



QUANTIFYING RISK, ENABLING OPPORTUNITY

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Operational Risk Modelling

Operational Risk Modelling

IF YOU MUST

Spuriouser and Spuriouser...

Agenda

Reasons why you should model operational risk

Standard formulae models for operational risk capital

Data

The model

The model

Data

**Standard formulae models
for operational risk capital**

**Reasons why you should
model operational risk**

The model

- Operational risk losses similar to general insurance claims
 - there can be multiple losses per year
 - the amount of the loss is variable

- Use frequency/severity approach
“actuarial approach” a.k.a. the Loss
Distribution Approach (“LDA”) as per Basel III

Homogeneous category e.g. split by event type/business line

Number of losses per period

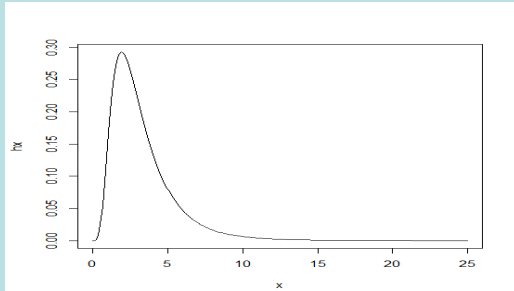
- For each operational risk category i :

$$L_i = \sum_{j=1}^{N_i} L_{i,j}$$

The amount of the j^{th} loss for category i

The model (for each i)

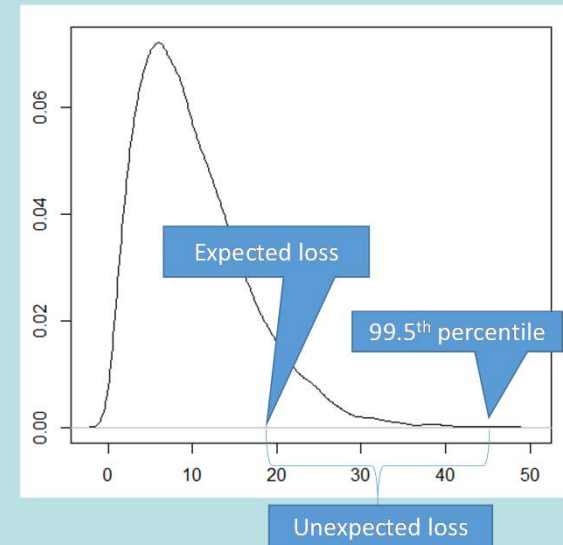
Severity distribution for $L_{i,j}$



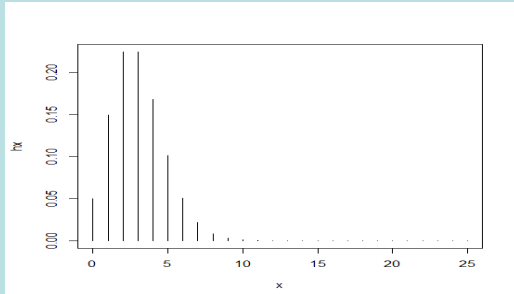
Convolution

Monte Carlo simulation

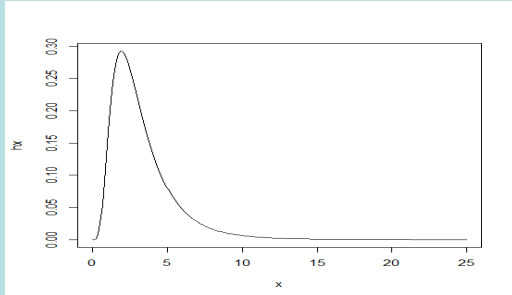
Distribution for L_i



Frequency distribution for N_i



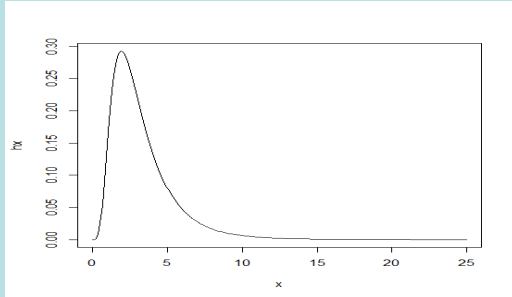
Severity distribution for $L_{i,j}$



The severity distribution

- Fat tailed distribution required
 - Lognormal: most often used
 - Other options Weibull, Beta
- Often fit different distribution to body and tail of the distribution
- EVT used to fit distribution to tail
 - Generalised Pareto Distribution often used
- Need to blend body and tail distribution to get a valid distribution function for each category

