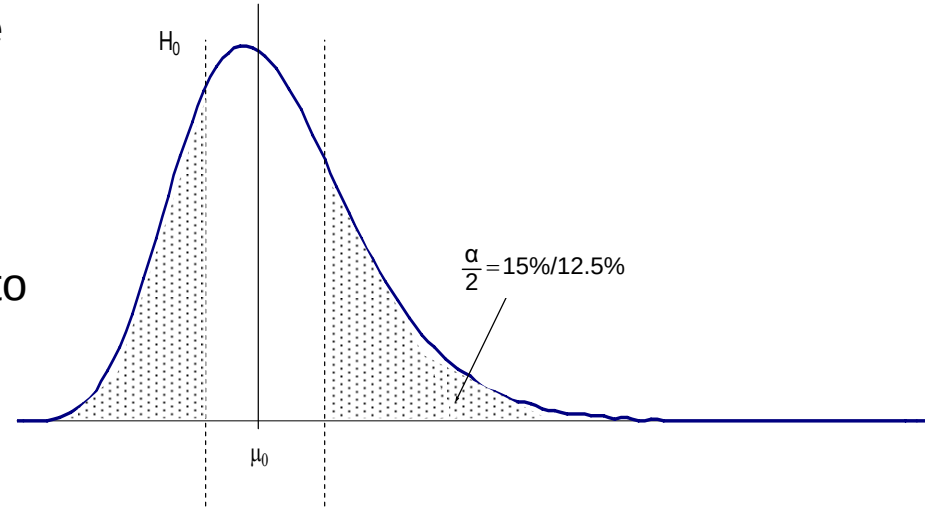
Distribution around the mean

- We employ the Mack stochastic reserving method on Company X line of business triangles to come up with the following CVs:

Line of Business	CV (Parameter Risk)
Personal Auto Liability	4.0%
Workers Compensation	5.5%
Other Liability-Occurrence	8.0%

Determination of ranges – theory

- Select ranges by line of business assuming lognormal distribution with calculated CV and mean equal to Opining Actuary's indicated using the VaR approach:
- For each line of business:
  - Range of reasonable estimates can be calculated corresponding to α = 0.30 two-tail test
  - Range of probable outcomes can be calculated corresponding to α = 0.25 two-tail test



Determination of ranges – parameters

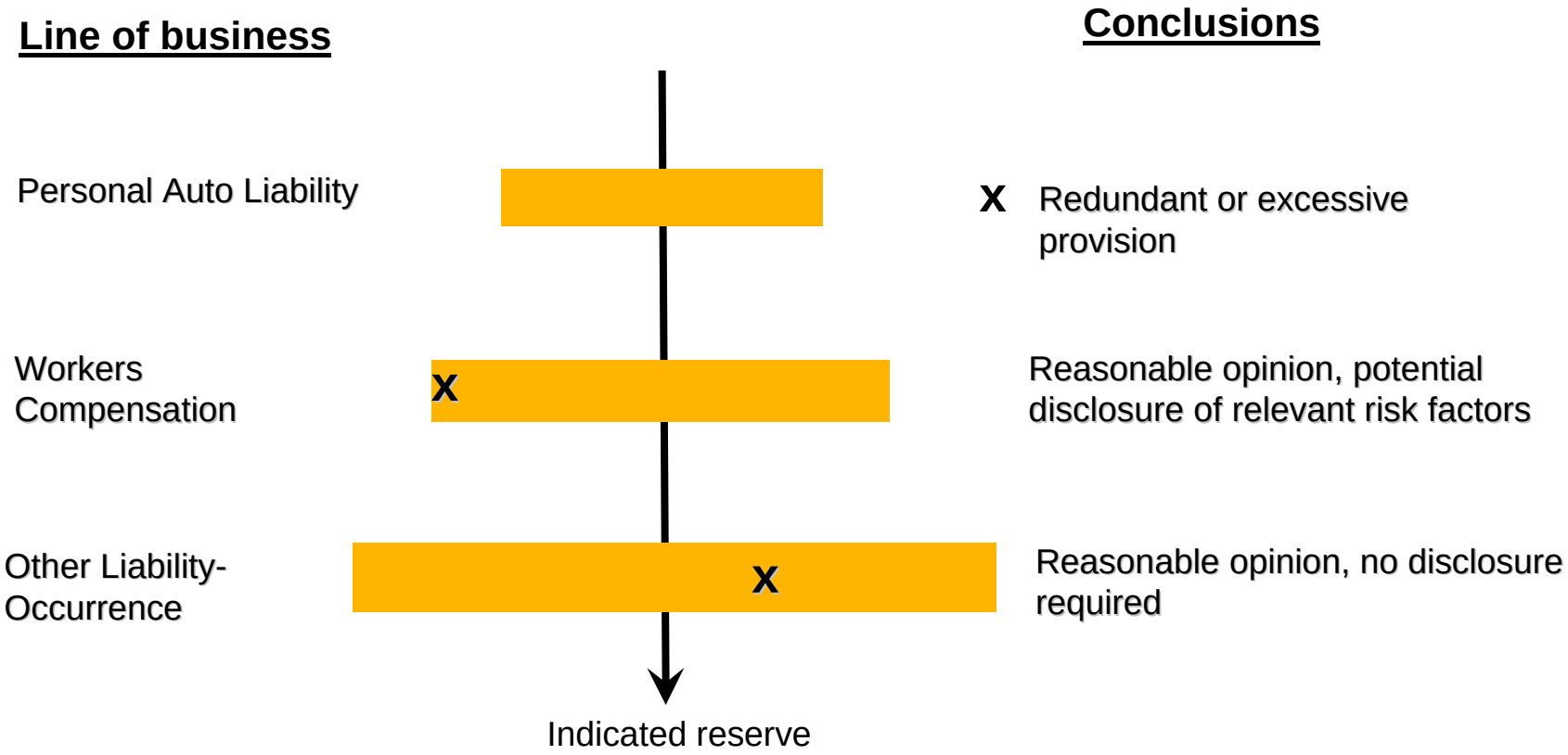
- To calculate ranges of reasonable estimates we need to know
  - CV, a measure of the uncertainty of the claim liability estimates
  - α, the benchmark significance level

	Selected CV	Range of Insignificance (α = .50)		Range of Reasonable Estimate (α = .30)	
		Lower	Upper	Lower	Upper
Personal Auto Liability	4.0%	-2.7%	2.7%	-4.1%	4.1%
Workers Comp	5.5%	-3.8%	3.8%	-5.7%	5.7%
Other Liability – Occurrence	8.0%	-5.5%	5.6%	-8.2%	8.3%

