The Actuarial Profession
making financial sense of the future

Risk and Investment Conference
Justin Skinner

To boldly go where no ERM has gone before

ERM research that defined the future

Agenda

- ERM
- Risk appetite
- Capital models
- Capital allocation
- Risk measures
- Reserve risk
- Operational risk
- Correlations

CAVEATS

- The following are all personal views.
  - Many might object and/or disagree with my comments
- Reference materials are (mostly) freely available from the internet. Copy/paste has been liberally used from public materials

ERM

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- Gives an excellent foundation knowledge of ERM, without strolling into too much technical detail
  - *"Enterprise Risk Management : from incentives to controls", Lam.* Good, insightful, practical examples
  - *"Quantitative risk management: concepts, techniques, and tools", McNeil, Frey, and Embrechts.* Too much focus on quantitative analysis that is not used in practice.
  - *"Simple tools and techniques for enterprise risk management", Chapman.* Excellent overview of ERM

ERM

Solvency II

- Ignoring the detailed implementation requirements…
- The overall principles backing Solvency II cover how an effective insurance company should be run, covering:
  - Corporate governance
  - Risk management
  - Balance sheet management (technical provisions, assets and capital requirements)

Risk appetite

- "Plenary 4: Applications of complexity science"
- Neil Allan and Neil Cantle

- *Using systems thinking to give a better understanding of the interactions of risk to aid in setting risk appetite*

Capital models

- "A new level of Enterprise Risk Management analysis: Methodology for assessing insurer's Economic Capital Models"
- Standard and Poor's
- http://www2.standardandpoors.com/spf/pdf/events/FITconJuly13.pdf

- *Probably the best guide to good capital modelling I have seen to date*

Capital models

- Standard and Poor's proposal covers their criteria for analysing ECMs to assess their credibility
- ECMs themselves are part of a strong ERM program, but is only one component of their overall ERM rating
- Based on the output of this, the ECM is given a credibility factor (10% used within their illustrative example) to assess capital alongside the S&P capital model

Capital models

- Some factors may override the model credibility (to zero):
  - No material validation on ECM output
  - Insurer does not have adequate processes to assume a diversification benefit
  - Less than 75% of the insurers business is modelled
  - Unexplained material inconsistencies between actual results and projected results

Capital models

- Requirements are split into two categories:
  - “Indistinct risks” (e.g. capital assessment methodology, pension fund risk, management decisions, diversification and capital fungability)
  - Individual risk groups (e.g. credit, market, insurance and operational risk)
- Scoring is split into three ratings
  - Basic
  - Good
  - Superior

Capital models

Table 3
How Standard & Poor's Scores An Insurer's Approach To Risk

Risk score		
Basic	Good	Superior
• The insurer's approach appears rudimentary relative to the significance of the risk. • The insurer's approach appears rudimentary in comparison with peers and has limited capabilities. • For a given risk, the insurer's risk management practices appear undifferentiated across its business lines. • The insurer addresses some but not all of the considerations of the risk that is being evaluated. • The insurer appears to have limited governance processes, if any, regarding the risk.	• The insurer's approach appears more flexible and advanced than for insurers we score as "basic." • The insurer shows some evidence of developing and applying best practices to develop appropriate risk management practices for its risks. • The insurer may not consistently apply governance processes regarding the risk.	• The insurer's approach appears to be more flexible and more advanced than for insurers we score as "good." • The insurer appears to consistently apply best practices where appropriate. • The insurer's governance processes regarding the risk appear to be well-structured and consistently applied.

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Capital models

- Diversification methodology:
  - Basic. Generic high level correlation matrix with little or no empirical justification
  - Good. Empirically derived dependency assumptions
  - Superior. Copula approach to diversification to capture tail dependencies

Capital models

- Operational risk methodology:
  - Basic. Simple factor based approach
  - Good. Frequency/severity approach
  - Superior. Frequency/severity approach also considering control effectiveness, loss mitigants (e.g. insurance) and basis risk

Capital allocation

- I have yet to see a good quality, practical piece of research on capital allocation
- From what I have seen, existing materials are theoretically elegant, but practically useless

Risk measures

- "Risk Horizon and the Measurement of Economic Capital for General Insurers"
- Stephen Lowe, François Morin and Dean Swallw
- Towers Watson
- http://www.towerswatson.com/assets/pdf/3933/Towers-Watson-Risk-Horizon-White-Paper.pdf