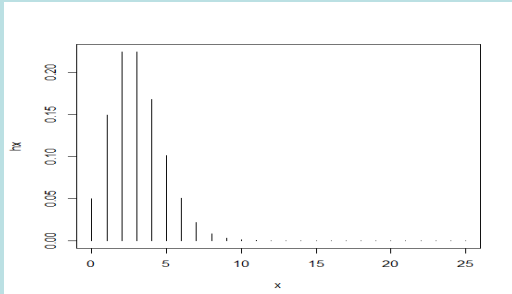
Severity distribution for $L_{i,j}$



The severity distribution (continued)

- Use exploratory data analysis to find appropriate distribution for each category
- Range of goodness-of-fit tests available to determine whether chosen distribution appropriate

Frequency distribution for N_i



The frequency distribution

- Discrete distribution required for the number of operational risk losses per category per period
- Bernoulli, Poisson or Negative Binomial

Ideal for low frequency events, but mean and variance the same

Underlying assumptions

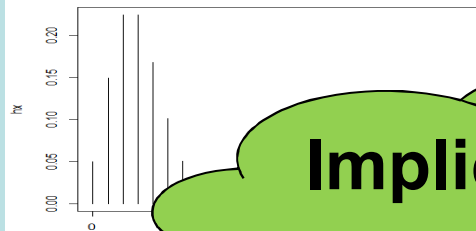
Severity distribution for $L_{i,j}$

Convolution

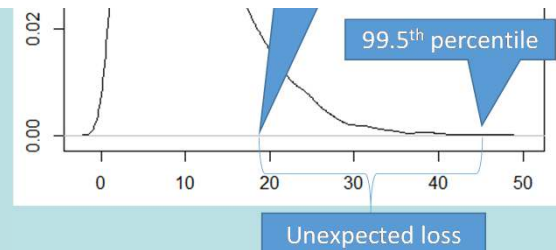
Distribution for L_i

- Individual losses are independent in each category
- The individual losses are independent of the number of losses per period

Frequency distribution for N_i



Monte Carlo simulation



Implications for correlation...

Standard formula for operational risk under Solvency II and hence SAM calibrated not to allow for diversification

Correlation

- Different categories of operational risk are not perfectly correlated ... summing the capital charges may be conservative
 - E.g. low correlation between discrimination in the workplace (Employment practices and workplace safety) and External Fraud
- Does correlation between aggregate losses for different categories arise from correlation between severity distributions or frequency distributions?

Correlation (continued)

- Practical ways of allowing for correlation:
 - Ignore it and just sum the capital charges from the different categories...being conservative
 - The variance-covariance approach (used in the standard formula SCR approach)
 - Copulas

Flexible joint distribution for any number of variables where you can have different marginal distributions for the different variables and the copula function describes the joint distribution

Correlation (continued)

- To calculate the total capital charge for operational risk more simulation required
- For each simulation:
 - Simulate a $u(0,1)$ variable for each of the operational risk categories using the copula function
 - Find the loss from the aggregate loss distribution for each category by applying $x_i = F^{-1}(u_i)$
 - Sum all the losses together to give the total loss for the simulation from all the different categories
- Order all the total losses from simulation from small to large
- Pick the observation corresponding to the percentile (e.g. for 10000 simulations take 9950th observation as capital)

Correlation (continued)

- Need to allocate total capital back to the categories
 - allocation to different business units very important as this is the level at which operational risk is controlled
- Should one allow for correlation between operational risk and other risks?
 - Basel allows no diversification benefit
 - Standard formula SCR under SAM allows no diversification
 - Will be difficult to calibrate and justify?