Determination of ranges – results

	Indicated Reserve	Range of Insignificance (α = .30)		Range of Reasonable Estimate (α = .30)		Carried Reserve
		Lower	Upper	Lower	Upper	
Personal Auto Liability	$55	$54	$56	$53	$57	$65
Workers Comp	$185	$178	$192	$174	$196	$175
Other Liability – Occurrence	$150	$142	$158	$138	$162	$155

Comparison of differences between carried and indicated amounts with estimated materiality amounts



= range of reasonable estimate, percentages

X = Company carried reserve

A detailed illustration of the research

Steps in the methodology

- Data
- Estimate claim liability distributions
- Select significance thresholds
- Calculate materiality standards for various measures of risk
- Aggregate various lines together

Step 1: Data

- The AM Best database was employed in our analysis
  - Schedule P (for premium, losses)
  - Five-Year Historical data (for surplus)
- Four lines of business were analyzed:
  - PAL: Personal Auto Liability
    - short tail line, stable development
  - HO: Homeowners
    - short tail line, less stable development
  - WC: Workers Compensation
    - long tail line, stable development
  - OLO: Other Liability-Occurrence
    - long tail line, non stable development
- Analysis happened at the legal entity level
  - Figures were adjusted for pooling arrangements
- Insurers were classified into Small/Medium/Large based on net earned premium volume

Step 2: Estimate claim liability distributions

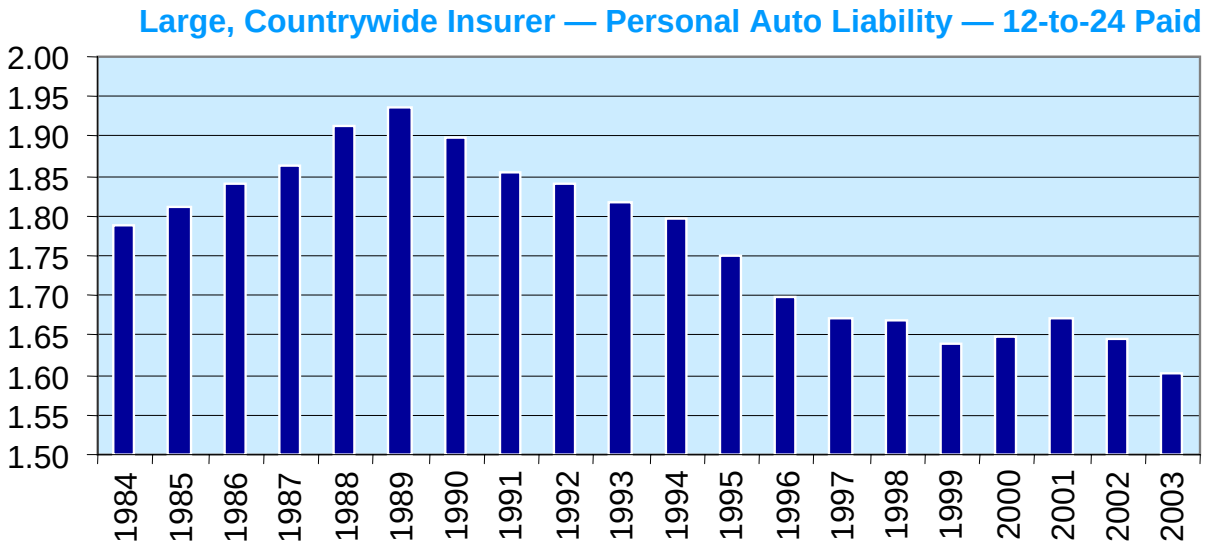
- The claim liability distributions were calculated based on two stochastic methods:
  - *Mack method:*
    - the method generates the first two moments of the claim liability distribution
    - Assumptions are needed for the form of the distribution and the triangle's tail
  - *Bootstrapping method:*
    - Produces an empirical distribution of the claim liabilities
    - Inverse power curves are fitted in the tail
- Both stochastic methods are employing paid loss development data
- Both methods are not responding well to reported losses where negative loss development is prevalent

Stationarity: one notable limitation of both stochastic reserving methods

- Both methods assume a stationary process, i.e. they assume the absence of any influences other than the loss generating process:
- Realistically triangle development data is hardly stationary due to:
  - Exogenous factors: non-company specific like economic or social inflation
  - Endogenous factors: company-specific like claim settlement and changes in case reserve adequacy
- Stochastic methods are overstating the volatility of the underlying loss generating process
  - Hindcast testing results, based on empirical results, support the assertion of overstatement

Stationarity: an example

- Reserving methods assume that past experience is predictive of the future
  - Exogenous non-stationary factors (economic/social inflation)
  - Endogenous non-stationary factors (claim settlement/coverage)
  - Non-stationarity overstates the loss generating process volatility
- The volatility of the loss generating process can be significantly overstated in the absence of stationarity

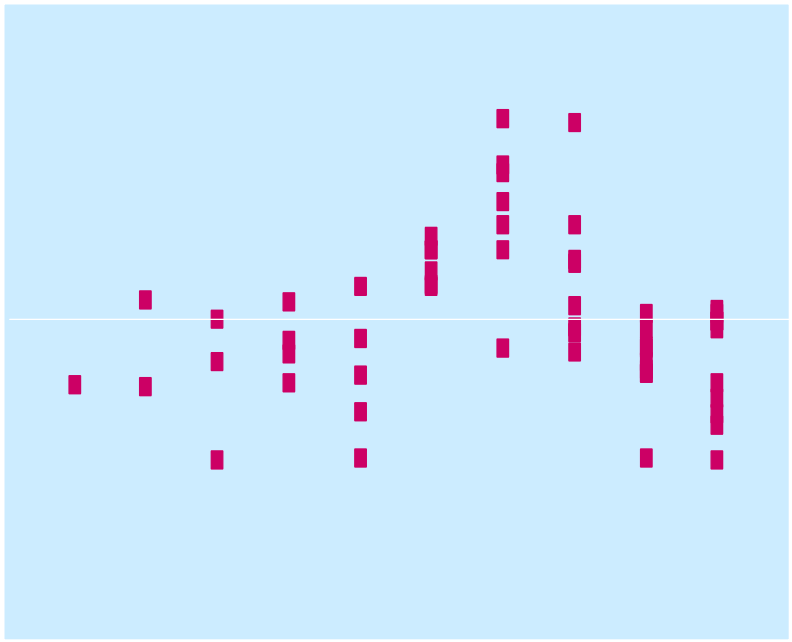


- This actual data sample of development factors shows that variation is not purely random

