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Practical Modelling of Operational Risk

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06 December 2005

STRUCTURE

- Background
- Identification
- Parameterisation
- Modelling – Monte Carlo
- Sensitivities
- Aggregation

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Background

- Not an ideal world - Quantifying Operational Risk (OR) Capital is problematic
- However, in certain cases, it is necessary to quantify the Operational Risk capital requirements.
- Examples
  - ICA – Individual Capital Assessment
  - Economic Capital Requirements
- Aim: To cover the practical aspects, particularly in the modelling of OR Capital requirements, taking into consideration problematic areas

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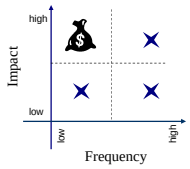
Identification

- Aim – To identify the most important risks (in terms of capital)
- Consider:
  - Frequency
  - Capital Impact
- Thus - 4 broad classes



Identification

- Low frequency & High Impact 
  - Most important in terms of capital
  - Key component of capital at extreme levels of probability (e.g. 0.5% for ICA)
  - Results in greatest uncertainty about capital
- Most time and effort should be spent assessing these risk events

Identification

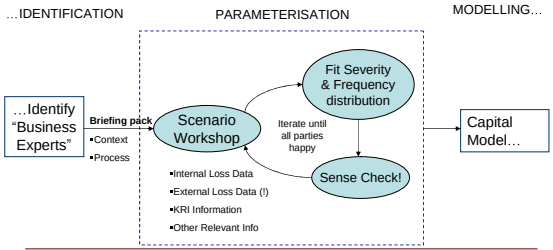
- What range of events to consider?
- GN46 - “Cannot exclude events that in isolation, have probability of occurrence < required level”
  - Affect overall distribution of capital
  - Sensitivity analysis
  - Easier to revisit
- Practical solution
  - Define a higher cut-off point (e.g. 1-in-500 years) for exclusion of isolated events

Parameterisation

- Element of subjectivity due to lack of data
  - Internal loss data – usually limited availability
  - External data: - more available, but…
    - Has its limitations
    - Recommend that it should be used with care (e.g. to provide examples before eliciting subjective probabilities)
  - Often need to resort to opinion of "business experts"
    - Suggest a process to best handle this…

Parameterisation -

- Process



Parameterisation

- Choice of Frequency Distribution
  - Bernoulli
    - Simplest distribution
  - * Poisson
    - Classical 'rare event' distribution
    - Industry standard for low frequency
    - Simple to parameterise – only 1 parameter
  - Negative Binomial
    - Generalisation of poisson
    - Disadvantage - 2 parameter required
    - May be suitable for higher frequency

Parameterisation

- Choice of Severity Distribution
  - * Lognormal
    - Allows generously for positive outliers
    - Easy to parameterise
    - Relatively simple, commonly used
  - GPD – Generalised Pareto Distribution
    - More sophisticated
    - Uses EVT - Suitable for modelling tail of distributions
  - Weibull, Beta
    - May be spurious given current scarcity of data

Modelling

- Choice of Approach:
- Closed form
  - Simple at first sight
  - Quickly becomes complex and impractical
- * Monte Carlo Approach
  - Appears to be by far the best approach
  - Simple!
  - Flexible – not constrained to narrow range of distributions and components
  - Versatile – variety of output

Modelling

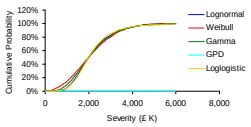
- Monte Carlo - Steps
  - Sample freq distribution
  - If freq = k, sample severity k times
  - Total capital requirement for that risk
  - Repeat for all risks
  - Consider impact, insurance, allocation, etc…
  - Repeat for many simulations
  - Rank simulations
  - Output useful information (e.g. percentiles)

Modelling

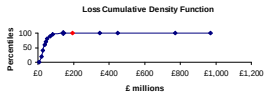
- Types of useful output:
  - Mean and standard deviation
  - Various percentiles
  - CDF for each risk
  - Aggregate CDF
  - Allocation of aggregate amount for each risk
  - Bivariate plots – to investigate dependencies
  - Other output – e.g. impact of insurance

Modelling

- Examples of Output
  - Impact of different severity distributions for given inputs



  - CDF for the aggregate loss distribution:



Modelling

- Monte Carlo Modelling – Useful hints & tips
  - * Random number seed
  - Choosing appropriate no. of simulations
  - Allocating to different entities (e.g. subsidiaries)
  - Extending to allow for insurance
  - Modelling dependencies?

Sensitivities

- * Very important given subjective aspects to avoid giving a false sense of security
- Subjective Input Parameters
  - Frequency
  - Severity
- Impact of distribution choice
- Dependencies
- Other parameters – (specific to a model)
  - Insurance
  - Allocation

Aggregation

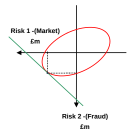
- Within Operational Risks – Monte Carlo
  - Decide on correlation between Operational Risks
  - Check for internal consistency
  - Embed within Monte Carlo model
  - Aggregate capital is simply Monte Carlo output

Aggregation

- With other Risk Capital components - MVN
  - Decide what risks are correlated with other risk categories – e.g. misselling vs. market
  - separate into 'buckets'
  - Establish relevant correlations
  - Aggregate capital within 'buckets' by Monte Carlo
  - Use MVN assumption to aggregate total capital

Aggregation

- MVN – The locus of equi-density within the joint pdf is a perfect ellipsoid
- The point where the capital plane meets the ellipsoid defined by the locus of the 99.5th percentile events gives the required answer.
- Example in 2D



The n capital components are represented by an MVN in n dimensions

Let $\Sigma = n \times n$ correlation matrix

$c = n \times 1$ vector representing 99.5th percentile capital component for each risk

$$DiversifiedCapital = \sqrt{c^T \Sigma c}$$

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