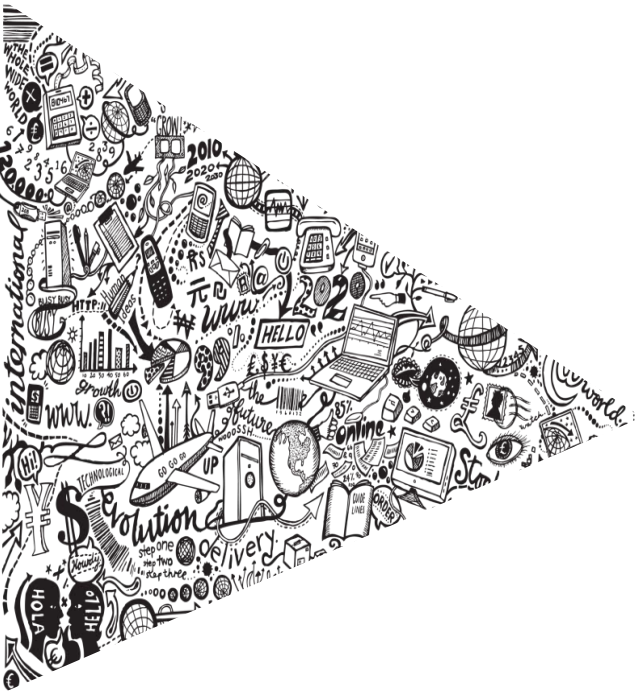

Dynamic Risk Modeling Handbook

Reserving risk chapter

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Agenda

- Introduction
- Conceptual framework of dynamic modeling in loss reserving
- Dynamic models in loss reserving risk
- Link to Dynamic Risk Modeling (DRM) handbook
- Questions and answers

Introduction

- The purpose of this chapter of the handbook is to address dynamic modeling in a loss reserving context.
- Reserving risk is generally concerned with the variability of the unpaid loss estimates.
- Three critical components need to be considered in using dynamic modeling in loss reserving.
  1. Purpose of the reserving analysis
  2. Intended audience and user of results of the reserving analysis
  3. Practical limitations of models used in the analysis

Introduction

Purpose of reserving analysis

- The purpose of the analysis will tell the actuary whether or not he should use dynamic or static models.
- Static models are usually used in traditional statutory analysis.
- Dynamic models are used to serve insurance company's business needs.
  - Probability of ruin
  - Intelligent allocation of capital
- Dynamic models are also used to fulfill emerging future solvency regulation requirements.
  - European Solvency II
  - NAIC ORSA
- Actuary should not judge a model per se, in some absolute sense, but rather consider how the model serves its intended purpose.

Introduction

- Audience and user of results of analysis
  - Actuary should be aware that the audience of an analysis is closely related to the purpose of the analysis.
    - Traditional statutory reserving analysis – state insurance departments
    - Company's business needs – CEO, CRO or Board of Directors
  - Audience and users of analysis are not always the same.
    - The audience of a reserve study serving a Company's business needs are a CEO or a Board of Directors. The study can also be used by NAIC or rating agencies to assess the ERM of the Company; the Company's external auditors may also review the results and / or *the process*, as part of a risk-based audit.

Introduction

- Practical limitations of models used in analysis
  - The actuary needs to know the limitations of the dynamic models used in a reserve analysis.
    - For example, there are potentially unknown factors that are not identified or modeled.
    - The actuary must be able to reasonably parameterize the model with an acceptable level of accuracy.
    - These limitations can extend into data quality, data volume, changes in the loss process over time.
  - The Actuary owes a duty to point out these limitations in the model, especially when dealing with non-practitioners.

Conceptual framework of dynamic modeling

- In practice, the conceptual framework of dynamic modeling in loss reserving context includes but not limited to the following:
  - Time horizon
  - Gross vs. net reserving
  - Range of possible outcomes vs. range of reasonable estimates
  - Sources of reserving risks
- These items are worth extra considerations while building a dynamic model in loss reserving risk analysis.

Conceptual framework of dynamic modeling

Time horizon

- This is the time period over which measurements of reserving risk are made.
- This concept is essential in estimating risk since it reflects the time period over which unknown events and circumstances will affect the value of reserves.
- It is expected that reserving risk is greater over a five-year time horizon than a one-year horizon, yet this concept is often overlooked or misunderstood.
- Commonly used time horizons include
  - Ultimate level
  - One-year time horizon in Solvency II

Gross vs. net of reinsurance

- Models on basis of gross and net of reinsurance reserving are needed under various contexts.
- When both gross and net reserving are modeled independently, care must be taken to ensure that the scenarios make sense relative to one another.
  - Years with highest gross reserves may not produce highest net reserves
- Use of the same scenario is necessary to ensure the integrity of the results between the estimates of gross and net reserving risk.

