Summary of Risk Margin analysis framework

Step	Component	Description
1	Portfolio Preparation	Determine valuation portfolios, groups
2	Independent Risk Analysis	Quantitative analysis, benchmarking
3	Internal Systemic Risk	Balanced scorecard, map scores to CoVs
4	External Systemic Risk	Potential future external sources of risk
5	Correlation Effects	Correlations between classes & liabilities
6	Consolidation of Analysis	Consolidate CoVs and correlations
7	Additional Analysis	Sensitivity testing, scenario testing, benchmarking, hindsight analysis
8	Documentation	Document analysis & judgment
9	Review	Review assumptions annually, full analysis every 3 years

Framework for assessing risk margin

Claims Portfolio	Insurer claims portfolio
↓	
Valuation Classes	e.g. Home vs. Auto
↓	
Homogenous Claims Groups	Property vs. Liability vs. CAT
↙ Systemic Risk ↘ Independent Risk	
Systemic Risk → External to Actuarial Process	e.g. labor costs, legislation risk
Systemic Risk → Internal to Actuarial Process	e.g. specification, data error

Sources of Uncertainty

Systemic Risk
Risks that are potentially common across valuation classes or claim groups

Independent Risk
Risks arising from randomness inherent in the insurance process

Sources of Systemic Risk

<u>Internal Systemic Risk</u>
Risks internal to the liability valuation process

→ Reflects the extent to which the actuarial valuation approach is an imperfect representation of a complex, real-life process

<u>External Systemic Risk</u>
Risks external to the actuarial modeling process

→ Even if the model represents current conditions well, future systemic trends may cause future experience to differ from current expectations

Sources of Independent Risk

- Random component of parameter risk
  - Randomness of the insurance process compromises ability to select appropriate parameters for valuation models
- Random component of process risk
  - Pure effect of randomness of the insurance process

Sources of uncertainty that quantitative modeling is best able to assess

- Quantitative modeling is best for analyzing independent risk and past episodes of external systemic risk.
- Quantitative modeling must be supplemented with other qualitative or quantitative analysis to incorporate internal systemic risk and external systemic risk.
    - Future external systemic risk may differ from past episodes

Main sources of internal systemic risk

Specification Error

Error arising from an inability to build a model that fully represents the underlying insurance process.

Parameter Selection Error

Error that the model can't adequately measure all predictors of claim cost outcomes or trends in predictors. May be more cost drivers than can be captured in the valuation model.

Data Error

Error from poor data or unavailability of data required for a credible valuation model.

PDLD Ratios:
Retro Formulas

$$PDLD_1 = \left(\frac{BP}{SP}\right) \cdot \frac{TM}{ELR \cdot \%Loss_1} + \left(\frac{CL}{L_1}\right) \cdot LCF \cdot TM$$

$$PDLD_n = \frac{\Delta CL_n}{\Delta L_n} \cdot LCF \cdot TM$$

$\frac{\Delta CL_n}{\Delta L_n} \rightarrow$ Incremental Loss Capping $Ratio_n$

Retro PDLD formula: Advantages and Disadvantages

Advantages

- Responsive to changes in the retro rating parameters that are sold
    - If parameters change significantly, should give more weight to retro formula PDLD ratios than those from historical data

Disadvantages

- Must select retro rating parameters
    - This may be difficult because parameters will vary between policies sold

Reviewing historical quarterly PDLD Ratios

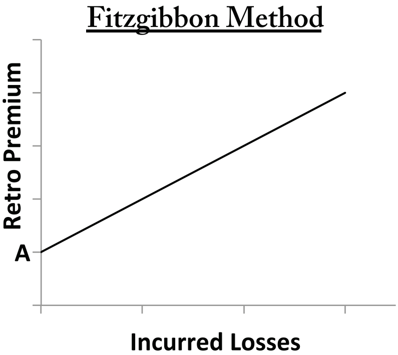
- Upward trend could indicate:
    - More "liberal" rating parameters that increase capped losses and premium (e.g. higher max premium or per-accident limit)
    - Better loss experience → More losses are within the capped limit
- Historical PDLD ratios may be volatile after 1st retro adjustment because incremental premium development may reflect loss development on a small number of policies
- May see negative PDLD ratios when loss development is positive

