

# CAS Spring Meeting: ERM Capital Modeling

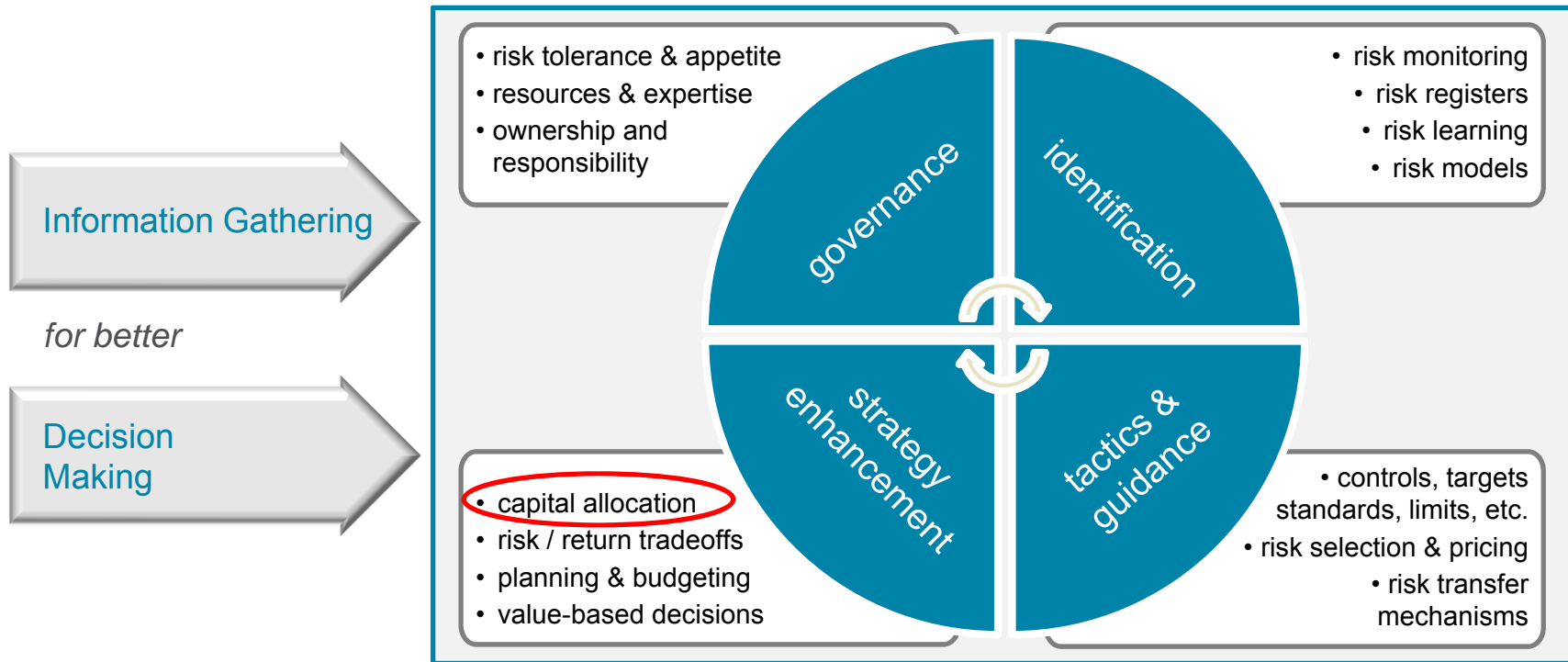
May 21, 2013



# Economic Capital Model Introduction

- ERM vs ECM
- What are they good for?
- ECMs and ORSA

# Enterprise Risk Management ≠ Economic Capital Modeling



- ERM is a larger framework, including qualitative components
- ECM is a subset of ERM

## (Economic) Capital Modeling = Risk Modeling

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$$\text{\$} - \text{\$} = 0 \quad \text{X}$$

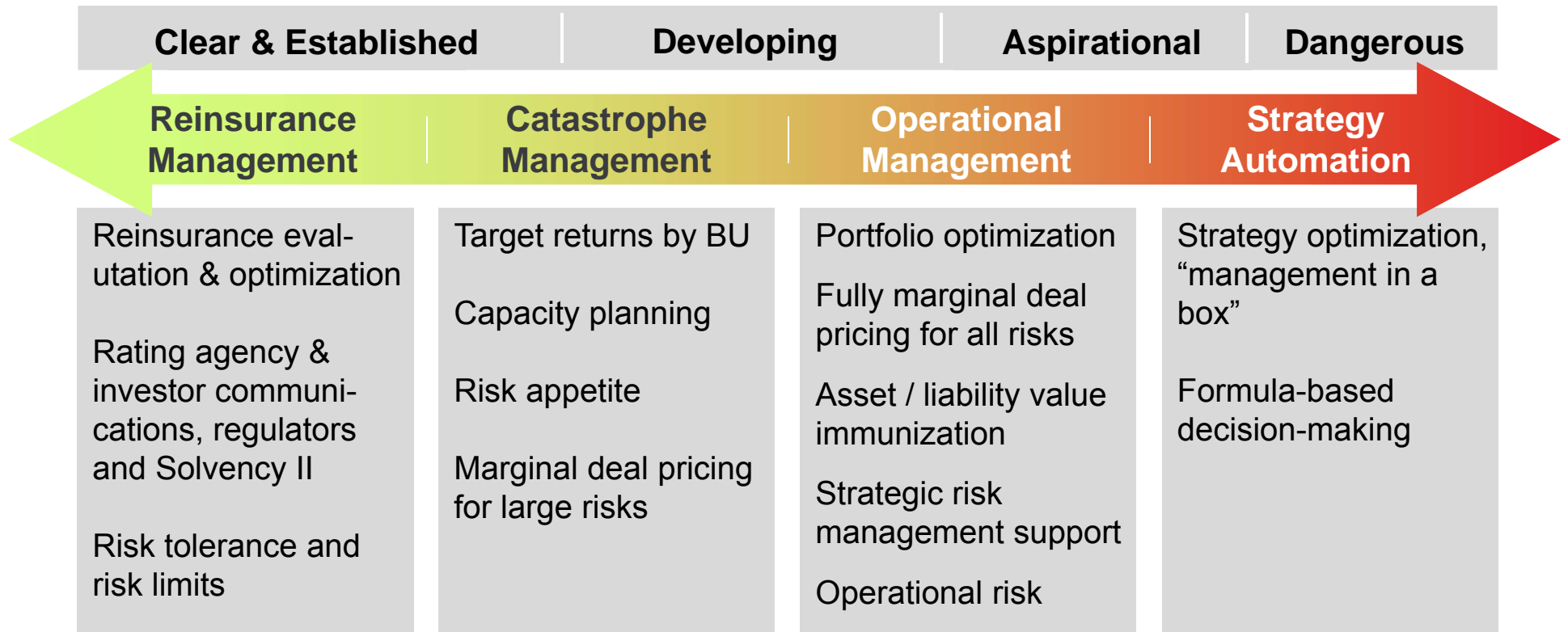
$$\text{\$\$} - \text{\$} = \text{\$} \quad \checkmark$$

