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The Very Very Basic Guide to Reserve Variability/Ranges

Casualty Loss Reserve Seminar, Chicago, IL

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Agenda

- The first half of the session will answer the question “why care about reserve variability?” We will explore drivers internal and external to insurance companies
- The second half will provide an introduction to the terminology and basic concepts associated with the development of reserve ranges
- We plan to have time at the end for questions

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Why Care about Reserve Variability?

There are a number of existing or growing forces driving the increased interest in reserve variability

- Insurance company management
- Securities and Exchange Commission (SEC)
- Fair value accounting concepts
- Rating agencies
- Actuarial best practices

Because the development of relevant and meaningful information about reserve variability takes time, companies should start climbing the learning curve today

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The best reason to do this work is that information about reserve variability is useful in a business context

- Anticipating “negative surprises”
  - Rigorous range analysis allows assessment of the probability of “worse than expected” results
  - Allows for risk management interventions
- Effective capital management considers the uncertainty of the largest balance sheet entry
  - How to allocate surplus to line, branch? It should consider the riskiness of each level of the operation
- Asset management may be improved by gaining a better grasp of how shared economic driver variables (e.g., interest rates and inflation) affect both assets and liabilities

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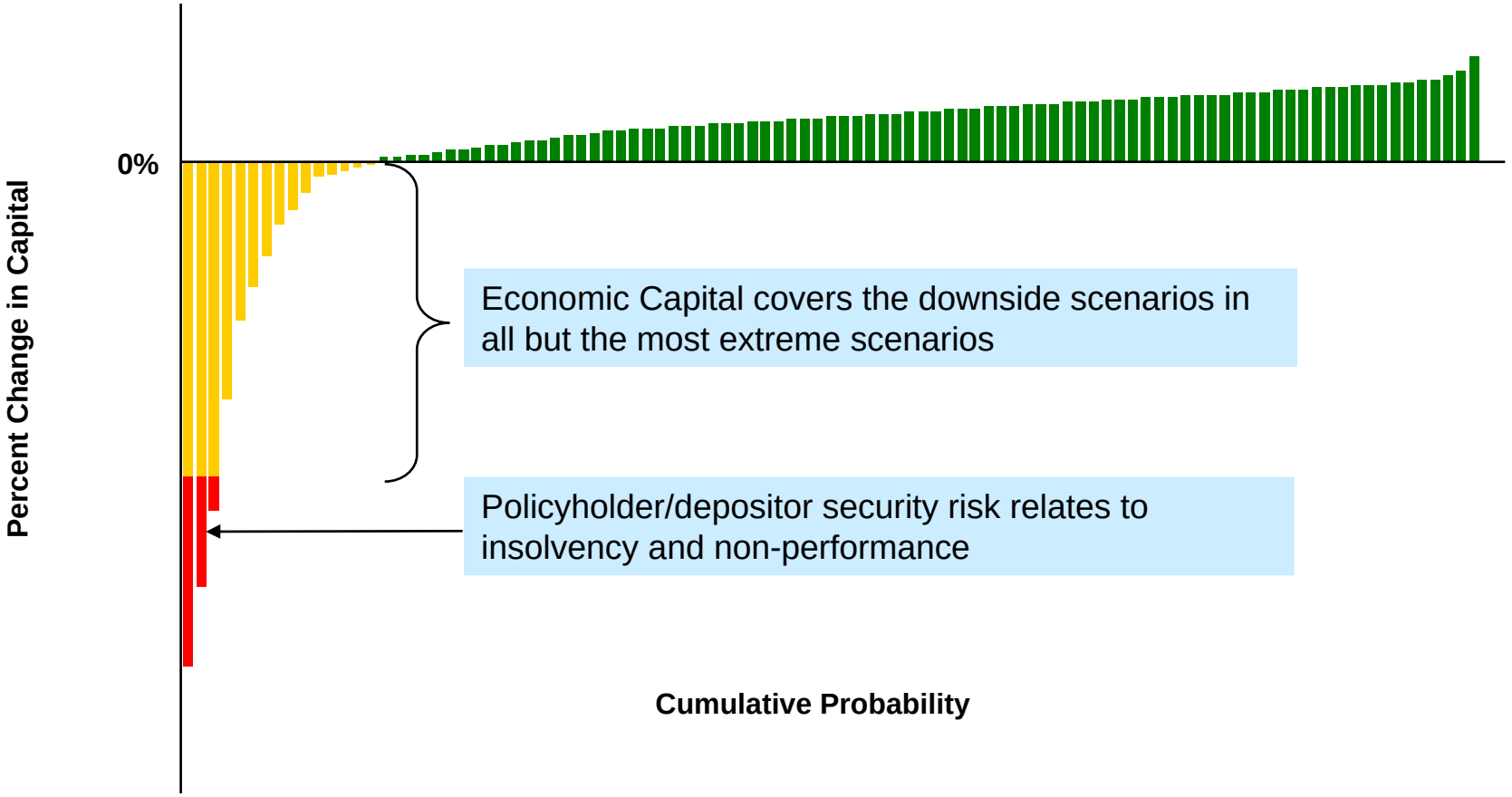
Economic capital considers estimated variation in results

Impact of Hypothetical Scenarios on Company Capital Structure (One-year Time Horizon)



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The SEC is pressuring registrants for more robust analysis and disclosure of potential variability of loss reserves

- Although the SEC's 10-K filing does not specifically require a company to disclose ranges of loss liability estimates, questions directed at P/C insurers have required them to begin to disclose their current practices. Similar to the 10-K itself, these additional disclosures are publicly available
  - Companies have responded cautiously
  - Current practices appear to vary widely
- Additional information sought by the SEC includes
  - Key assumptions underlying the methods used to determine reported reserves
  - Effects on reported reserves of reasonably likely changes to these assumptions
  - How ranges of estimates were calculated
  - Retrospective tests of the quality of previous estimates and their influence on current selections
  - Rationale for selection of one method over another
- Given the current economic turmoil, it can be expected that the SEC will only intensify its demands for more transparency

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Recent SEC inquiries have resulted in disclosure by publicly traded P/C insurers of current practices with respect to reserve variability analysis

Survey of SEC 10-K Filings over Past Three Years

Disclosure Type	2008	2007	2006
Point estimate only	6%	31%	60%
Sensitivity analysis	64%	33%	4%
Range	30%	35%	36%

Source: Towers Perrin analysis of recent SEC filings

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Fair value accounting is a hot topic in regulatory circles, driven by the desire for improved quantification of insurance company risks