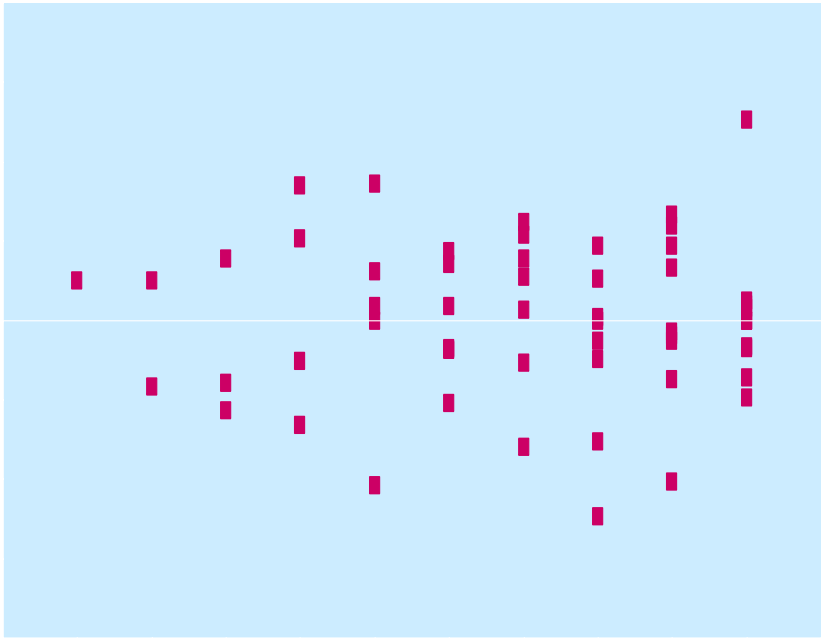
The historical data needs to be adjusted to a stationary basis

Other Liability Residuals

Before Adjustment



After Adjustment



Step 3: Benchmark significance level thresholds

- For outcome materiality, the calculations are based on the “Bright Line” Test:
  - Measures the difference between surplus as regards to policyholders and the NAIC Risk Based Capital (RBC) that would downgrade the company into the next lower RBC level
  - Difference serves as a maximum standard of materiality
- 39 financially healthy and16 financially impaired companies were analyzed, for all lines combined, (total risk basis)
  - Claim liability distribution was calculated
  - Standard of materiality based on “Bright Line” test was calculated
  - Benchmark significance level threshold measures the probability of losses in excess of:

  (P= mean of claim liability distribution + materiality standard)
    - Benchmark exceedence ratio measures the expected losses in excess of P as a ratio to the mean
- For most financial healthy companies the resulting significance threshold levels were 0.0%

Materiality standards for financially healthy companies

	Percentile Threshold Benchmark Significance Levels		Tail Value at Risk Benchmark Exceedence Ratio	
	Lower Tail	Upper Tail	Lower Tail	Upper Tail
Estimation materiality	10.0%	7.5%	n/a	2.0%
Outcome materiality	8.0%	6.0%*	n/a	1.5%

*Corresponding standard for financially impaired companies is 18.0%

Step 4: Calculate materiality standards

- Calculate claim liability distributions (for Mack vs. Bootstrapping methods) by legal entity
- Normalize the claim liability distribution so that mean of the distribution is equal to the carried reserves
- The upper tail outcome/estimation materiality standard =

  (percentile implied by the outcome/estimation benchmark significance level/exceedence ratio) – (percentile of the carried reserves)

Step 5: Aggregate various lines together

- Mack and Bootstrapping calculate claim liability distributions for individual lines of business
- The volatility of the aggregate claim liability distribution increases with:
  - The volatility of each individual line of business
  - The correlation across lines
- We employed a Normal Copula approach to calculate multi-line claim liability distributions and the implied estimation and outcome materiality standards