### Alternatives:

- **CAPM/APT:** Cummings and Phillips, “Estimating The Cost of Equity Capital For Property-Liability Insurers”
- **Option Pricing:** Wacek, Michael G., “Application of the Option Market Paradigm to the Solution of Insurance Problems”
- **Capital Hoteling:** Donald Mango, “Insurance Capital as a Shared Asset”
- **Variance of Loss:** Robert Miccolis, “On the Theory of Increased Limits and Excess of Loss Pricing”
- **Risk-Neutral Measures:** Shaun Wang, “A Universal Framework for Pricing Financial and Insurance Risks”
- **Axiomatic Geometry / Topology:** Steve Mildenhall, “Actuarial Geometry”

# What Use Are Economic Capital Models?

## Spectrum of Commonly Proposed Applications



- **Misconceptions:** ECMs are not the best tool to help with
  - Detailed accounting pro formas and detailed business planning
  - Estimated loss ratios by line of business or business unit (no simulation required)
- **ECMs are concerned with volatility and risk and not point estimates**

# ORSA Summary Report

## Expected Components

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### Section 1: Risk Management Framework

- Risk Culture and Governance
  - Risk Identification and Prioritization
  - Risk Appetite, Tolerances, and Limits
  - Risk Management and Controls
  - Risk Reporting and Communication
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### Section 2: Assessment of Risk Exposure

- Documentation of the quantitative and/or qualitative assessments of risk exposure in both normal and stressed environments for each material risk category of Section 1
  - Detailed description of risks identified, assessment methods, key assumptions, and adverse scenarios should be documented
  - Analysis should be consistent with the way business is managed
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### Section 3: Group Risk and Prospective Solvency Assessment

- Testing of aggregate available capital against the various risks that can adversely affect the enterprise
- Multiple views of risk capital via different time horizons or accounting frameworks may be appropriate
- Expect that intra-group transactions and double-gearing of capital should be eliminated as part of the analysis
- Effects of contagion risk, liquidity risk and diversification impact, along with fungibility of capital within the holding company system should also be considered

In analyzing an ORSA Summary Report, the supervisor will expect that the Report represents a work product of the enterprise risk management process that include all of the material risks to which an insurer (or group of insurers) is exposed.

# Satisfying ORSA Requirements

## Range of Approaches

	Sufficient	Intermediate	Elaborate
<b>Risk Management Framework</b>	Document key risks and their handling	Additional ERM risk governance oversight framework and coordinated documentation building upon current executive management structure	Separate risk management function with cross responsibilities by legal entity and group, with accountability to CEO and board committees linked to detailed risk identification process with formalized risk tolerance, appetite and limits
<b>Assessment of Risk Exposure</b>	Cat modeling + Historical Experience	Formal view of volatility and target combined ratio by line of business; catastrophe PML assessment; stress test evaluation of asset risk and underwriting risk scenarios	Detailed risk identification process across all businesses linked to the development of formalized risk quantification and reporting process with data validation and controls for all risk functions
<b>Group Risk and Prospective Solvency Assessment</b>	Pro-forma plan, Expected vs Stressed	Multi-year pro-forma summary of financial plan under expected and stressed scenarios, supplemented with view of key risks such as catastrophe and underwriting risk	Detailed, multi-year economic capital model results linking accident year, underwriting year and calendar year results on both economic and accounting basis across all dimensions with linkage to strategic decision-making, supplemented with detailed stress testing

# Parts of an Economic Capital Model



## Economic Capital: Key Risk Components

Underwriting	Reinsurance	Reserve	Market	Credit
Pricing Risk Parameter Risk Loss Process Risk Cat Risk Product Design Risk	Coverage Terms Basis Risk ALAE / ECO / XPL Long-Tailed Lines	1 year Run-off Long-Tailed Lines Latent risks (A&E) Steady-State?	Equity Interest Rate (GAAP) Currency	Reinsurance Recoverables Bonds Default Downgrade migration

- Sophisticated software modeling / components available for these risks.
- Sophisticated software not mandatory