- "Fair Value" is the amount at which an asset or liability could be exchanged in a current transaction between knowledgeable unrelated willing parties when neither is acting under compulsion
  - The price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date
  - Perceived as the best measurement basis that will show the present condition of the assets and liabilities of an entity and its capacity to generate future cash flows
    - Market based and not entity based (or entity specific)
    - Includes reflection of risk
- Fair value accounting is an initiative of the International Accounting Standards Board (IASB) and the Financial Accounting Standards Board (FASB)
  - Greater transparency, reliability and relevance of financial statements
  - Forward looking to assist investors and creditors to make business decisions about the entity (ability to generate cash in the future)

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Measurement of liabilities for insurance contracts is a key focus of current discussions of an IASB/FASB working group

- Liabilities for insurance contracts must reflect three elements
  - The expected value of the liability
  - The time value of money
  - A risk margin
- The risk margin reflects uncertainty associated with expected cash flows
  - Policyholder protection
  - Provision for the cost of bearing risk
- Current consensus moving toward adoption of the IAS 37 model to value insurance contract liabilities
  - Model includes an explicit risk margin determined by quantile methods
    - Percentile or confidence levels (VaR)
    - Related methods, specifically, conditional tail expectations (CTE, also called tail value at risk or TVaR)
    - Multiples of the second and higher moments of the risk distribution
  - Exposure draft expected by December 2009; final draft by December 2010
  - Field testing with 15 voluntary insurers starting in July 2009 and complete by year-end

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The rating criteria used by the S&P and A.M. Best cite reserve variability as a consideration

- Standard & Poor's (S&P)
  - "P/C Criteria for Assessing Insurers/Reinsurers' Loss Reserve Adequacy"
    - States S&P "may calculate a range into which the level of adequacy will likely fall and quantify the possible effect on capital. The point estimate and the endpoints for the range of estimates are compared with existing capital to approximate the effect any potential reserve deficiency might have on the company's ability to meet its obligations"
    - Published May 18, 2009
  - It is anticipated that in the near term S&P will expect higher rated companies to stochastically model loss reserve distributions to gain more confidence in the loss reserve variability
  - Consideration of the variability inherent in the loss reserve is also consistent with their stated desire for insurers/reinsurers to develop robust enterprise risk management programs, including the quantification of economic capital

Continued…

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The rating criteria used by the S&P and A.M. Best cite reserve variability as a consideration

- A.M. Best
  - "An Explanation of Best's Rating System and Procedures"
    - States Best's evaluates "the degree of uncertainty in loss reserves. If the level of uncertainty exceeds any equity in the reserves, or is considered large in relation to net income and surplus, we will require a company to maintain a more conservative capital position…"
    - 2008 Edition
  - It is anticipated that A.M. Best will be slower to implement probabilistic reserve distributions. However, more robust reserve modeling will be a positive rating factor, provided range estimates are reasonable relative to industry trends and historical experience

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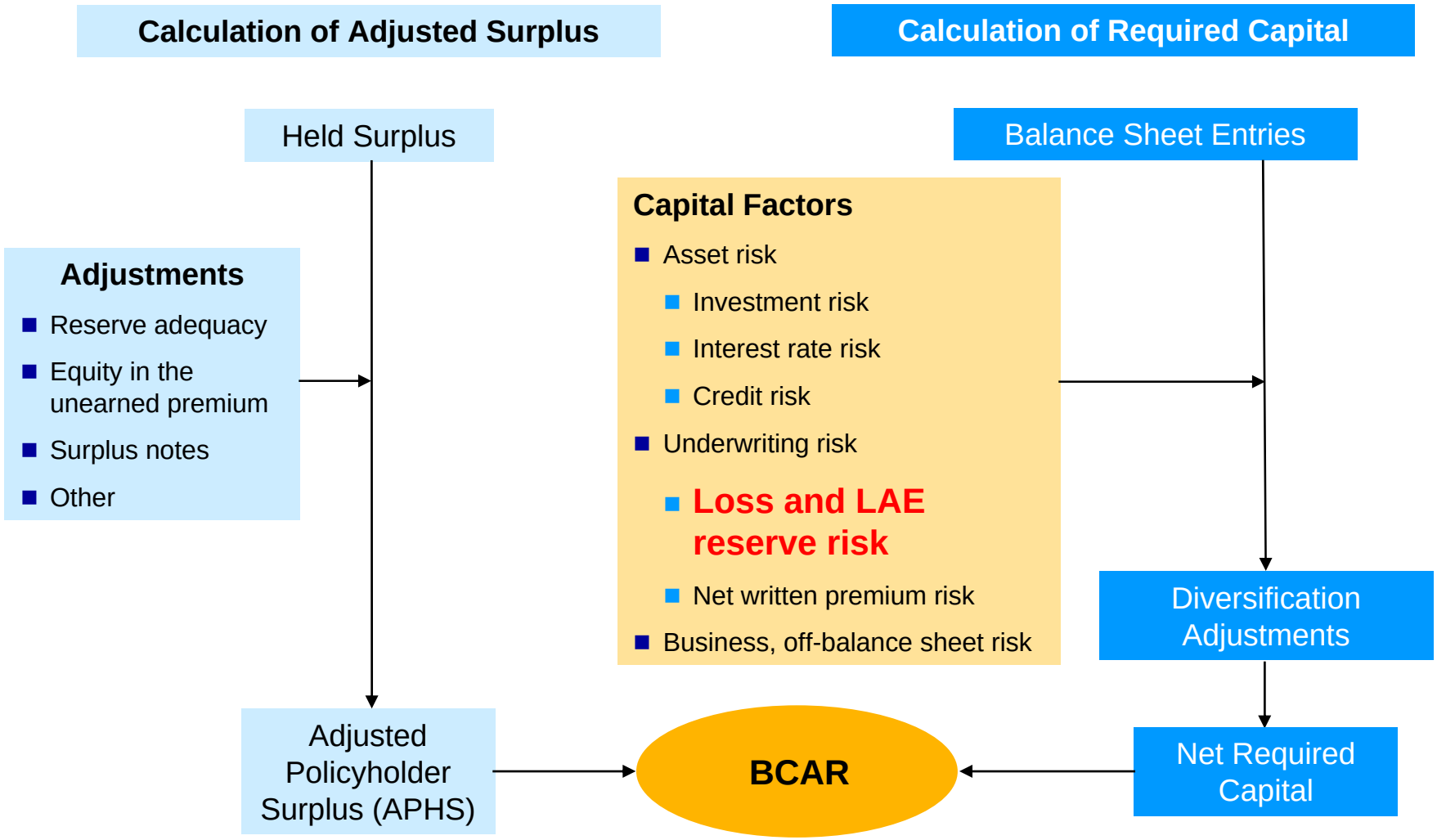
A.M. Best's Capital Adequacy Ratio (BCAR) currently uses a factor-based approach to risk, but have announced their intention to build a stochastic capital adequacy model