- *Considers the issues around a problem I didn't think I had*

Risk measures

One year balance sheet to balance sheet approach

- Capital based on potential change in the value of assets and liabilities over a single financial year
- Includes a single underwriting year (but only realising the first year of uncertainty around this year)

- Solvency II risk measure
- APRA stated risk measure

Risk measures

Run-off risk horizon

- Capital based on potential change in assets and liabilities as they are run off until ultimate
- Includes a single underwriting year
- Excess assets usually released from the model

- ICA risk measure
- APRA used risk measure
- Lloyd's risk measure for capital allocation
- General insurance actuaries favourite???

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Chart 3.1: The Economic Balance Sheet in the Runoff Risk-Horizon Approach

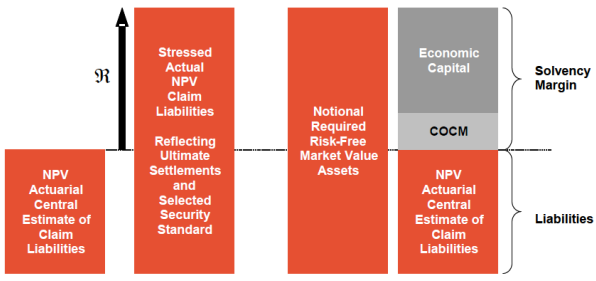
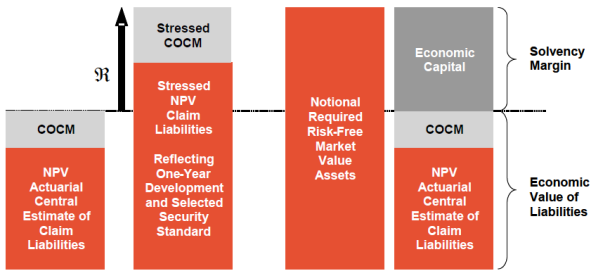


Chart 3.2: The Economic Balance Sheet in the One-Year Approach



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Risk measures

Setting economic capital

- Obviously the run-off approach is the right one…
- … but
  - Solvency is ultimate assessed via balance sheets with market valuations
  - Capital efficiency is maximised by having the capital when it is required, rather than when it might be required
  - Projections of ultimate reserve uncertainty are somewhat uncertain
  - Ultimate approach includes arbitrary periods for different risks (e.g. ultimate for market and credit, one year for underwriting, …)

Reserve risk

- "Bootstrap Estimation of the Predictive Distributions of Reserves Using Paid and Incurred Claims"
- Huijuan Liu and Richard Verrall
- http://www.variancejournal.org/issues/04-02/121.pdf

- *Allows paid and incurred bootstrapping to be carried out, and looks at relationship between the two results*

Reserve risk

- The problem with incurred bootstraps…

	Dev 10	Dev 11
UW year 1	100	150
UW year 2	100	99
UW year 3	100	*100 estimate*

Dev factor close to 1

Very small expected movement

Pearson residuals (A – E) / sqrt (E) blow up

They are not IID across triangle

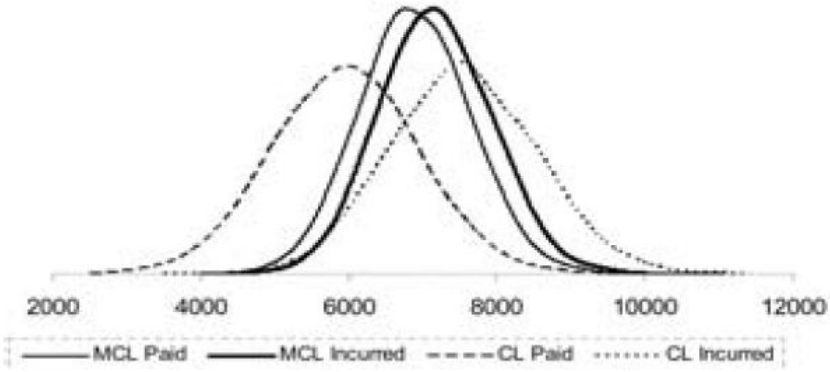
Normal bootstrapping gives silly results