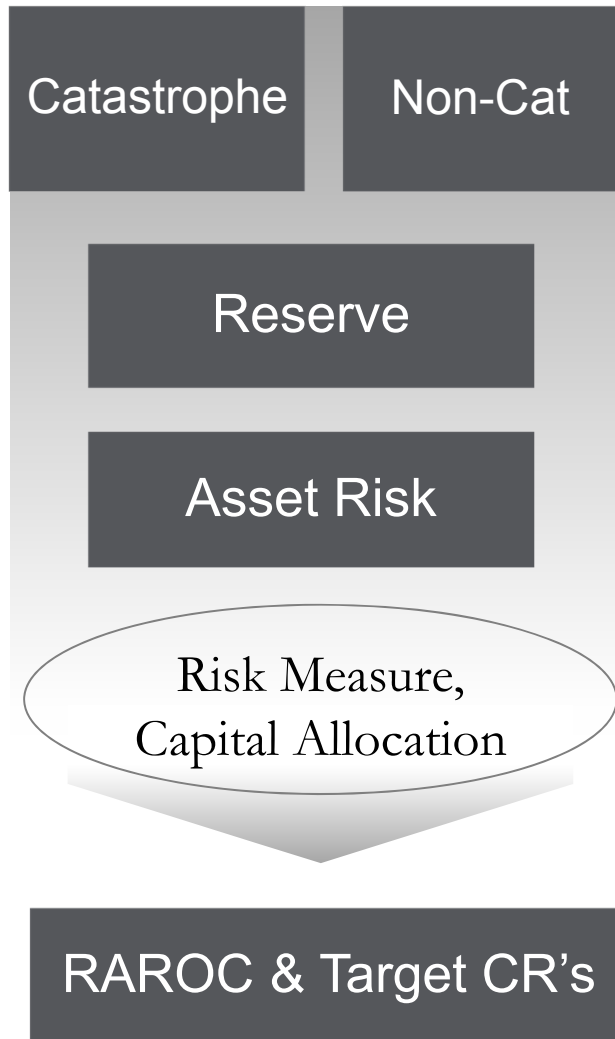
**Operational**

Basel II banking defn:  
 “the risk of loss resulting from inadequate or failed internal processes, people, or systems, or from external events

- Tack on flat factor at end
- Rating agencies often want more here

# Economic Capital Model Governance

## Develop Actionable Indications



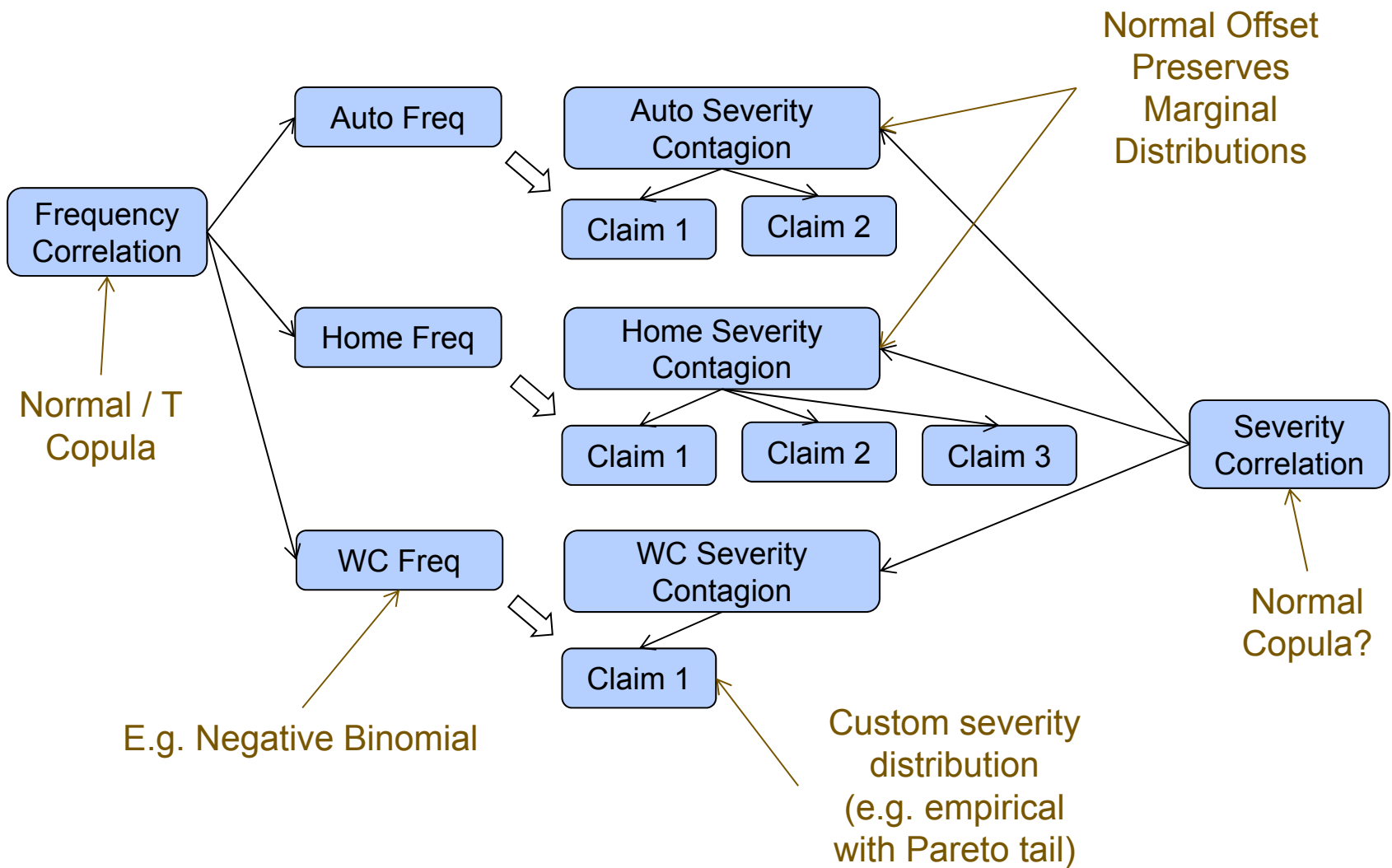
Current Accident Year Capital

Additional capital for asset risk, allocated back to reserves + required UW capital