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Recent papers published by two actuarial organizations reflect the increasing sophistication of the discussion of the uncertainty surrounding loss liability estimates

- "P/C Actuarial Communication on Reserves Ranges and Variability of Unpaid Claim Estimates"
  - Issue Brief of the American Academy of Actuaries, published in September 2008
  - Written by the Committee on Property and Liability Financial Reporting (COPLFR)
  - Stated goal is to improve "casualty actuaries' communications with regard to ranges of unpaid claim estimates"
- "Measurement of Liabilities for Insurance Contracts: Current Estimates and Risk Margins"
  - A Research Paper of the International Actuarial Association, published April 15, 2009
  - Written by the Ad Hoc Risk Margin Working Group
  - Stated purpose is to address those issues "that will help determine future practice for measuring liabilities for insurance contracts for both regulatory and general purpose financial reporting"

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Actuarial Standards of Practice (ASOP) cite the importance of considering the variability inherent in the loss estimates

Source	Topic	Considerations
ASOP 43: P/C Unpaid Claim Estimates	Uncertainty	■ Consider uncertainty associated with unpaid claim estimate analysis; does not require or prohibit the measurement of this uncertainty ■ Consider the types, sources (model, parameter and process risks), and correlation of uncertainty; choosing appropriate methods, models and assumptions

ASOP 36: SAO Regarding P/C Loss & LAE Reserves	Uncertainty	■ Actuarial estimates are inherently uncertain
		  ■ Dependent on future contingent events
		  ■ Future events/conditions often differ from the past
		  ■ Actual settlement amount for unpaid claims can differ from stated reserve amount

ASOP 9: Documentation and Disclosure in P/C Insurance Ratemaking, Loss Reserves and Valuations (Appendix 1)	Risk	■ Charges to be reflected in the profit and contingency provision
		  ■ Rate should include charge for risk of random variation from expected costs
		  ■ Rate should include a charge for any systematic variation of the estimated costs from the expected costs

ASOP 9: Documentation and Disclosure in P/C Insurance Ratemaking, Loss Reserves and Valuations (Appendix 3)	Sensitivity testing	■ Address the sensitivities of the appraisal value to changes in key assumptions ■ Consider whether the results reflect a reasonable range of variation in the key assumptions

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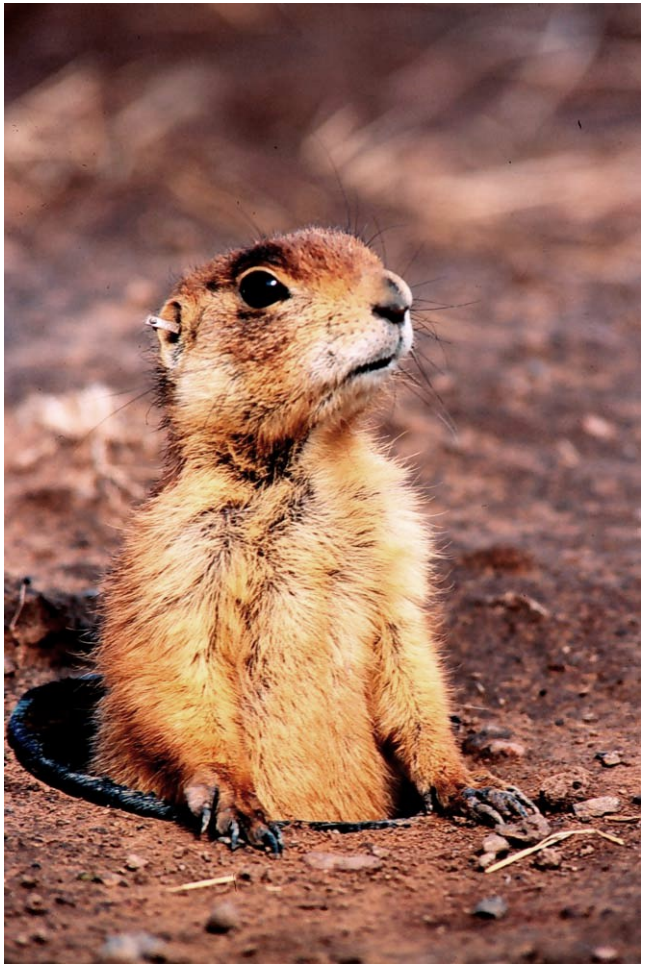
Now is the time to stop being the proverbial ostrich and to start looking forward to the benefits of understanding the range of results



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Very Basic Introduction to Development of Reserve Ranges

Agenda

- Background on stochastic techniques
- Terminology
- Popular stochastic techniques
- Aggregation of liabilities