Reserve risk

- Based around Munich Chain Ladder method
  - Chain ladder factors adjusted to reflect correlations between paid and incurred data
  - Chain ladder factors therefore differ across underwriting and development years
  - Gives closer estimation of paid and incurred projections
- Then uses repeated sampling from the residuals (picking the paid and incurred residuals in the same part of the triangle to maintain the dependency implied by the data)
- Can (fairly easily) be coded into Excel

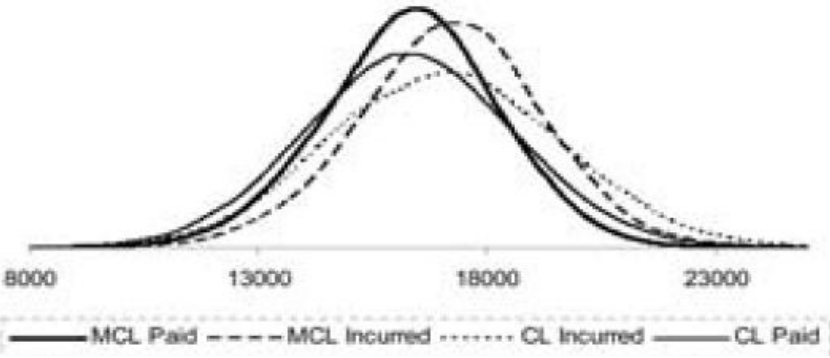
Reserve risk – Example of well behaved data

Figure 3. Comparison of predictive distributions of overall reserves for CL and MCL reserves for paid and incurred claims



Reserve risk – Example of Lloyd's syndicate data

Figure 6. Comparison of predictive distributions of CL and MCL reserves predicted on paid and incurred claims



Operational risk

- "A New Approach for Managing Operational Risk"
- OpRisk Advisory and Towers Perrin
- http://www.soa.org/files/pdf/research-new-approach.pdf

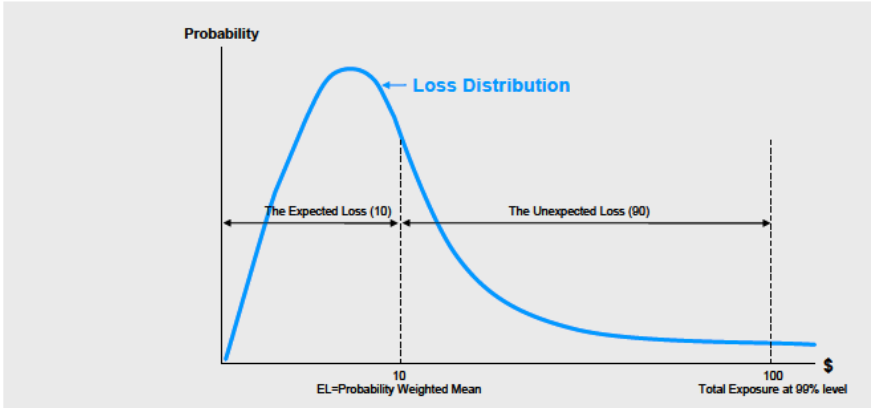
- *Details the new way of managing operation risk. Mirrors many features of banking operational risk management*

Operational risk

- The paper summarises traditional operational risk management and modern operational risk management
- Most notably is the move from banded likelihood/impact assessments to frequency/severity simulation assessments

