The Actuarial Profession
making financial sense of the future

Measurement and Modelling of Dependencies in Economic Capital
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## Why diversification is important

**Diversification benefit within Economic Capital**

- Modelling dependency between risks usually reduces the total capital requirement (compared to the sum of the stand-alone amounts)
- Required capital depends on other factors besides the dependency model
  - Choice of risk measure
  - Level of granularity
- Large variation between companies



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## Dependence in Solvency II

**Internal model approval process – Use test**

- Senior management needs to demonstrate understanding of the internal model, including its limitations
- Model's limitations need to be taken into account in management's decision-making
- The timely calculation of results is essential for decision-making processes

**Statistical quality standards**

- Statistical analysis
- Expert judgement
- Use of external models and data



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## Main conclusions of our modelling work

**Dependency is one of the most complex and subjective areas of the Economic Capital modelling process**

- Wide choice of approaches and models
- Some models can get very complex
- Parameterisation is challenging for any model
- Issues arising over 12-month VaR are compounded in a multi-year modelling framework




## Main conclusions of our modelling work

**Even a simple correlation matrix can raise a lot of very hard questions and cause practical difficulties**

- High dimensionality
- Filling in the missing terms
- Positive semi-definiteness
- Spurious relationships
- Availability of data
- Technical constraints




## Main conclusions of our modelling work

**Using copulas can address some issues with correlations**

- Correlation is a single parameter, copula introduces the distribution-based approach to dependencies
- Allows a separation of the modelling of individual risks from the modelling of dependency between them
- Allows the direct modelling of tail dependence, but calibration based on past data suffers practical difficulties
- The benefits of greater flexibility need to be balanced with the difficulty of estimating a larger number of parameters

## Main conclusions of our modelling work

**Using higher correlations as a substitute for explicit dependence is not always a good solution**

- Higher correlation coefficient does not reflect different levels of dependence in the main body and in the tail
- Explicit dependence modelled by copulas is a more flexible and statistically coherent approach
- Measuring correlations in key regions using half-space depth is a promising alternative




## Main conclusions of our modelling work

**Causal modelling**

- Appealing modelling framework
- Challenges in specifying both the structural dependencies and their associated parameters
  - Especially in the "stressed" states of a company
- In common with other approaches, the choice of model approach is a key determinant of the output.
- Sparse data makes it difficult to evaluate objectively the merits of competing approaches.




## Questions or comments?

Expressions of individual views by members of The Actuarial Profession and are encouraged.

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