Additional capital for reserve risk, allocated back relative to payout pattern

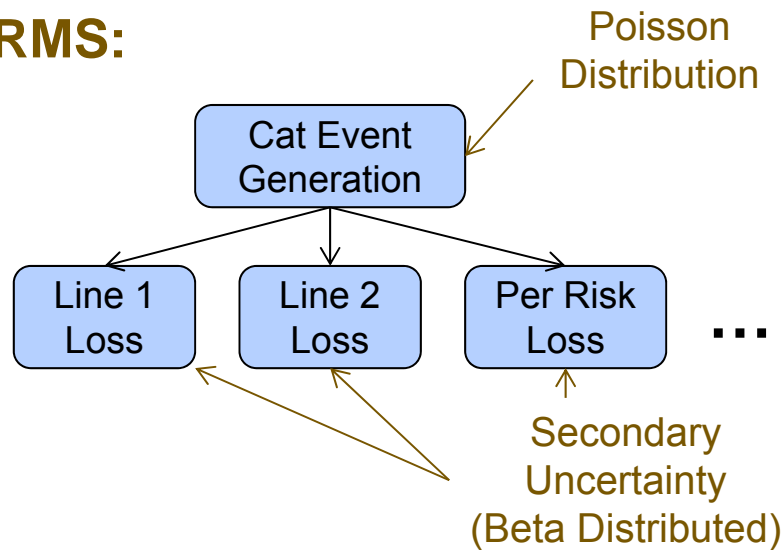
- Objective should be the development of a rational link between:
  - Required Capital
  - Profit Load
  - Target Combined Ratios

# Non-Cat Underwriting Loss Risk

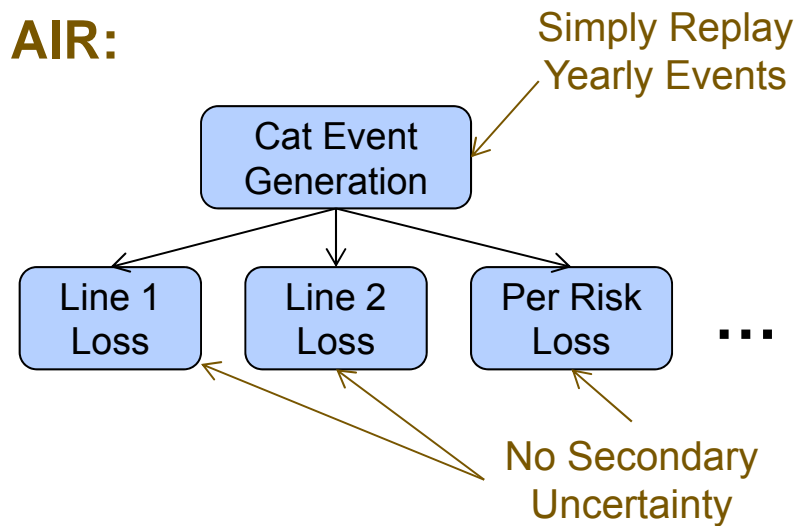


# Underwriting Catastrophe Loss Risk

## RMS:



## AIR:



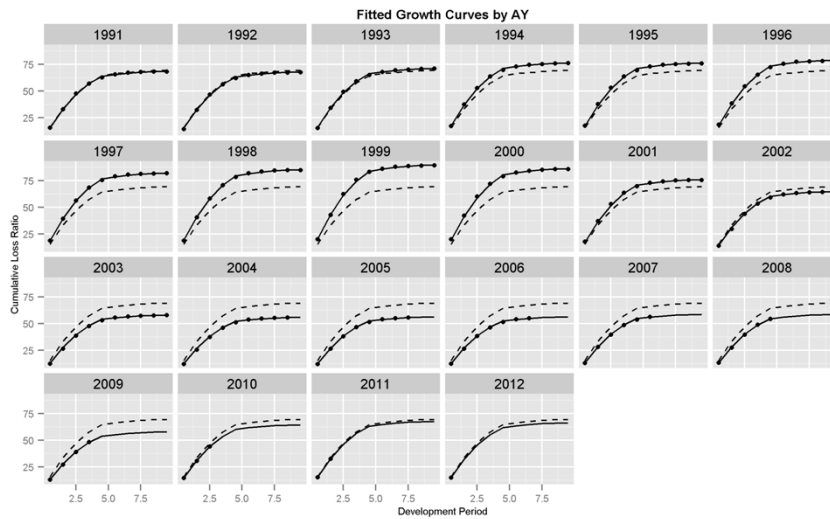
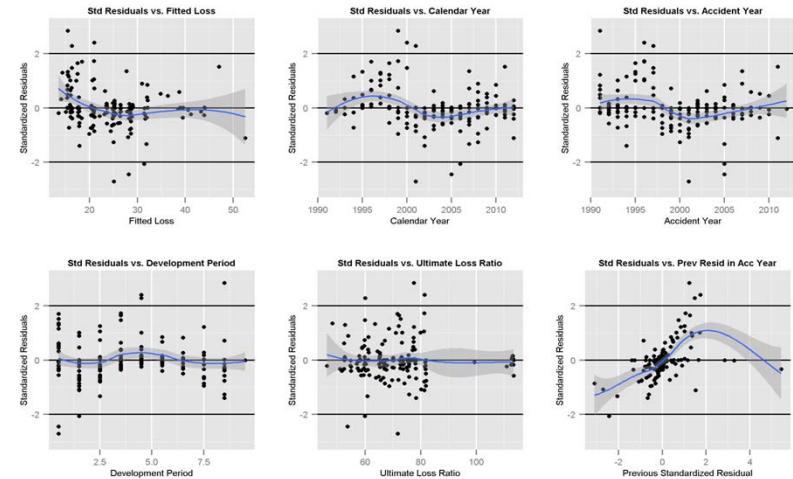
- Straightforward conceptually but some tricky details
  - **Reinsurance handling:** routing of per risk losses and treaty terms
  - **Convergence:** Traditional Monte Carlo may converge slowly
  - **Small Event Handling:** Threshold selection
  - **Modeling Granularity:** Level of detail, reporting requirements
  - **Model blending:** E.g. line 1 is RMS and line 2 AIR
  - **Year over Year Changes:** Isolating changes can be difficult