Results and Conclusions

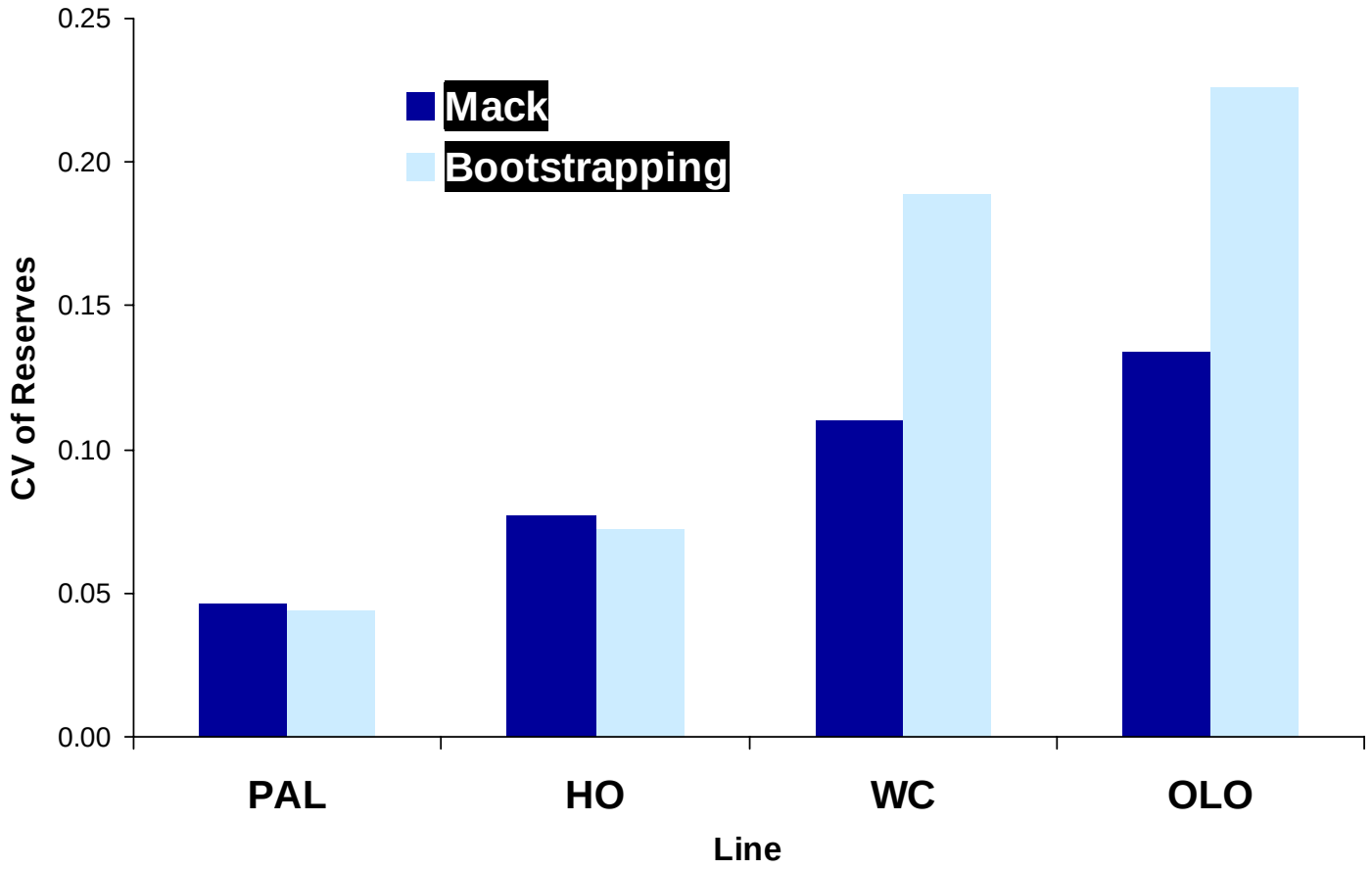
Executive Summary

- Materiality can have different implications when viewed from a statistical, financial or solvency perspective
- Standards of materiality vary by line of business
- Materiality standards can be arrived at using a framework of statistical hypothesis testing
- Any approach to deriving standards of materiality requires the measure of an appetite for adverse outcomes
  - Percentile Threshold and Expected Exceedence Ratio:
    - Type I/Type II error in the hypothesis testing framework
- Percentile Threshold an Expected Exceedence Ratio approach yield different standards of materiality
- Benchmarks should be derived based on combined industry data

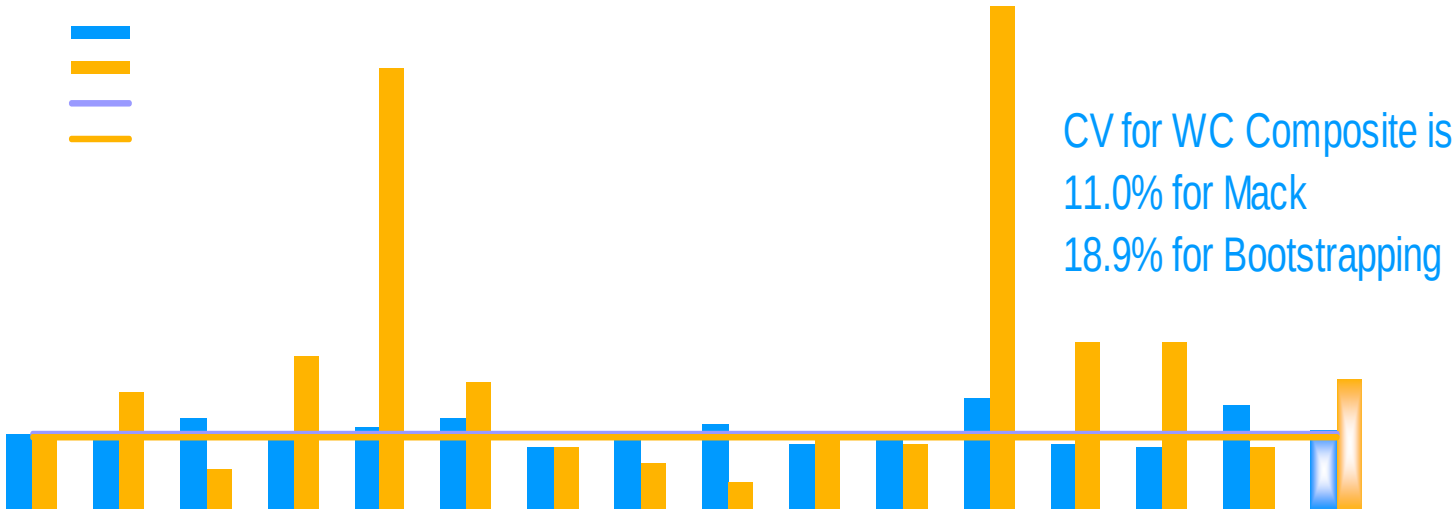
Observations on stochastic methodologies

- Standard volatility measuring techniques overstate the volatility of the underlying loss exposure
- Results inconsistent between paid and incurred loss data
- Mack and Bootstrapping techniques employed in our study produce different measures of volatility
- The standard stochastic methodologies do not differentiate well between process and parameter risks