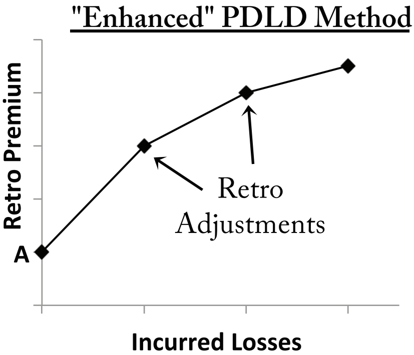
  → e.g. upward development on claim already past per-accident limit

Reasons historical PDLD ratios may differ from retro formula ratios

- Worse (or better) than expected loss experience can cause more (or less) losses to be capped, resulting in historical PDLD ratios that are smaller (or larger) than the retro formula PDLD ratios
- Average retro rating parameters may change over time

Graphical representation of the Fitzgibbon method vs the “Enhanced” PDLD method





Note: The "normal" PDLD graph goes through the origin.

Key Aspects of ERM

- An effective ERM program should be a regular process
- Should consider risks on an enterprise-wide basis
- Focus on risks that represent a material impact to the value of the firm
- Risk can be positive or negative; it’s the fact that actual outcomes vary from expected
- Risks must be quantified where possible, including correlations among risks
- Create strategies to avoid, mitigate, or exploit risk factors
- Evaluate risk management strategies for risk/return to maximize firm value

Types of insurance company Risk Factors

Insurance Hazard Risk - Risk assumed by insurer

- Underwriting (non-cat) } in-force
- Accumulation/cat-risk } in-force
- Reserve Deterioration ← from past exposures

Financial Risk - Risk to asset portfolio due to volatility in interest rates, foreign exchange rates, equity prices, credit quality, liquidity

Operational Risks - Risks in the operation/execution of the company; the *actions* the company takes

Strategic Risks – The risks of strategic choices the company takes → The risk of choosing the wrong plan

Enterprise Risk Management Process

Diagnose - High-level risk assessment of risk factors that pose a potentially serious threat to the firm

→ General environment risks
→ Industry risks
→ Firm-specific risks

Analyze - Quantify risks with probability distributions of potential outcomes. Include correlations.

Implement Risk Management - Avoidance, reduction, mitigation, elimination/transfer, or retain/assume risks

Monitor - Monitor results vs. expectation, update plans

Enterprise Risk Modeling
helps with the following strategic decisions

- Determining capital needed to support risk or maintain rating
- Identifying sources of significant risk
- Deciding on reinsurance strategies
- Planning growth
- Managing asset mix
- Valuing companies for M&A

Most important elements for model quality

- Model reflects relative importance of different risks to business decisions
- Modelers have a deep knowledge of the risk fundamentals
- Model incorporates the dependencies between different risks
- Modelers have a trusted relationship with senior management

“Essential elements” of an enterprise risk model

- Underwriting risk
- Reserving risk
- Asset risk
- Dependencies (correlation)

Underwriting Risk

Loss Frequency and Severity Distributions

Used to quantify loss potential

Pricing Risk

Underwriting cycle, risk of unnoticed underpricing until losses accumulate, resulting in a reserve deficiency

Parameter Risk

Risks from mis-estimated parameters, imperfect model form, unmodeled risks (Estimation, projection event, systemic risk)

Catastrophe Modeling Uncertainty

Uncertainty in 3rd party CAT models (e.g. probability of events/loss)

Parameter Risk

<u>Estimation Risk</u>

Risk that the form and parameters of the frequency/severity distributions don't reflect the "true" form and parameters

<u>Projection Risk</u>

- Changes over time and uncertainty in the projection of changes
- Trends in frequency/severity from time of data to current/future periods
- Development of losses to ultimate

<u>Event Risk</u> – Events outside company control that impact frequency/severity trends (e.g. class action suits, asbestos, new cause of loss)

<u>Systematic Risk</u> – Nondiversifying, impacting many policies (e.g. inflation)

Naïve approach to measuring reinsurance value

Comparing ceded premium (cost of reinsurance) to reinsurance recoveries and ceding commissions (benefit) over many years typically shows a negative net benefit.

Reinsurers expect to make a profit, so a simple cost-benefit analysis is a poor way to assess reinsurance value.