Computation  
Space and Time

# Reserve Risk

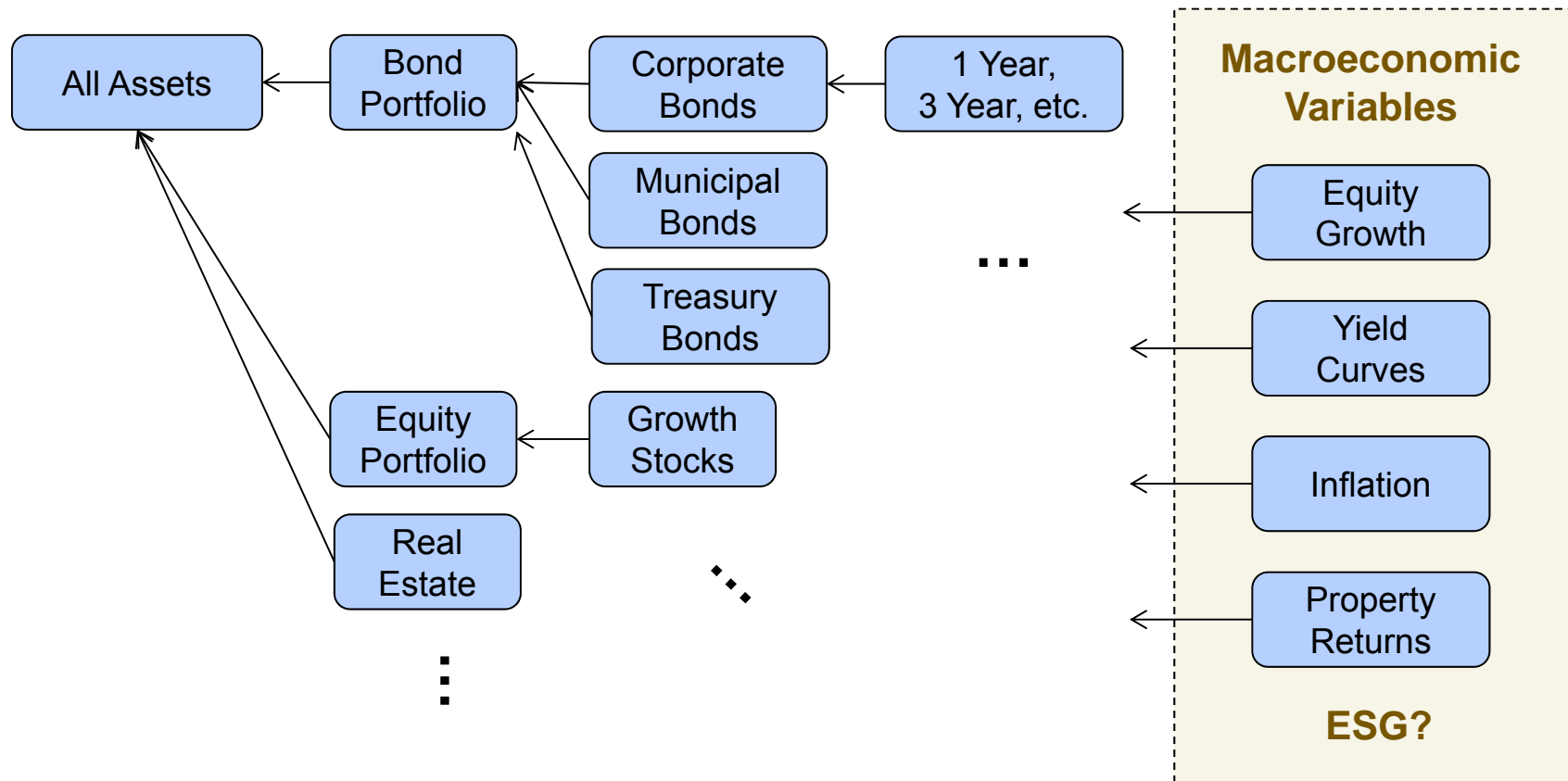
## Stochastic Reserving Techniques

- Mack Chain Ladder: Thomas Mack, “Measuring the Variability of Chain Ladder Reserve Estimates”
- Bootstrap Chain Ladder: England and Verrall, “Stochastic Claims Reserving in General Insurance”
- AB Reserving Method: Adam Troyer (forthcoming), “Distribution of One Year Reserve Development - A Link Ratio Simulation Approach”
- Hierarchical Growth Curve: Zhang, Dukic, Guszczka, “A Bayesian Nonlinear Model for Forecasting Insurance Loss Payments”