Comparison of parameter variability from Mack and Bootstrapping methods

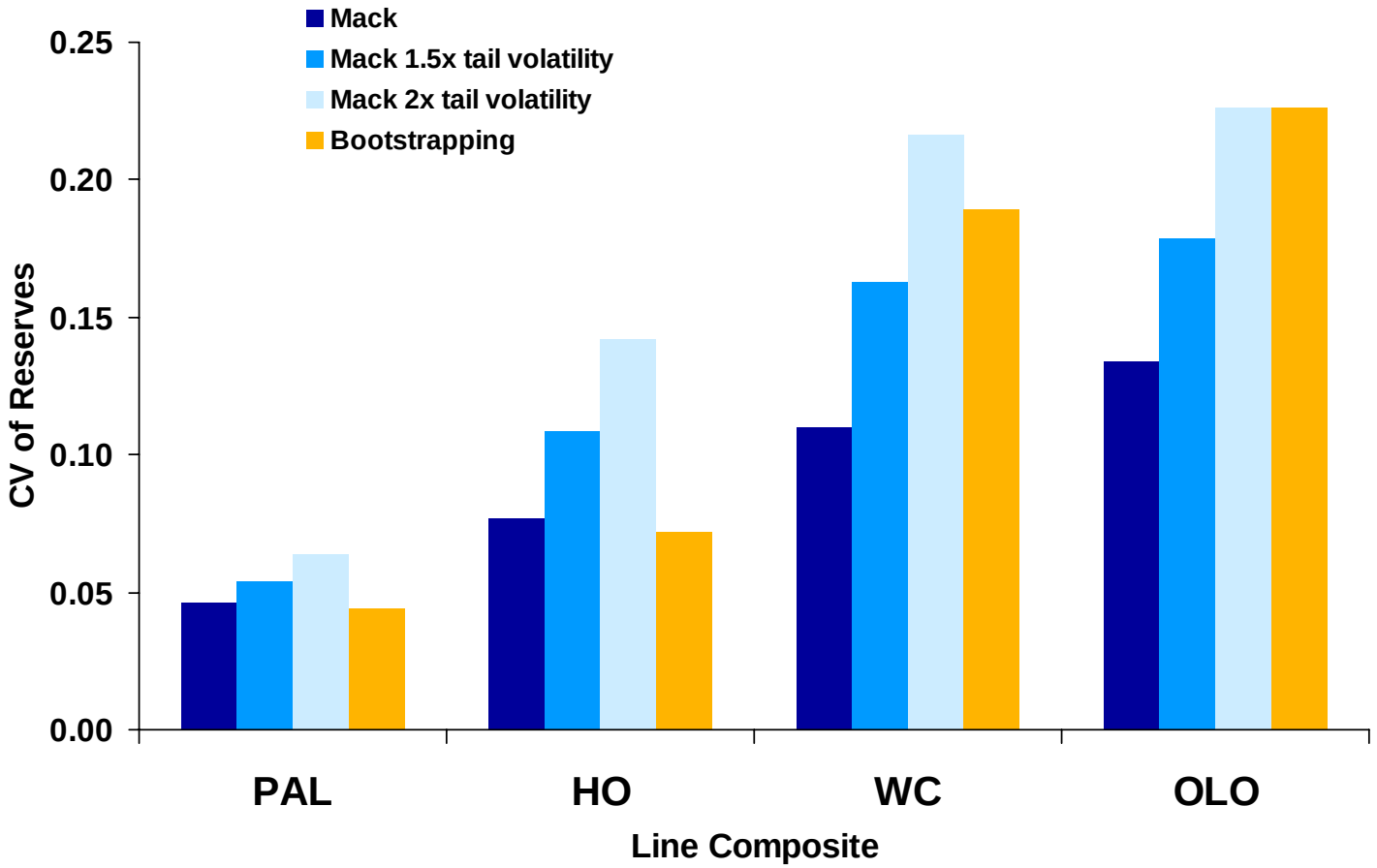


Comparison of parameter variability break from Mack and Bootstrapping methods - WC

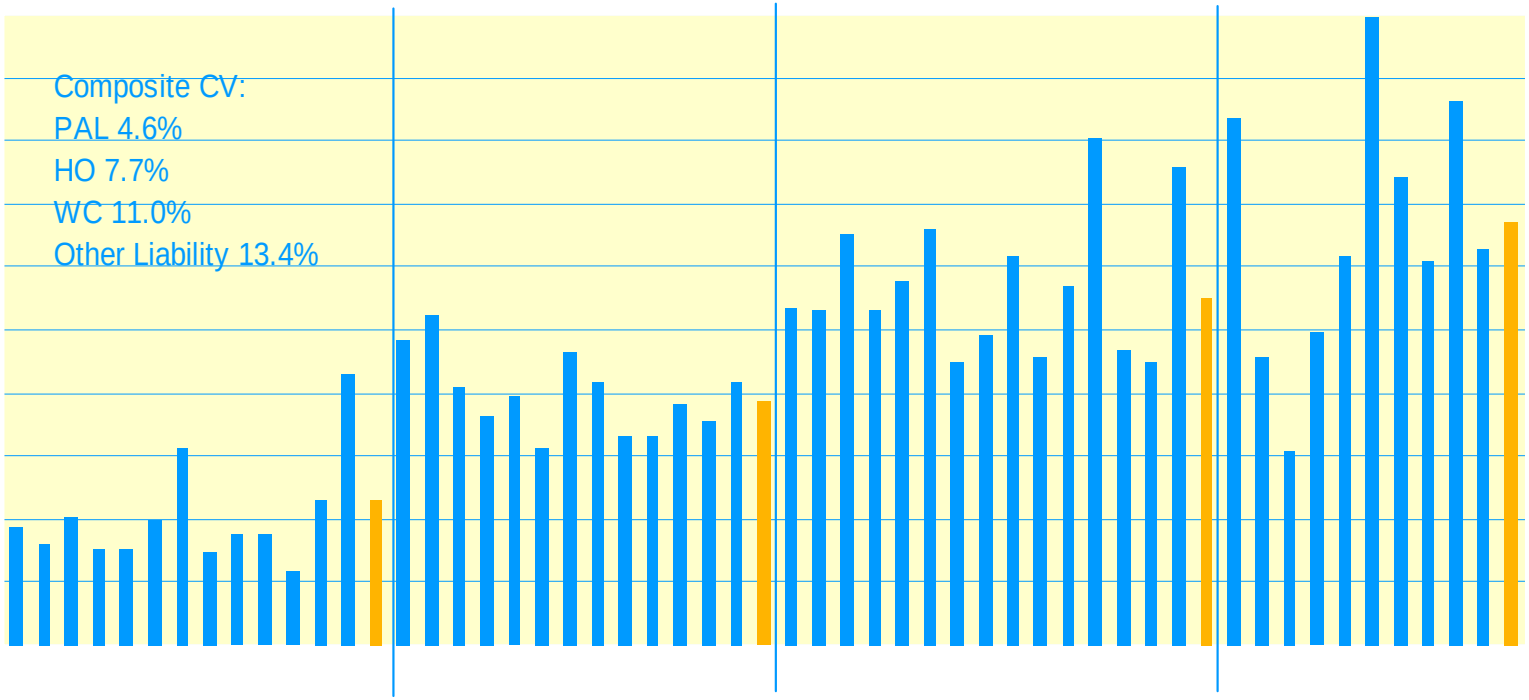


- The bootstrapping method is sensitive to outliers in the data
- The median CVs are close for both stochastic methods

Comparison of parameter variability from the Mack method under various tail assumptions and the Bootstrapping method

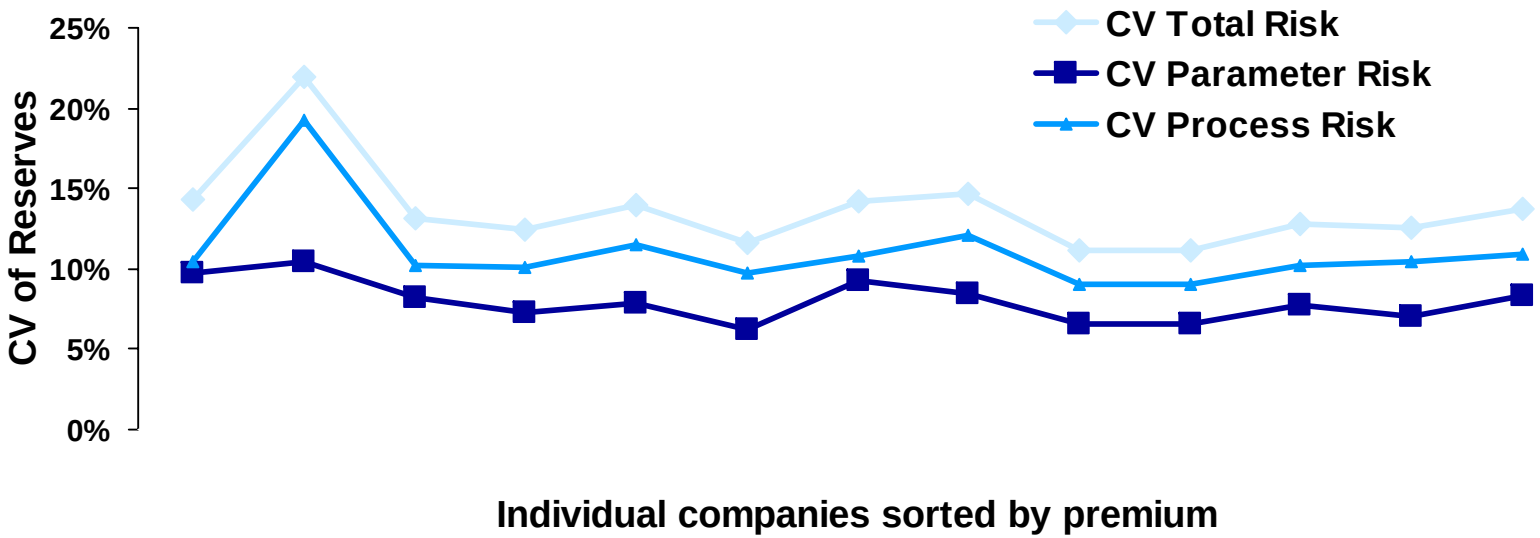


Comparison of parameter variability from the Mack method: by size of company



- No clear relationship between claim liability volatility and the size of the company