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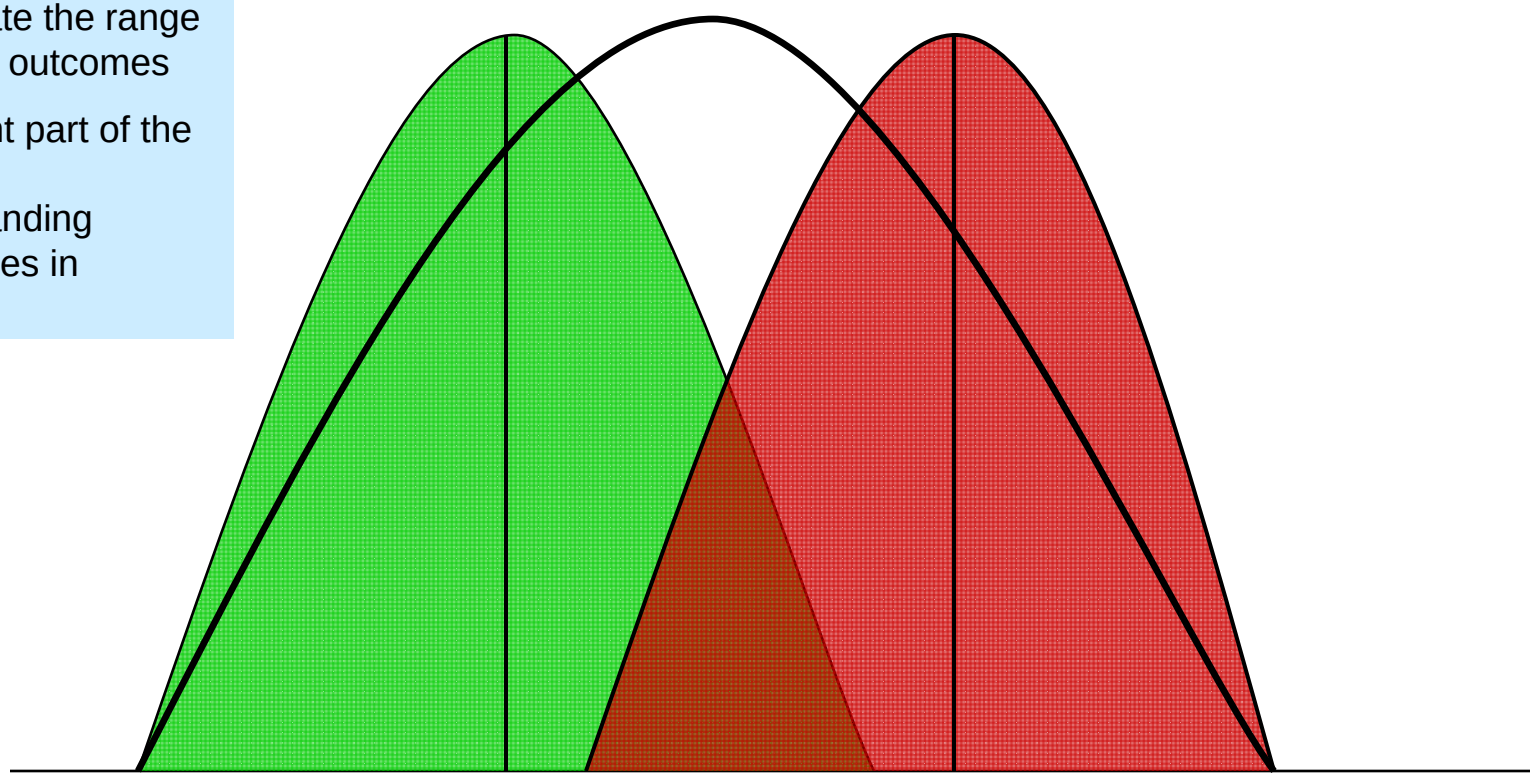
Background on Stochastic Techniques

Stochastic techniques consider the entire range of outcomes

- The range of best estimates is likely to understate the range of actual outcomes
- Important part of the process: understanding differences in methods



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Stochastic techniques quantify the claim liability uncertainty

- Loss development is a stochastic process; the historical data is a specific realization
- Deterministic methods provide a point estimate of claim liabilities
  - Multiple methods can give a range of estimates
  - Best estimate usually chosen judgmentally
- Stochastic methods are more informative than deterministic methods
  - Produce a full distribution of possible outcomes
    - Confidence levels of held reserves

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Terminology

Method vs. Model

Method	Model
■ Mathematical algorithm for estimating unpaid amounts ■ Parameters are selected ■ Selections assumed appropriate based on judgment ■ Chain Ladder algorithm	■ Mathematical description of the world ■ “Best-Fitted” Parameters ■ Selections can be tested ■ Mack, Bootstrapping models

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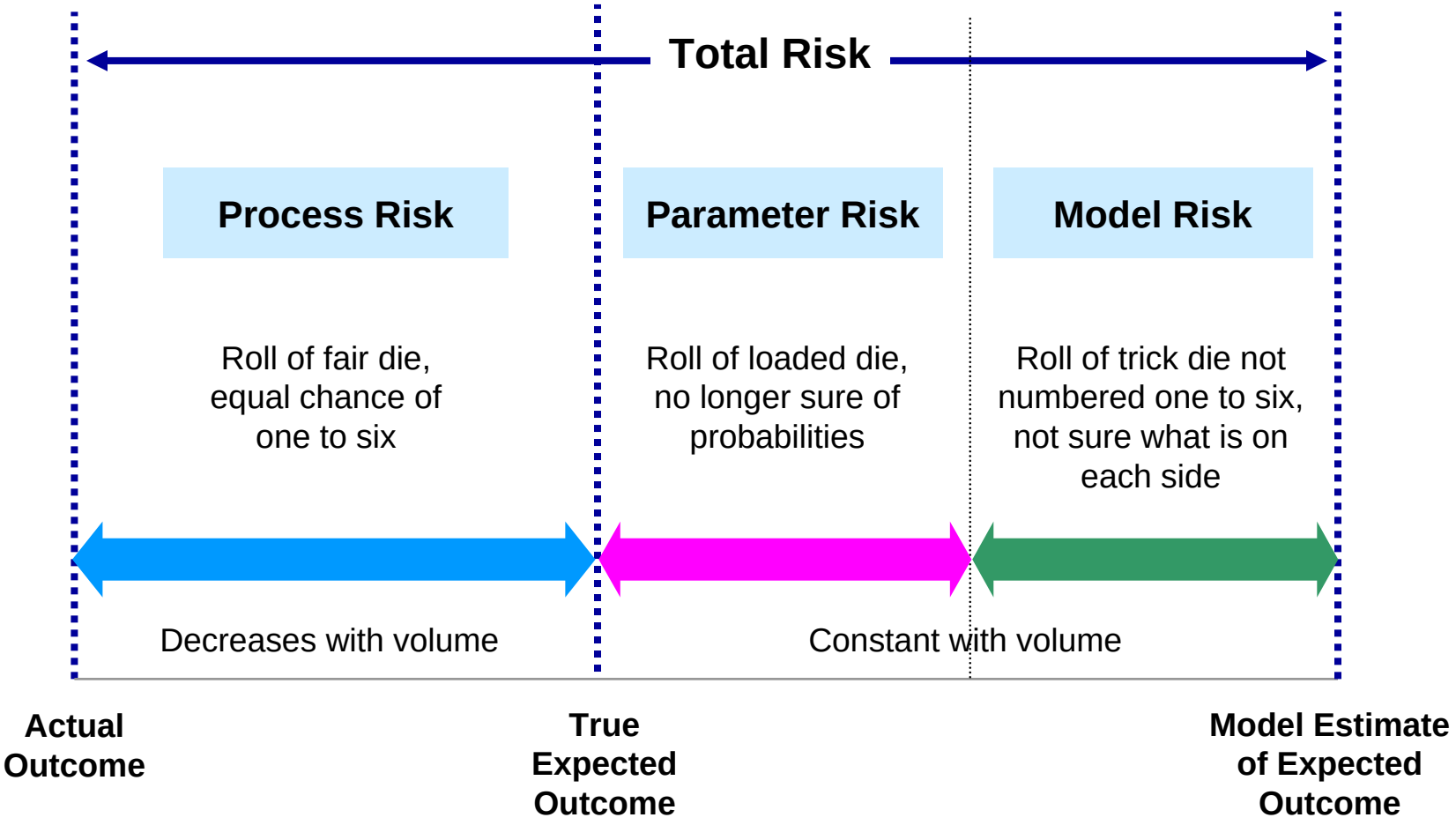
Several distinct types of risks are inherent in the measurement of claim liabilities — the actuary and the audience need to be clear about which are relevant to a particular application



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Relevant sources of variability depend on the exercise at hand

- Financial Solvency/Capital adequacy context
  - "Stress testing" the balance sheet
  - Variation of actual outcome around the true expected outcome
  - All types of risk are relevant here
- Reserve variability context
  - Comparing two actuarial estimates
    - Variation around the true expected outcome
    - Parameter and model risk are relevant here

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What “risk” do stochastic methods measure?

