Operational Risk

Bending the tail of the dragon

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AGENDA

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Operational Risk Universe

Level 1
- Crime
- Employment Practices
- External Requirements
- External Events
- Internal Changes
- Systems
- Business Processing
- Relationship with Counterparties

Level 2
- External Fraud
- Internal Fraud
- Diversity and Discrimination
- Employee Relations
- Money Laundering
- Market Misconduct
- Natural Disasters
- War and Terrorism

Level 3
- Internal Change
- Mergers, Acquisition and Disposals
- Hardware Failures
- Software Failure
- Transaction Capture, Execution and Maintenance
- Customer Management
- Outsourcing Contracts
- Vendors and Suppliers

- Solomon Brothers - $303 million - change in computer technology resulted in "unreconciled balances".
Operational Risk Universe

More than 100 losses exceeding $100 Million over the last decade in the financial industry

Operational Risk Loss Characteristic

- High frequency low impact operational risk events
- Low frequency high impact operational risk events

Operational Risk Quantification

- Loss Distribution Approach (LDA)
- Monte Carlo Simulation
- Frequency Distribution
- Severity Distribution
Questions we hope to answer…

1. How much is the capital calculation affected by the choice of model for operational risk assessment?

2. Is it necessary to make use of more sophisticated models?

Data Availability

- Internal data not collected.
- Insufficient internal data.
- Insufficient internal data / external data.
- Internal data / external data.
- Internal data / consortium data / publicly available data.

Scenario Analysis Model

- Expert opinions on annual frequency and on percentile values of the severity.
- Distribution assumption for the severity and frequency distribution.
- Find the inverse function of the distribution.
- Solve system of equations.
- Weibull distribution

\[
\begin{align*}
\alpha x^\beta + \gamma x^{\beta + 1} &= z, \\
\beta \log x + \gamma (\beta + 1) \log x &= z.
\end{align*}
\]
Parametric Model

- Parametric fit based on internal data / external data.
- Distribution assumption for the severity and frequency distribution.
- Maximum likelihood estimation.
- For example, the lognormal distribution.

Underreporting Model

- Underreporting means that not all losses in the company are reported.

\[
\text{Occurred losses} \sim g_{\text{501}}(\leq \leq i i X) \leq 50 \leq 1 (i X_i) \text{ reported is } 1 (i X_i) \sum \leq 50_i \leq 1 (i i N) \text{ otherwise } 0.
\]

Underreporting Model

- Underreporting function encodes the likelihood that a loss of particular size is reported.

\[
\text{Underreporting function } g_u(x) = \int_0^\infty \left( \int \text{d}w \text{w} w g(x | \lambda) \right) \text{d}w,
\]

\[
\text{Ref: } [1] \text{ & } [2]
\]
When data are limited, the model is close to a parametric model. As the number of losses increases, the model becomes more non-parametric.

\[ \hat{F}(x) = \left( \sum_{i=1}^{n} K_{h}(x-x_{i}) \right) / n \]

Semiparametric Model

Kernel Density Estimation

Transformed Data

Density

Semiparametric Model

Kernel Density Estimation

0.0 0.2 0.4 0.6 0.8 1.0

0.0 0.5 1.0 1.5 2.0

Semiparametric Model


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Semiparametric Model

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Kernel Density Estimation

Transformed Data

Density

Semiparametric Model

Mixing Model

- Include prior knowledge from external data.
- Correct the external global state with internal observed data.

- Ref: [5]
Mixing Model

Density Estimation (Main Body)

Size

Probability

Internal Lognormal

External Lognormal

Semi-parametric Internal

Density Estimation (Tail)

Size

Probability

Internal Lognormal

External Lognormal

Semi-parametric Internal

Mixing Credibility Model

Kernel Density Estimation External - $\hat{u}(\cdot)$ and Internal - $\hat{v}(\cdot)$

Credibility Density Estimation

Semi-parametric density, $\hat{v}(\cdot)$

Ref: [6] and [7]
### Case Study

#### Summary Severity Assumption

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#### Case Study

**Total Loss Distribution**

**Risk Tolerance**

**Scenario Analysis**
Case Study

Total Loss Distribution

- Internal Parametric
- Internal Semi-Parametric
- Internal Parametric Underreporting
- External Parametric
- Mixing
- Mixing Credibility
Questions we hope to answer...

1. How much is the capital calculation affected by the choice of model for operational risk assessment?

   Very much! The model choice depends on the information available.

2. Is it necessary to make use of more sophisticated models?

   "All models are wrong, but some models are useful".
   — Box (1979).

Thanks for your attention.

Questions?

References