- Open Source Implementation:
  - ChainLadder Package for R on CRAN
- Can insert into company model as aggregate quantity
  - Gross of reinsurance
  - Net of reinsurance

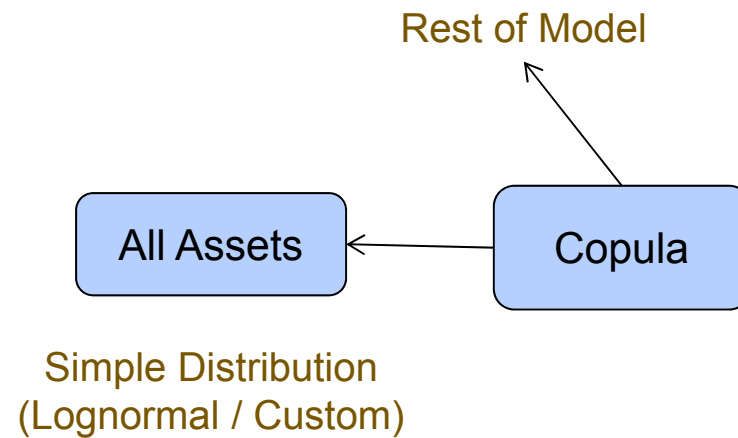
## Asset Risk



- Try not to duplicate work of finance department / investment managers
- Level of detail sufficient to represent connections with underwriting variables
  - Avoid CUSIP level!
- Can be very time consuming to dial-in all parameters and verify output

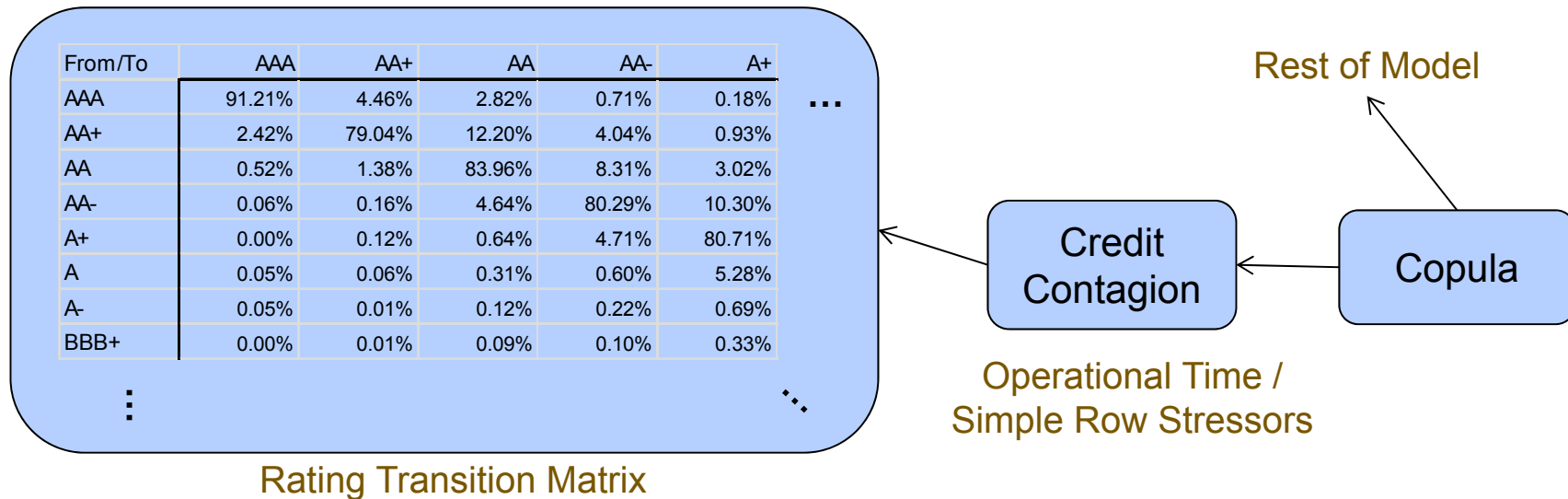
## Asset Risk Alternative Model

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- Scenario testing handles, for instance, high inflation case.