- Risk could mean different things to different audiences
- Actuaries usually think of risk in terms of “variance” and “standard deviation”
  - “coefficient of variation” (CV) is “scaled” by the mean and measures “relative” risk
- Other definitions
  - (VAR) - Value at Risk: a percentile (i.e. losses at the 75th)
  - (TVar) – Tail value at Risk: expected losses in excess of a given percentile

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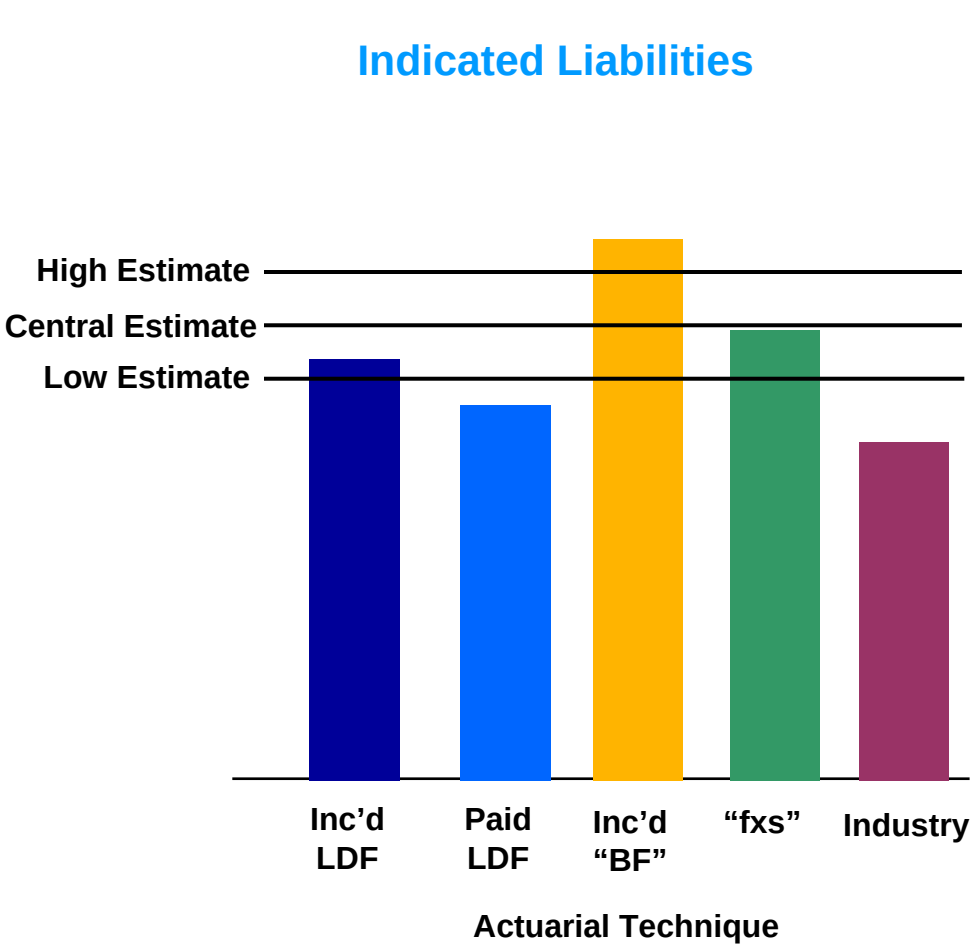
Deterministic: What range of estimates is implied by the actuarial techniques used?



General Approach — Deterministic

- Estimate range of claim liabilities based on the results of several projections
- Applied to current data evaluation

Advantages	Disadvantages
■ Easy to understand and apply	■ Does not include process risk
■ Based on liability estimates of traditional actuarial methods	■ Does not separate model and parameter risk
■ No extra work needed	■ Does not produce confidence interval estimates
	■ Highly judgmental
	■ Simplistic

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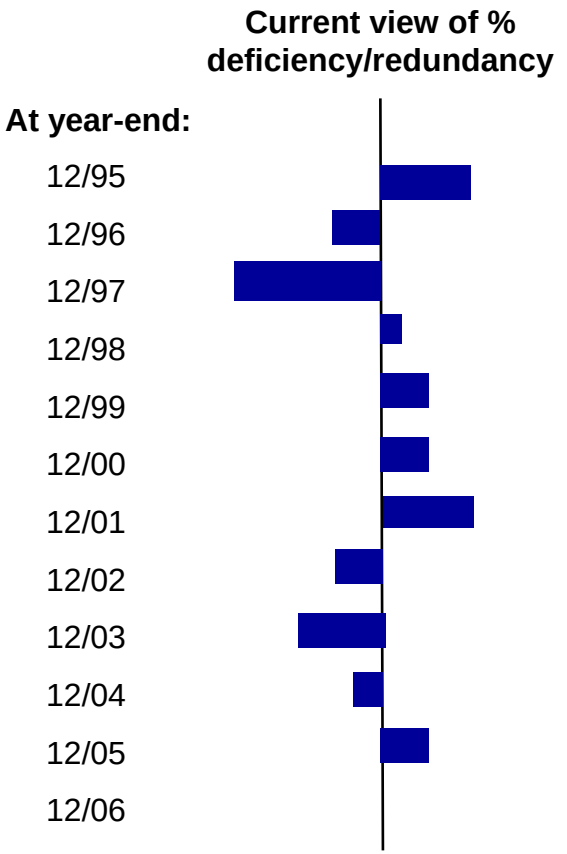
Performance Test: How accurate have the past estimates proven to be?