Comparison of total, process and parameter variability from the Mack method: Homeowners



- Parameter risk is invariant of the size of the company
- Process risk should decrease for larger companies
  - Empirical data does not support that assertion
- Process risk might be overstated by the Mack method

Estimation Materiality Standard – Bootstrapping and Mack

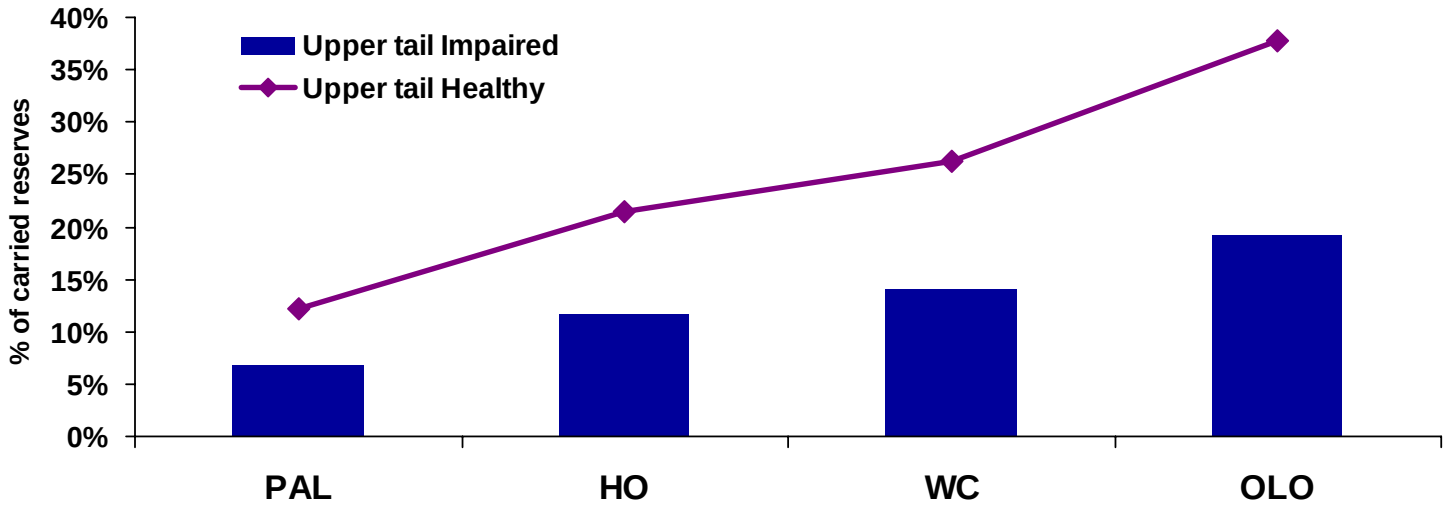
Line of Business	Mack		Bootstrapping	
	Lower Tail	Upper Tail	Lower Tail	Upper Tail
Personal Auto Liability	-5.8%	6.7%	-5.4%	6.3%
Homeowners	-9.7%	11.4%	-8.8%	10.5%
Workers Compensation	-13.6%	16.4%	-19.0%	25.3%
Other Liability	-16.4%	20.2%	25.7%	32.7%

Estimation and Outcome Materiality Standard – Mack

Line of Business	Estimation Standards		Outcome Standards	
	Lower Tail	Upper Tail	Lower Tail	Upper Tail
Personal Auto Liability	-5.8%	6.7%	-10.2%	12.2%
Homeowners	-9.7%	11.4%	-17.5%	21.5%
Workers Compensation	-13.6%	16.4%	-20.8%	26.2%
Other Liability	-16.4%	20.2%	-28.0%	37.7%

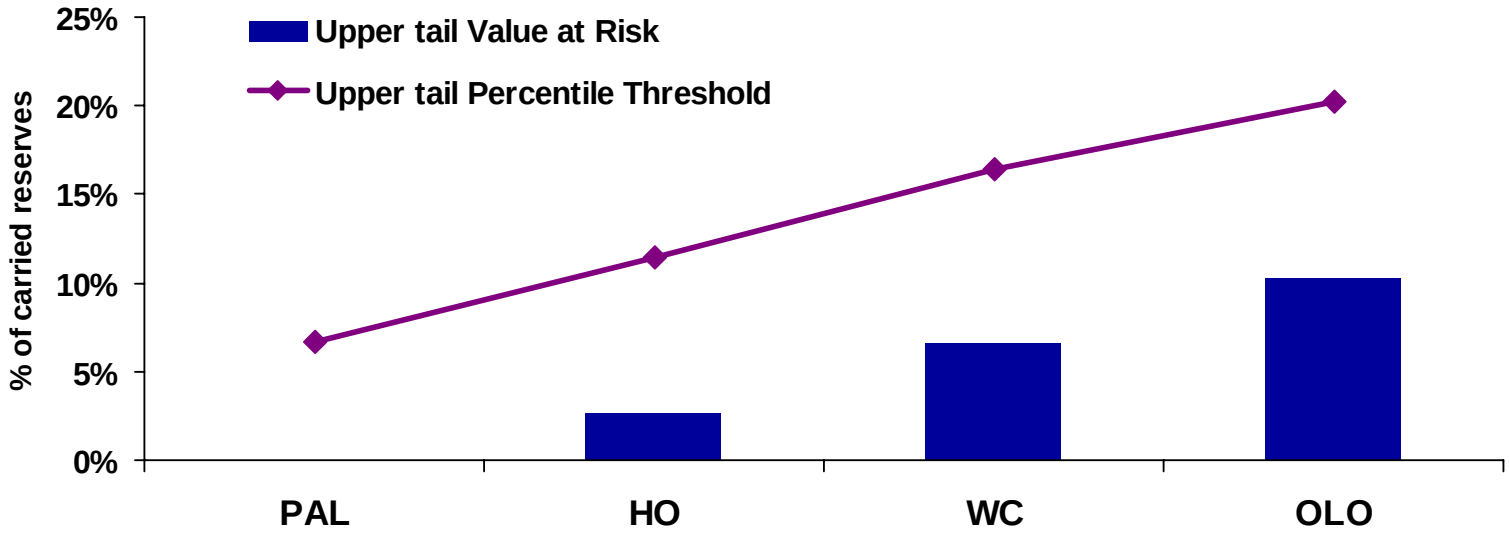
- Outcome materiality standards employ both process and parameter risk
- Estimation materiality standards employ parameter risk only
- Higher significance level benchmarks apply for estimation materiality