Conceptual framework of dynamic modeling

Range of possible outcomes vs. range of reasonable estimates

- Range of possible outcomes relates to aggregate liability distribution
  - Aggregate liability measures aggregate ultimate loss estimates subtracting loss payments made to date
  - Aggregate liability distribution is a stochastic random variable
- Range of reasonable estimates relates to liability estimate distribution.
  - Liability estimate is the expected value (mean) of the aggregate liability, as selected by actuary using actuarial reserving methods.
  - The distribution of this selected liability estimate and its uncertainty can be looked at as parameter risk of the aggregate loss distribution.
- Example – let L represent loss reserves. G() denote the functional form of the distribution of L, with a mean and a standard deviation. The true mean is unknown and MU() denotes the distribution of the mean.
  - G() represents aggregate liability and is used to derive the range of possible outcomes.
  - MU() represents liability estimate and is used to derive the range of reasonable estimates.

Conceptual framework of dynamic modeling

Sources of reserving risk

- These sources include process risk, parameter risk and black swan event.
- Process risk
  - The risk associated with the projection of future contingencies which are inherently variable. Even if parameters are reasonably estimated, the actual observed results will generally vary from the underlying means.
  - The dynamic model should target to properly reflect the true nature of process variability.
- Parameter risk
  - The risk associated with the selection of the parameters in the dynamic loss reserving model. For example, loss development factors are wrongly selected.
  - The dynamic model should target to minimize the variability arising from parameter risk.
- Model risk
  - The risk that the actual, but unknown, expected value of the liability deviates from the estimates due to the use of the wrong models.
  - The "unknown unknown"

Black swan event – a special case of model risk and also referred to as "binary events"

- Highly improbable and unpredictable events that have massive impact on reserves
- This source of risk is addressed by Solvency II as "extreme or exceptional events."

Dynamic models in loss reserving risk

- Dynamic risk modeling in loss reserving risk needs to establish
  - A model describing how the loss process behaves
  - Expected values of the parameters required by the model
  - A distribution of the parameters themselves (parameter uncertainty)
- Several classes of models in estimating and evaluating reserve variability
  - Methods based on variance in link ratios
  - Methods based on the collective risk model
  - Methods based on parametric models of development
  - Methods based on individual claim modeling
- Again, each type of model has its practical limitations and its advantages and the actuary must be aware of these

Dynamic models in loss reserving risk

- Methods based on variance in link ratios
  - Generally, loss costs evaluated at an age are mathematically related with the same loss cost evaluated at its ultimate age.
  - Variability assigned to link ratios themselves can help in determining the variability of ultimate loss costs and reserves
- Sample models
  - Model presented by Thomas Mack in 1994
    - Relying on standard error as an estimate of standard deviation
    - Relying on chain ladder reserving model
    - Distribution fee
  - Model presented by Michael Wacek in 2007
    - Age-to-age link ratio to be distributed as Lognormal

Dynamic models in loss reserving risk

- Methods based on the collective risk model
  - Model frequency and severity separately to determine the aggregate loss distribution
  - Make assumption about the distributional forms of frequency and severity
  - Presume that actuary can
    - Specify and parameterize the model
    - Minimize model specific errors
    - Model parameter uncertainty
- Sample distributions used in the model
  - Frequency distribution
    - Poisson
    - Negative binomial
  - Severity distribution
    - Lognormal
    - Pareto

Dynamic models in loss reserving risk

- Methods based on parametric models of development
  - Focus on “incremental” loss developments and then utilize independent observations
  - Make the estimation of process risk a challenge due to lack of data
- Sample models
  - Probabilistic development factor model presented by Ben Zehnwirth in 1994
    - Model trends in three directions, development year, accident year and calendar year
    - Resultant residuals can be used to test whether the trends were fully captured in the model
    - Rely on linear regressions

Dynamic models in loss reserving risk

- Methods based on individual claim modeling
  - These models can address those issues that are not addressed by models based on aggregate losses, including:
    - Assess the impact of per occurrence reinsurance treaties
    - Incorporate business changes over time in loss history
    - Predictive variables in rating practice and claim characteristics are not accounted for in the aggregate triangles
- Sample models developed by actuary include
  - Model presented by Murphy and McLennan
    - Model variability in loss developments of individual large claims
    - Combined with collective model in modeling IBNR claims and aggregate models in attritional losses
  - Model presented by Guszcza and Lommele
    - Predictive modeling technique was used in assessing reserving variability.

Dynamic models in loss reserving risk

- When evaluating various dynamic models in reserving risk analysis
  - Parameter risk
    - Selecting different parameters in modeling
    - Resulting in different levels of parameter uncertainty
  - Process risk
    - Describing loss development processes from different perspectives
    - Reflecting the volatility of the process
- Actuary should consider resultant parameter risk and process risk in the selection of dynamic model in the analysis of reserving risk

Link to DRM handbook

The DRM handbook, including reserving risk chapter, can be found in the following link

http://www.casact.org/research/drm/

Questions and answers

- Questions?