Actuarial Scorecard for Method X



General Approach — Hindcast Test

- Retrospective test of a consistently applied methodology
- Uses current view of claim liabilities versus historical estimates
- Quantifies the degree of departure that has occurred around the results that would have been indicated by that methodology

Advantages

- Easy to understand and apply
- Few assumptions needed for each model being tested
- Should do this test anyway in arriving at central estimate

Disadvantages

- Does not separate model, parameter and process risk
- Does not produce confidence interval estimates
- The actual “model” used is likely a combination of methods

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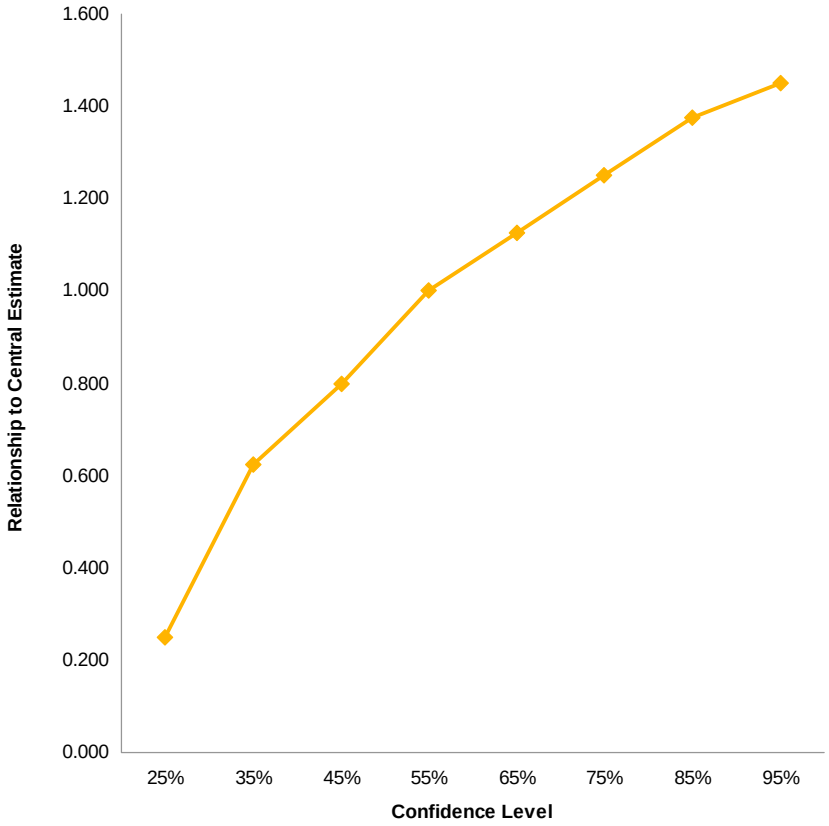
Stochastic: What claim liability outcomes are reasonably likely?

Indicated Unpaid Claim Liabilities as of December 31, 2008



General Approach — Stochastic Methods

- Estimate probability distribution
- Based on statistical methods
- Applied to historical development data

Advantages

- Produces estimates of confidence intervals
- Can approximately separate parameter and process risk
- More complete description of loss generating process
- Feeds other analyses (ERM)

Disadvantages

- Involves relatively complex statistical analysis
- An emerging practice within P/C actuarial field
- Lack of general agreement among actuaries on the best approach
- Some exposures not amenable to this approach (A&E)

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Popular Stochastic Methods

Analytical methods - Mack

- The Mack model measures the standard error of the chain ladder unpaid claim estimate
  - Based on the following simple regression model:

$$C_{ik+1} = f_k C_{i,k} + \sigma_k \varepsilon_{i,k} C_{i,k}^{1/2}$$

- This model is consistent with selected volume weighted RTRs
- Given the mean and standard error of claim liabilities percentiles are calculated
  - Recommended distributional formats are normal and log-normal
- Analytical calculation is based on
  - A “closed form” solution formula
  - A “recursive” calculation

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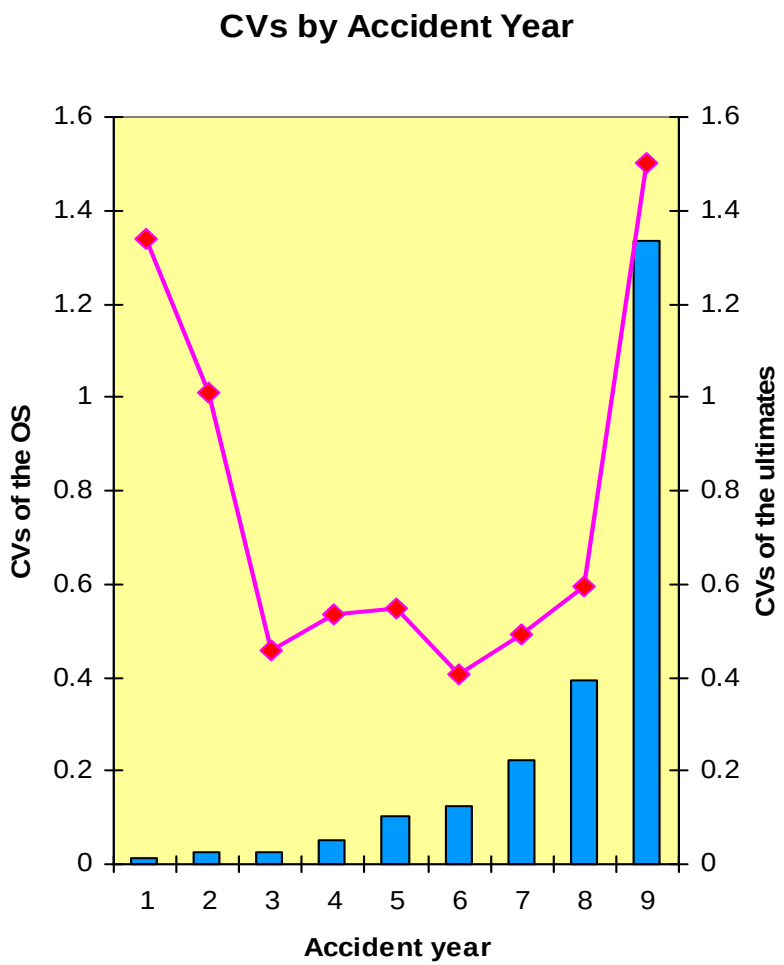
Mack CVs by Accident Year



- The CVs of OS are higher for:
  - Older years where the remaining OS amounts are very low
  - Recent years where the uncertainty of the liabilities increases
- The CVs of Ultimate amounts increases in recent years
  - The uncertainty of the liabilities increases

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Mack method: Pros and Cons

Pros	Cons

■ Intuitive, based on chain-ladder assumptions
■ Widely accepted among actuaries
■ Usually provides stable results
  ■ Very fast
  ■ Measures parameter, process and total risk
	■ Model provides, only, the mean and standard error of the claim distribution
	■ Does not explicitly measure tail variability
	■ Does not model well the situation when actuary selects factors other than weighted or simple average

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Simulation approach: Monte-Carlo