Other models...

- Different statistical methods in use
- Bayesian causal maps can improve understanding of cause, effect and consequence

The model

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**Standard formulae models
for operational risk capital**

**Reasons why you should
model operational risk**

Definition of operational risk

- Basel definition now also used under SAM and Solvency II:
“Operational risk is the risk of loss arising from inadequate or failed internal processes, or from personnel and systems, or from external events. Operational risk should include legal risks, and exclude risks arising from strategic decisions, as well as reputation risks. “
- Only cover operational risks to the extent that these have not been explicitly covered elsewhere in the capital
- Capital is required only for risks that impact the cashflows underlying the base balance sheet, therefore e.g. strategic risk not included

Categorisation

- Objective is to model homogeneous risks
- Standard categorisation enables industry to compare risks
- Basel II event types:

Is this appropriate for insurers?



Data

- Basel II specifies four types of data that should be considered:
 - Internal loss data
 - External loss data
 - Scenario based analysis
 - Business environment and control factors

Internal Loss Data

Need to adjust fitting for truncation. If truncation not consistently applied you may need a stochastic model.

- Good practice to have policies in place for internal loss data
- Process must be transparent and include review and approval
- Things to consider:
 - Collection threshold
 - What to include in operational risk losses
 - Consistent recording across different departments and business units
 - Data fields required for modelling

Internal data seldom sufficient as a result of low frequency of occurrence and short collection period

External Loss Data

- Various consortium, industry-wide data schemes are available for banking industry (ORX, BBA Gold, Algo First)
- Association of British Insurers launched ORIC for insurers – at least three South African participants
- Survey conducted by Martin & Hayes (2013) show that 86% of South African insurers would be interested in joining a consortium as subscriber and 75% as a contributor
- What can we learn from ASSA CSI committee?
- Scaling of data to be appropriate
- Potential bias in external data – only the large publicly known losses may be reported

Scenarios Analysis

How useful is a model based purely on scenario data?

...that happened in the past, but
...creating and control environment
...categories sufficient data will not be

- Use qualitative measures to calibrate a statistical model
- Scenario workshops:
 - Involve senior people from relevant areas of
 - Need to formulate questions so that correct r
audience not trained in statistics
- “loss of x occurs every d years”
- Combine scenarios with historical data...
- ...or use only scenarios to fit frequency and severity distributions

Special methods available to fit distributions correctly to scenarios

The model

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**Standard formulae models
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Reasons why you should
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Standard formulae

- Basel has hierarchy of standard formulae



- SAM standard formula based on Solvency II
- CEIOPS calibration paper explains that parameters set by considering operational risk capital charges from insurers with operational risk models...but many of the models were not robust

The model

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Standard formulae models
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**Reasons why you should
model operational risk**

Why?



Why?

- Improve understanding of operational risk – results can be scary but revealing
- Scenario workshops and allocation of capital to business units focus the mind of operational areas on operational risk
- Models enable you to test the effectiveness of mitigation strategies – insurance and internal controls
- Data useful for measurement and monitoring, MI
- Pillar II of SAM – help you to assess whether standard formula appropriate
- Opportunity to learn some new statistical and mathematical methods...

Some useful reading...

- Frachot, A, Moudoulaud, O & Roncalli, T (2004). Loss Distribution Approach in Practice. The Basel Handbook: A Guide for Financial Practitioners. Risk Books, <http://ssrn.com/abstract=1032592>
- Dexter, N, Ford, C, Jakhira, P, Kelliher, P, McCall, D, Mills, C, Probyn, A, Raddal, P & Ryan, J (2007). Quantifying operational risk in life insurance companies. *British Actuarial Journal* 13(2), 257–337
- Tripp, M, Bradley HL, Devitt, R, Orros, GC, Overton, GL, Pryor, LM & Shaw, RA. (2004). Quantifying operational risk in general insurance companies. *British Actuarial Journal* **10**, 919–1012