Operational risk

Exhibit 4.3 — Expected Loss and Unexpected Loss



Operational risk

Exhibit 1.1 — Summary of Differences between Traditional and Modern ORM

Traditional ORM	Modern ORM
■ **Definition:** Risk is defined primarily as a kind of undesirable incident/event, such as a fraud or a system failure (Operative question: What/where are your risks?)	■ **Definition:** Risk is defined primarily as a measure of exposure to loss from undesirable incidents/events (Operative question: How much risk do you have?)
■ **Risk Identification Process:** Ask managers to identify their major risks. (Risks include risk factors, controllable factors, events and effects; no restriction on overlaps; generally no differentiation made between risks and controls.) Leads to the creation of a huge and unmanageable set of risks	■ **Risk Identification Process:** First define the "risk" universe, consisting of a finite (comprehensive) set of mutually exclusive (non-overlapping) "risk" classes. Use hard or soft data to reveal where the large losses are taking place (where the largest risks actually exist)
■ **Risk Assessment/Measurement Method:** Calculate risk by multiplying likelihood and impact for each risk type (conditional on one event), one "risk" at a time	■ **Risk Assessment/Measurement Method:** Use Monte Carlo simulation and frequency and severity distributions to calculate the cumulative loss potential from multiple events, across all risk classes simultaneously
■ **Aggregation:** Likelihood cannot be aggregated, so results cannot be aggregated	■ **Aggregation:** Frequency can be aggregated, so results can be aggregated
■ **What is measured:** Probability weighted loss from one specific incident (the routine loss)	■ **What is measured:** Cumulative loss for one or more risk classes; both the expected loss and unexpected loss, which are comparable to the average and "worst case"
■ **Goal:** Day-to-day management of current threats arising from imminent operational failures: loss prevention through tactical intervention	■ **Goal:** Management of *key* risks, specifically the optimization of risk-reward, risk-control and risk-transfer in the context of cost-benefit analysis
■ **Cost:** Generally very resource intensive	■ **Cost:** Relatively much less resource intensive

Correlations

- "Observed Correlations and Dependencies Among Operational Losses in the ORX Consortium Database"
- Eric Cope and Gianluca Antonini
- http://www.orx.org/lib/uploads/public_folder/Observed_Correlations_and_Dependencies_Among_Op_Losses_in_the_ORX_Consortium_Database27November2008.pdf

- *Helps resolve an issue external flagged up in a number of regulatory capital reviews I have been involved in*

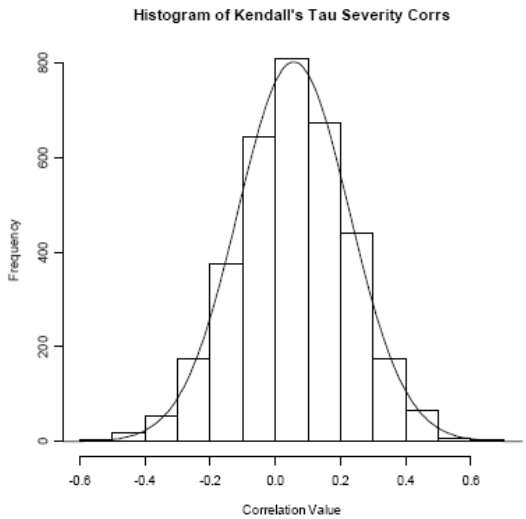
Correlations

- The study is based around 90,000 individual losses (excess 20k Euros) from 41 banks
- There are four main conclusions from the research:
  - Kendall rank correlations are low, typically not exceeding 0.2
  - There is homogeneity amongst correlations measure at different banks (so using a market correlation matrix is appropriate)
  - There is slight evidence of tail dependency between losses
  - There is diversification benefit in the high percentiles of the data, although no accurate estimate is assessed

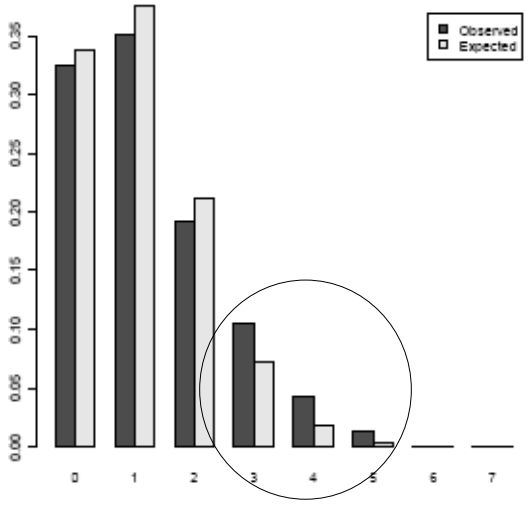
Correlations – Kendall rank correlations are low

	EPWS	DPS	TIF	EDPM	Malicious damage
Internal fraud	0.07	0.04	0.00	0.04	0.21
Health and safety		0.07	0.04	0.07	-1.4
Disasters and public safety			0.00	0.01	0.24
IT and infrastructure				0.1	0.04
Process failure					-0.01

Correlations – Different banks have the same correlations



Correlations – Slight evidence of tail dependency



Conclusions

- The pace of ERM research has picked up over the past few years
- There is a wealth of information out there, mostly available at the click of a button
  - Is there any appetite for an ERM library with summaries of papers?
- There are still some notable gaps in current papers