- Simulation techniques help model the complex loss generating process
- Simulation methods assume that the simulated data has the same statistical characteristics as the actual data
- Simulation works as follows:
  - Start with a deterministic method that generates ultimate loss outcomes (i.e. chain ladder)
  - Makes assumptions about the method parameters
    - i.e. the mean and variance of the link ratios
      - Parameter risk needs to handled separately
    - Randomly generate input values
    - Calculate and save ultimate outcomes
    - Repeat many times

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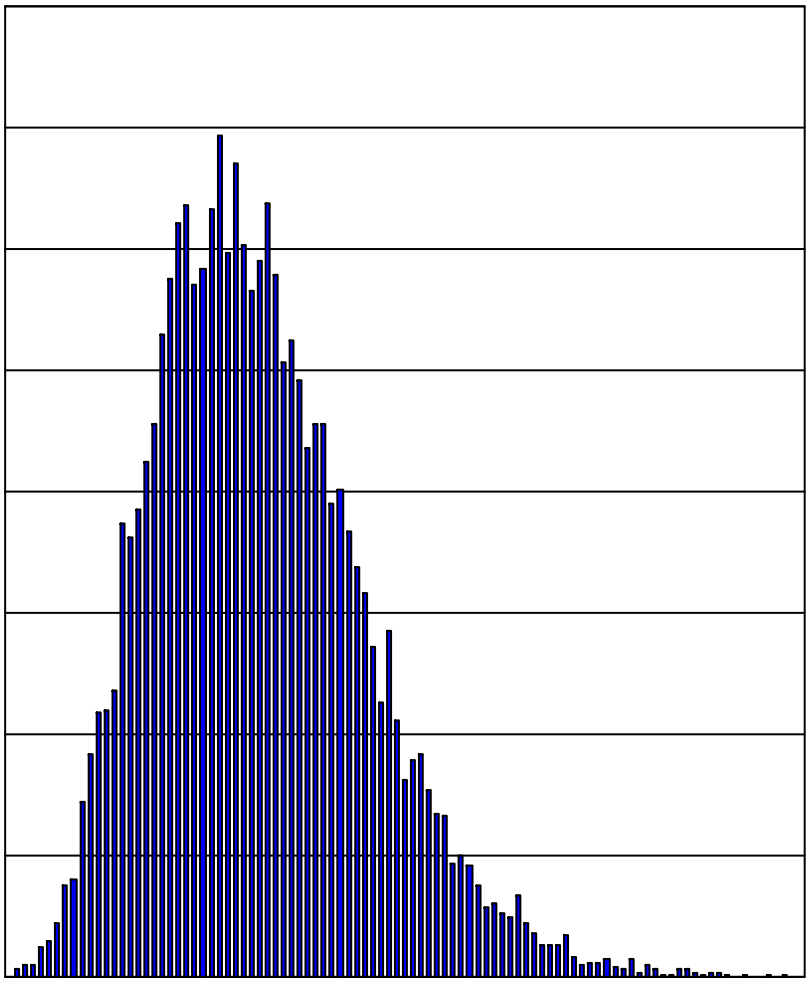
Output simulated distribution



- Simulated “empirical” distribution estimates “theoretical” claim liabilities distribution
- A “wealth” of statistical information is produced (i.e. mean, variance, skewness, etc.)
- Simulated distribution “smooths” with a larger number of simulations

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Monte Carlo simulations: Pros and Cons

Pros	Cons
■ Popular method in many sciences ■ Produces an empirical distribution of the reserves ■ Method can be applied to incomplete data triangles (i.e. trapezoids) ■ It explicitly calculates tail volatility	■ Data outliers can have a leveraged effect on the results ■ Needs additional complexity to measure parameter risk

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Bootstrapping is a “second generation” simulation technique

- Monte Carlo techniques simulate the parameter inputs of a method
- Bootstrapping simulates the actual data employed by these methods
  - If the distribution of the data is known then we sample from that distribution
    - Parameters are estimated
    - This is called **Parametric Bootstrapping**
  - If we do not know the distribution of the data then we simulate from the actual data
    - This is called **Nonparametric Bootstrapping**
    - The process “resample” the residuals with “replacement”

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Simulating reserves stochastically via nonparametric bootstrapping

Actual Cumulative Historical Data

Acc. Year	Development Age 12	24	36	48
1	1,000	1,500	1,750	2,000
2	1,200	2,000	2,300	
3	1,800	2,500		
4	2,100			
Ave Link Ratio	1.500	1.157	1.143	

1. Keep current diagonal intact
2. Apply average link ratios to "back-cast" a series of fitted historical payments
3. Difference of actual vs. recast data defines residuals which we sample with replacement

Recast Cumulative Historical Data

Acc. Year	Development Age 12	24	36	48
1	1,008	1,512	1,750	2,000
2	1,325	1,988	2,300	
3	1,667	2,500		
4	2,100			

Ex: 1,988 = 2,300÷1.157

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Bootstrapping: Pros and Cons

Pros	Cons
■ Actual data “guides” the simulation ■ No assumption needed for simulation of parameters ■ It is a “modern” simulation technique	■ Data outliers can have a leveraged effect on the results ■ Needs additional complexity to measure process risk ■ Residuals might need to be divided into similar resampling groups

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Aggregation of Liabilities

Aggregation: Correlation between Lines of Business

- Strength of the correlation is irrelevant if we only care about the mean reserve indication for two lines A and B:
  - mean(A + B) = mean(A) + mean(B)
- Strength of correlation matters when we look towards the ends of the aggregate distribution of (A+B)
- Generally, the aggregate distribution is less risky than the distribution of the individual lines:
  - 75^{th}percentile(A + B) < 75^{th}percentile(A) + 75^{th}percentile(B)
  - Equality only occurs in the case of perfect correlation across lines (this is very unlikely!)
- The volatility of the aggregate distribution increases:
  - By the volatility of the individual lines
  - By the correlation between the lines

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Theory of Copulas

- Copulas provide a convenient way to express the aggregate distributions of several random variables
- Copula components:
  - The distributions of individual random variables
  - Correlations of these variables
- Correlation coefficients measure the overall strength of association across various distributions
- Copulas can vary that degree of association over the various parts of the aggregate distribution
  - Example: for workers comp and property losses the correlation is higher in the tail of the distribution