Outcome Materiality Standards – Healthy vs. Impaired Companies – Mack



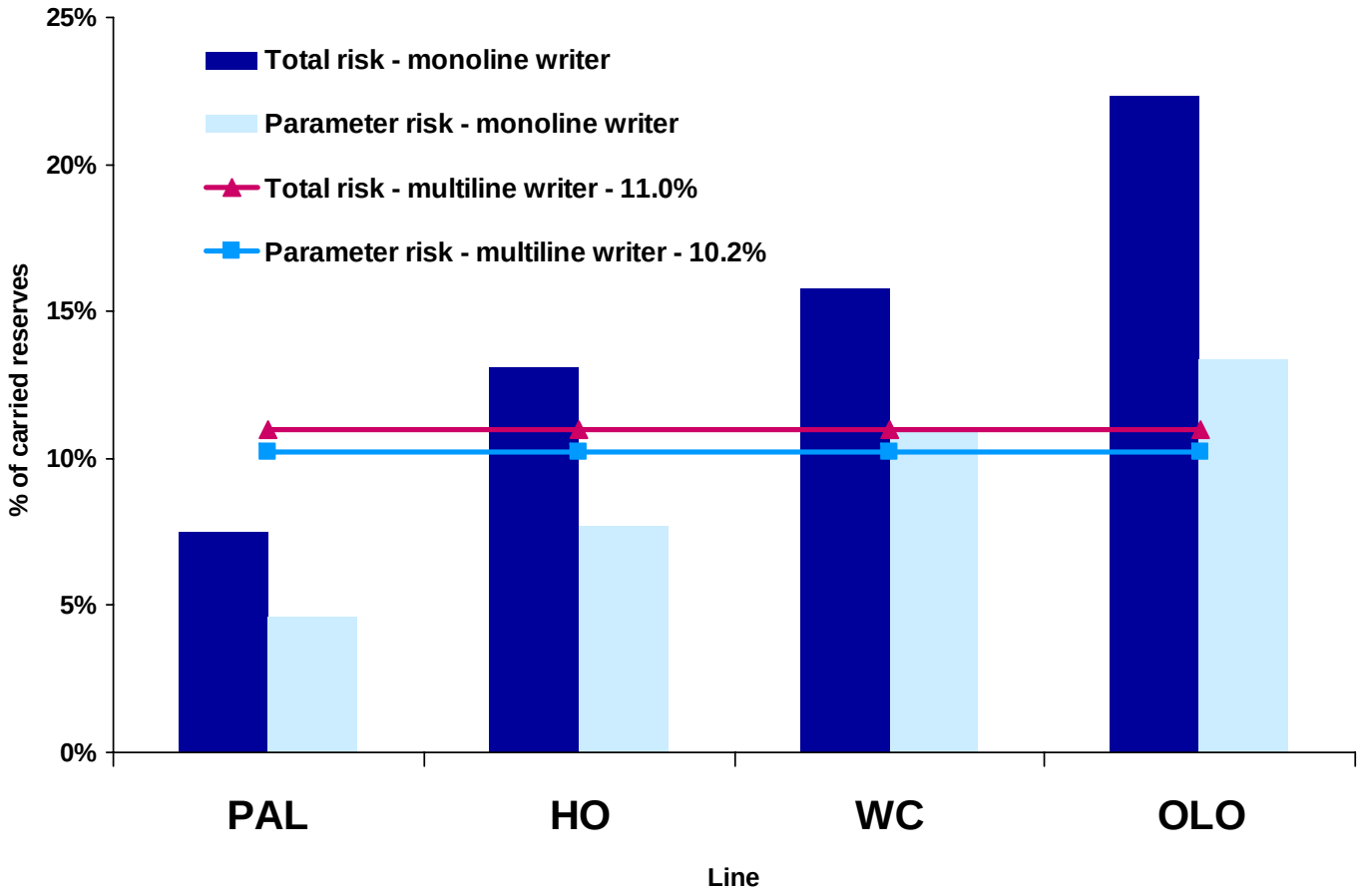
- There is a greater reserve uncertainty associated with the reserves of a financially impaired company
- Selected benchmarks significance level is higher for financial impaired companies