# Credit Risk

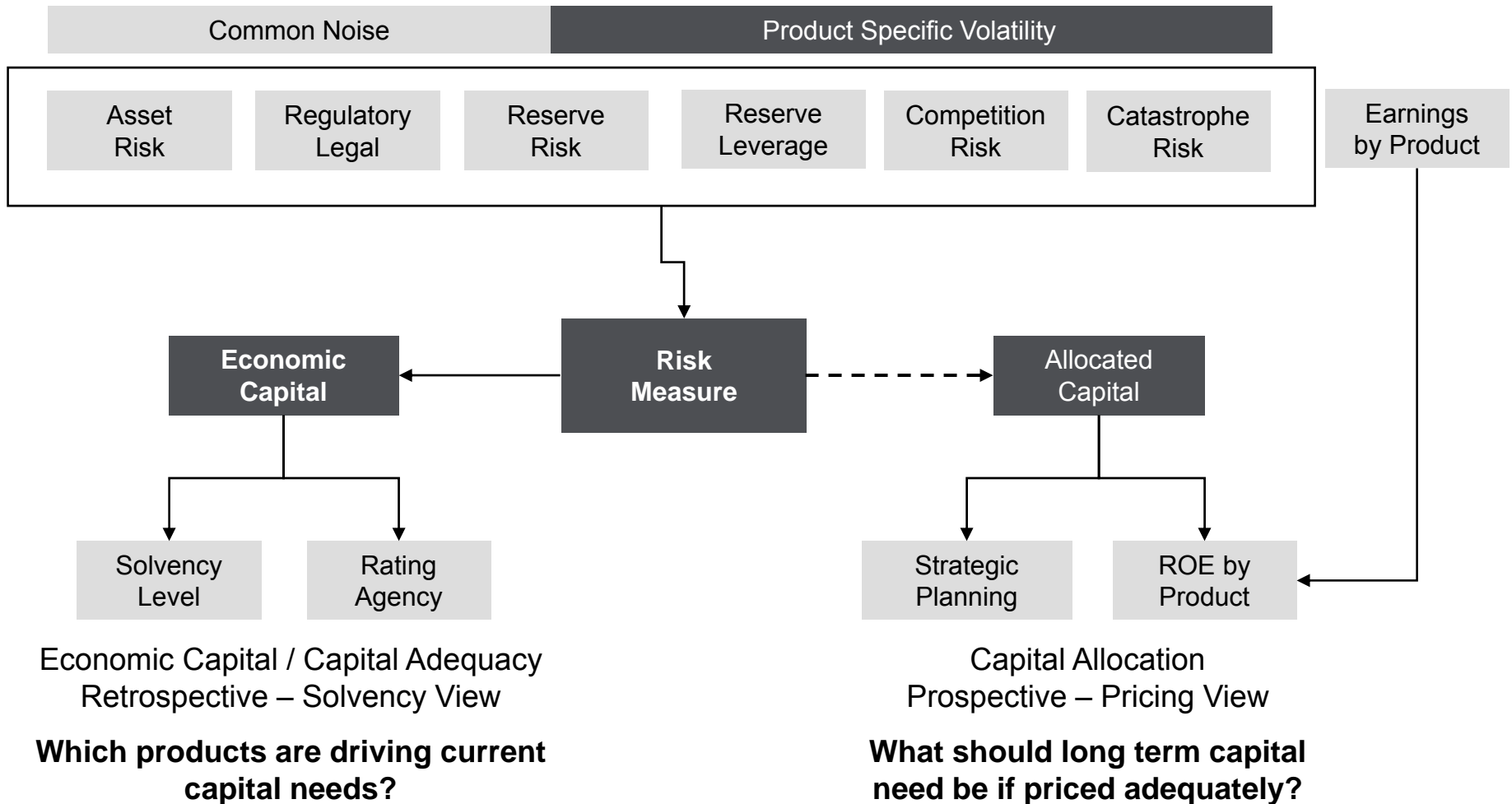


- Can apply to bonds / reinsurance / other debt
- Default risk vs credit spread
  - Stochastic yield curves by bond rating?
- Credit Risk can be complicated and often isn't
- Alternative: Discounting