Measuring Reinsurance Value: Paradigm 1

Reinsurance Provides Stability

- Protects surplus from adverse results
- Improves predictability of earnings and growth
- Improves customer confidence that they'll recover insured losses

Ceded Premium - Recoveries is a better cost measure under this paradigm.

Measuring Reinsurance Value: Paradigm 2

Reinsurance is a Substitute for Risk Capital

- Increased stability lowers the required risk capital

$$ROE\ Cost\ of\ Reinsurance = \frac{Reinsurance\ Cost}{Capital\ Freed}$$

If the ROE cost of reinsurance is less than the company's target return, getting reinsurance is a good deal.

Measuring Reinsurance Value: Paradigm 3

Reinsurance Adds Value

Ideally, we could measure the value of reinsurance by the incremental increase in market value to the company.

Credibility-Weighted Method formulas

$$\boxed{Deductible\ Loss\ Charge = Prem \cdot ELR \cdot \chi}$$

$$\boxed{Z_{BF} = \frac{1}{XSLDF}}$$

$$\boxed{Ult = Z \times (Loss \cdot XSLDF) + (1 - Z) \times \mathrm{E}[Loss]}$$

$$Ult = Cred \cdot Ult_{Direct\ Development} + (1 - Cred) \cdot Ult_{Loss\ Ratio\ Method}$$

Credibility-Weighted Method: Advantages and Disadvantages

Advantages

- Ties with pricing estimates for immature years where excess losses haven't emerged
- Estimates are more stable over time compared to direct development

Disadvantages

- Ignores actual experience for the complement of credibility

  → Might use alternative credibility weights that are more responsive to actual experience if desired

Limited Severity Relativity

Limited Severity Relativity

Ratio between limited and unlimited severity

$$R_t^L = \frac{\text{Severity Limited to limit } L \text{ at age } t}{\text{Unlimited Severity at age } t}$$

$$R^L = \frac{\text{Severity Limited to limit } L \text{ at ultimate}}{\text{Unlimited Severity at ultimate}}$$

Relationship between limited, excess, and unlimited LDFs

$$LDF_t = R_t^L \cdot LDF_t^L + \left(1 - R_t^L\right) \cdot XSLDF_t^L$$

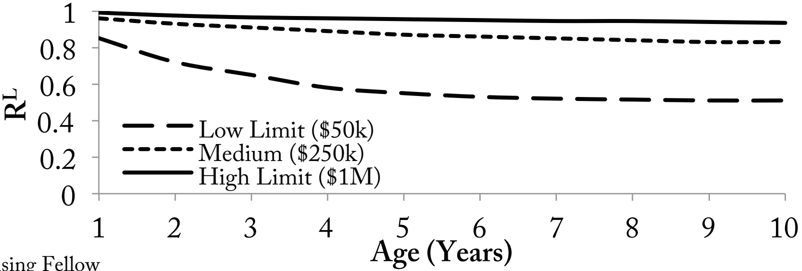
Relationship between limited severity relativities over time

Severity relativity should decrease as age increases

→ More losses are capped at the per-occurrence limit as age increases

Severity relativity should be higher for higher limits (and fall more slowly)

→ A higher limit means less of the loss is capped, so the relativity is higher



Distributional Model

Fit a model (e.g. Weibull) to severities in order to calculate consistent severity relativities and LDFs.

→ This makes it easy to interpolate among limits and years

Distribution parameters vary over time by development period.

→ Parameters can be estimated by minimizing χ^2 between actual & fitted severity relativities at the deductible size

→ Constrain parameters so that the model produces the actual unlimited severity at maturity

Partitioning expected development around the deductible limit

$$\%Unpaid = 1 - \frac{1}{LDF} = \frac{LDF - 1}{LDF}$$

$$= \underbrace{\frac{R_t^L \cdot \left(LDF^L - 1\right)}{LDF}}_{\text{Development below the deductible}} + \underbrace{\frac{\left(1 - R_t^L\right) \cdot \left(XSLDF^L - 1\right)}{LDF}}_{\text{Development above the deductible}}$$

Development *below* the deductible

Development *above* the deductible

Relationship of excess and limited development over time

As development age increases, an increasing proportion of development is excess the deductible limit.