Upper tail Estimation Materiality Standards – Mack

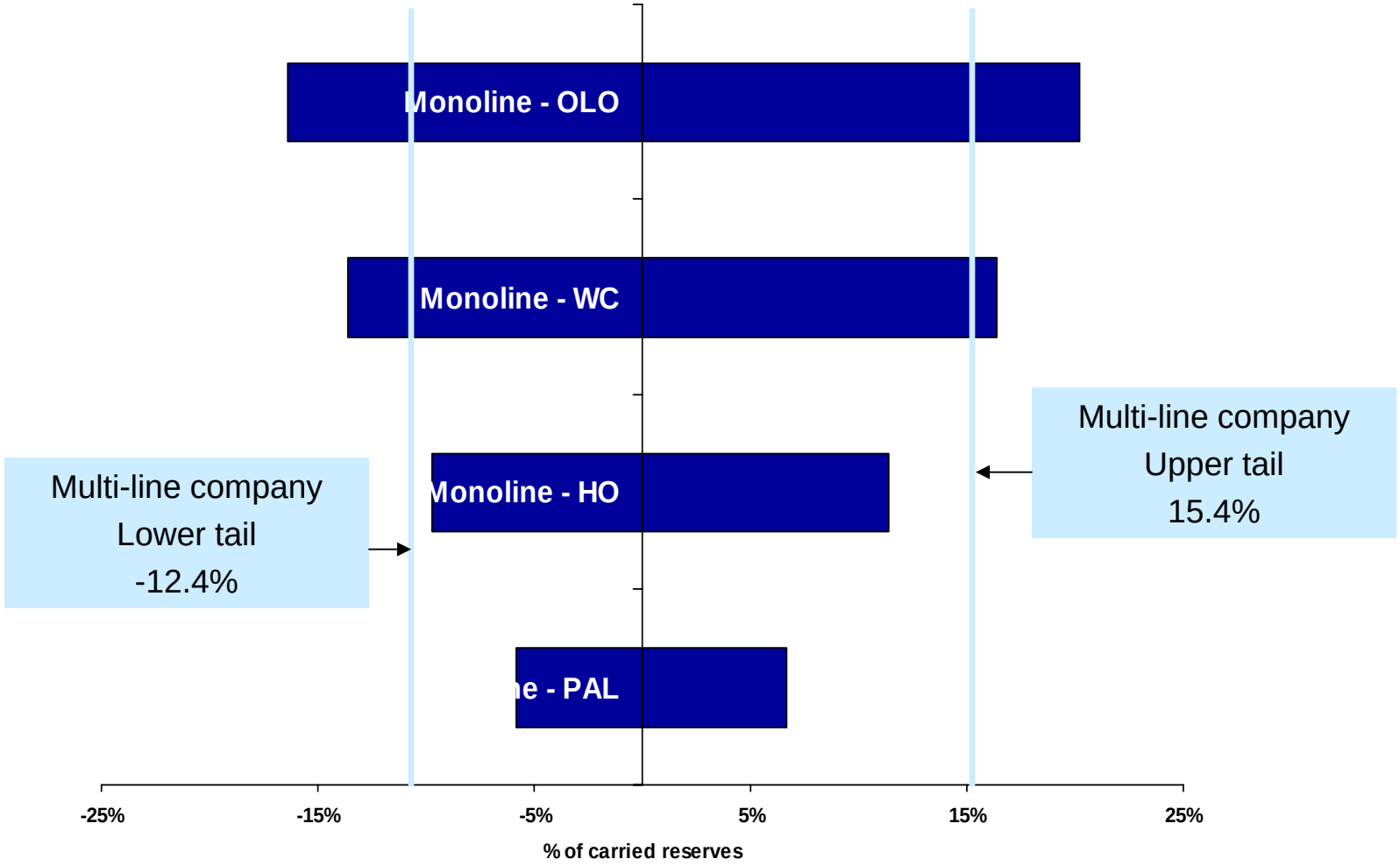


- The percentile threshold approach measures the probability that the actual claim liability amount would exceed a selected dollar threshold (i.e., carried reserves)
  - It does not consider the magnitude of the deficiency
- The tail value at risk approach measures the expected shortfall of claim liabilities
  - Is affected by the extreme claim liability outcomes

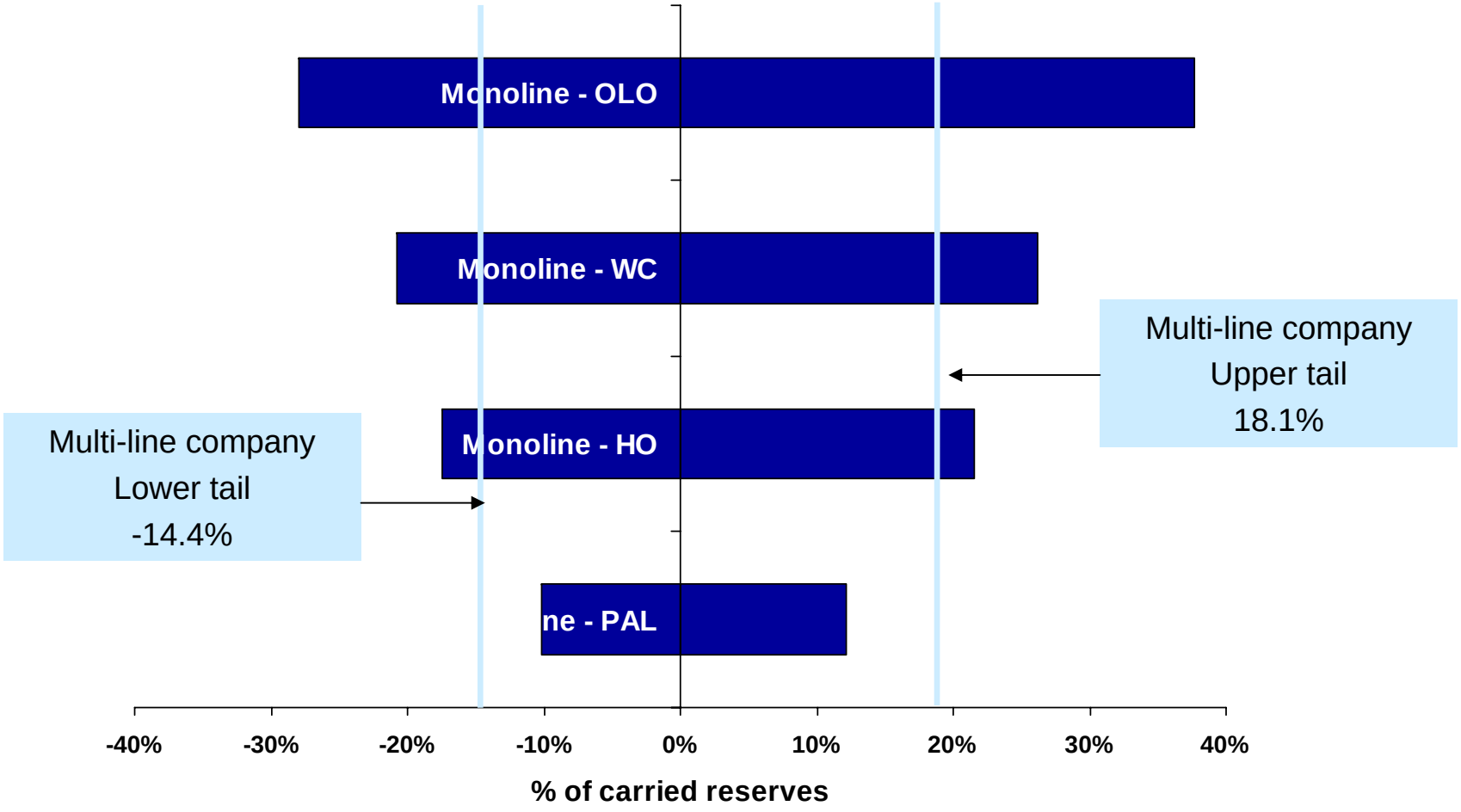
Coefficient of Variation



Estimation Materiality Standards



Outcome Materiality Standards



Outcome Materiality Standards – Mack Upper Tail or Adverse Deviation

Outcome Materiality Standards – Mack Upper Tail or Adverse Deviation

Line of Business	Before Adjustment	After Adjustment
Personal Auto Liability	12.2%	5.7%
Workers Compensation	26.2%	18.0%
Other Liability	37.7%	16.7%

Estimation Materiality Standards – Mack Upper Tail or Adverse Deviation

Line of Business	Before Adjustment	After Adjustment
Personal Auto Liability	6.7%	3.6%
Workers Compensation	16.4%	12.5%
Other Liability	20.2%	11.5%

- 27 to 30 companies composite AM Best data, adjusted for exogenous and endogenous influences
- Results suggests that standards are overstated in the absence of stationarity

Questions?

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