# Economic Capital Modeling

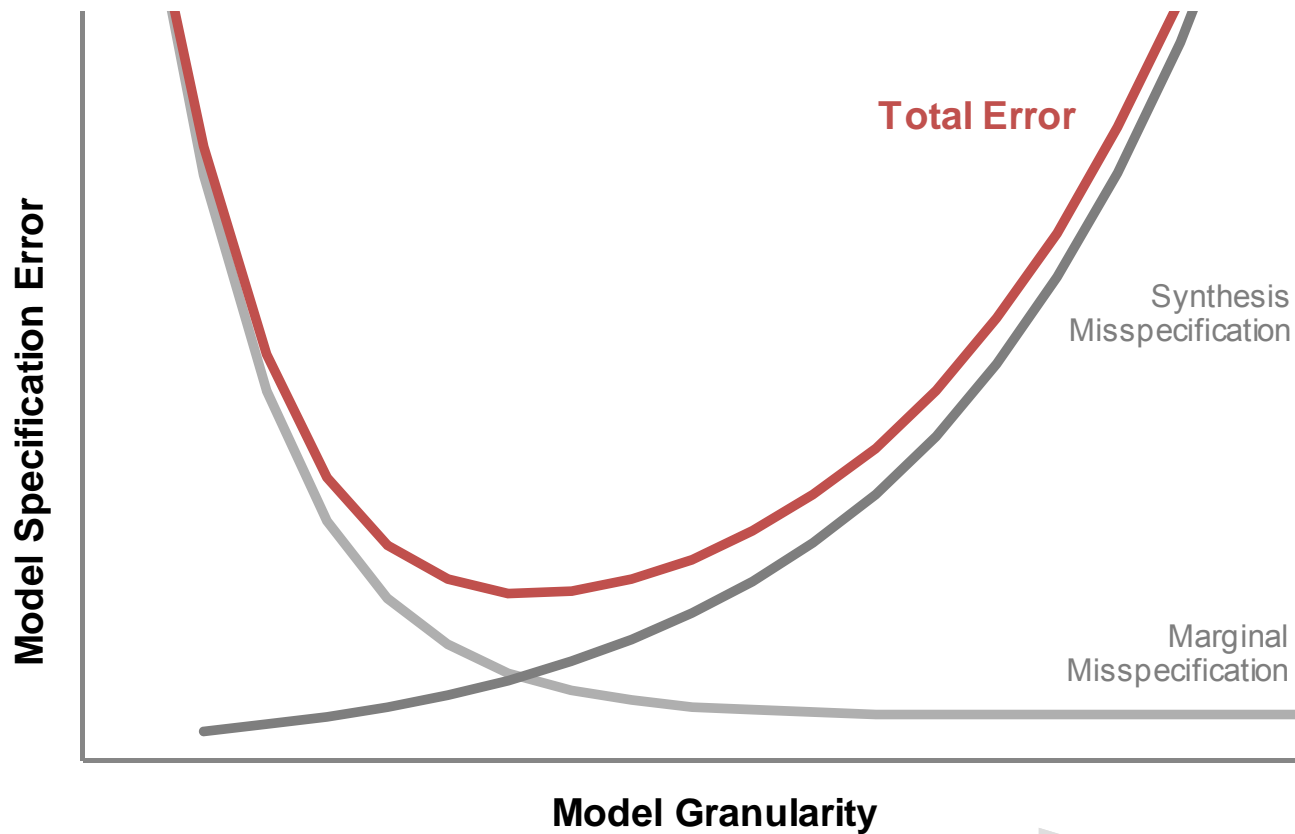
## By Line of Business Risk Drivers



# Models: Simple, Robust & Understandable

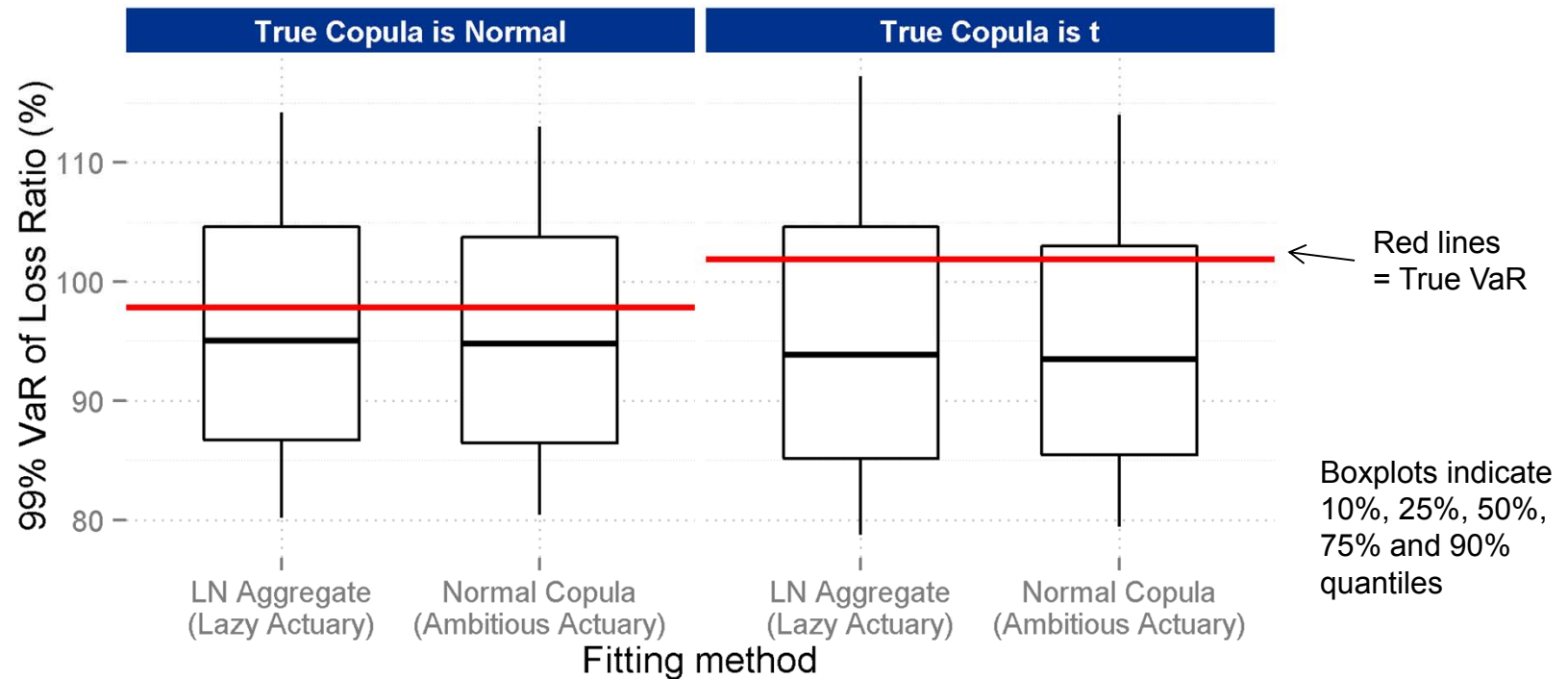
Balance Complexity And Accuracy

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**Business Desire for Greater Granularity**

# Copulas and Aggregation Error



- Assumptions:
  - Actual generating distribution (**the truth**)
    - 10 lines of business, lognormally distributed with mean loss ratio 60%, standard deviation 20%
    - Gaussian or t (3 degrees of freedom) copula. Correlation between different lines: 50%
  - Fit assumptions (**simulated actuary**)
    - 10 years of data available for fitting
    - 10 lines of business, lognormally distributed loss ratios (method of moments fit)
    - Normal copula or lognormal fit to all-lines loss ratio

## Worse Is Better?

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	Better	Worse
Simplicity	Be as simple as possible, <b>especially the interface.</b>	Be as simple as possible, <b>especially the implementation.</b>
Correctness	Results <b>must be correct.</b>	Strive for correctness, but <b>don't sacrifice simplicity.</b>
Consistency	This is a must; <b>consistency is as important as correctness.</b>	Consistency is important, often <b>drop tricky features which cause inconsistency.</b>
Completeness	All reasonable cases must be covered. <b>Complexity is allowed for completeness.</b>	Be as complete as possible, but completeness is <b>least important.</b>

See *Lisp: Good News Bad News How to Win Big* by Richard P. Gabriel 1991.

# Scenario Analysis

## Scenario Analysis + Probabilities = Economic Capital Model

- + Rounding out Scenario Set
- + Statistical Consistency
- + Practical Implementation / Reporting
- + Automated Decision Making

(w/ Standardized Reporting,  
Risk Pricing,  
Capital Adequacy,  
etc.)

- Example: Scenario Analysis and Planning Tool (SnAP):