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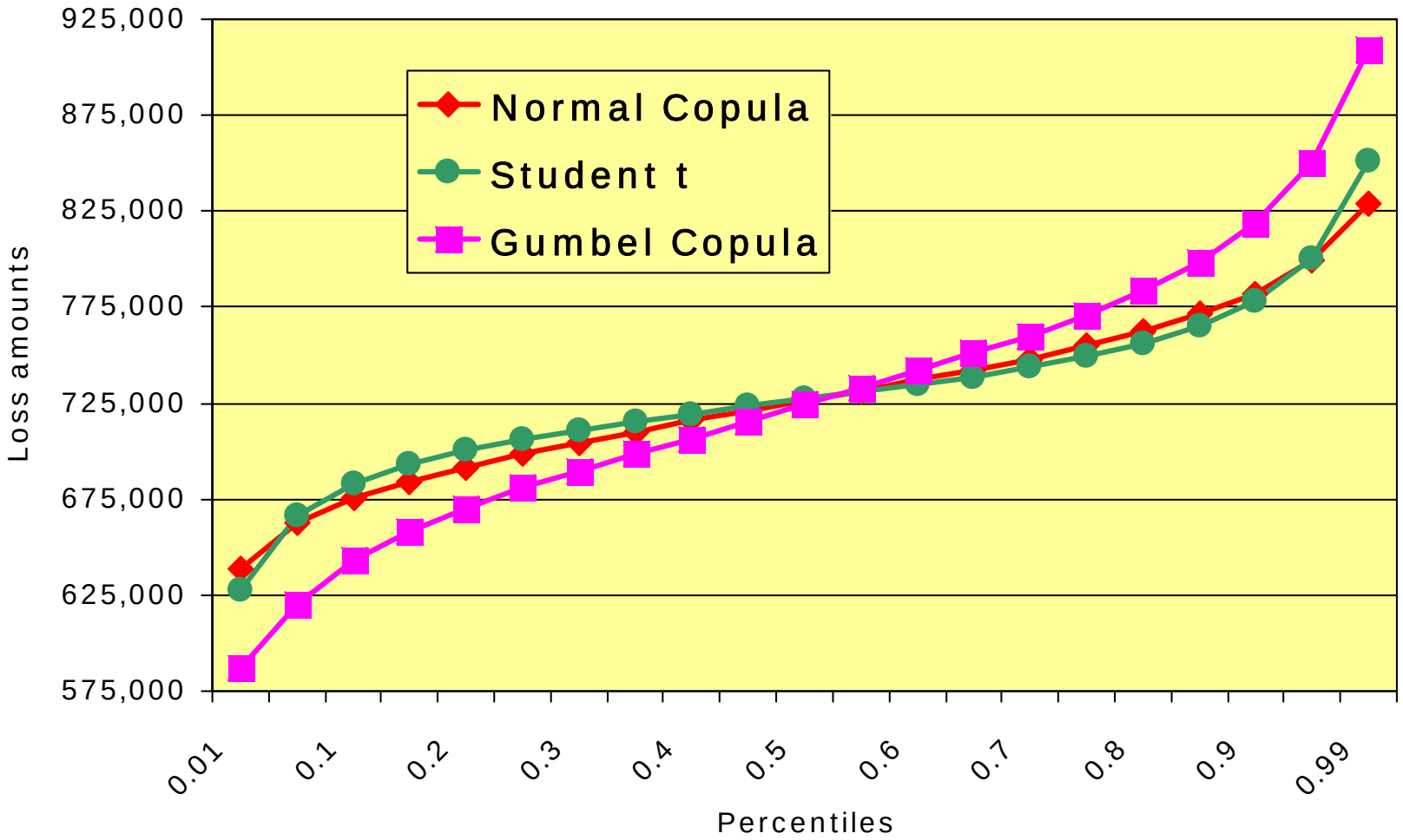
Comparison of Copulas



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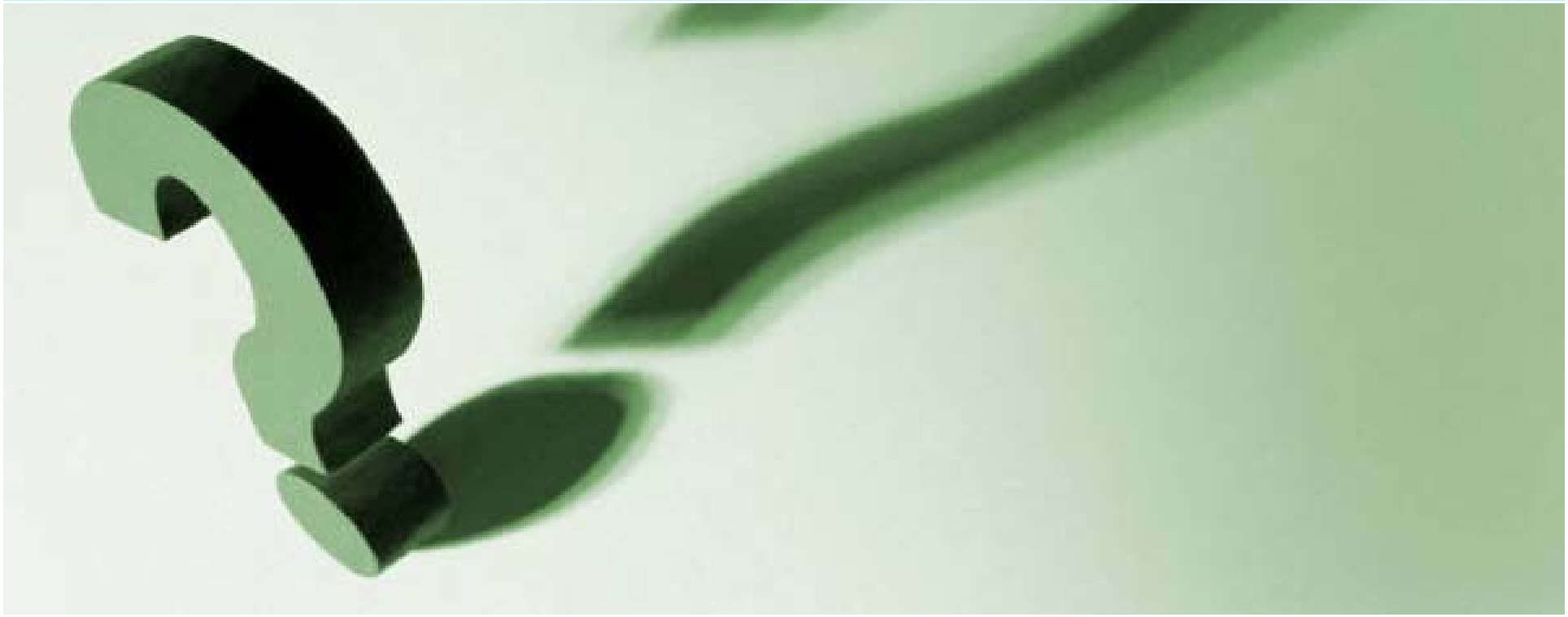
Questions?



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