Biometric Risk in Internal Models for Solvency II

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Agenda

Context and Focus

- Solvency II, internal models, biometric risk

Modeling Mortality

- Standard formula: stress scenarios and correlation for mortality and longevity
- Internal model: volatility around the trend and shock events

Portfolio Volatility

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Insurance Undertaking (direct or reinsurance)

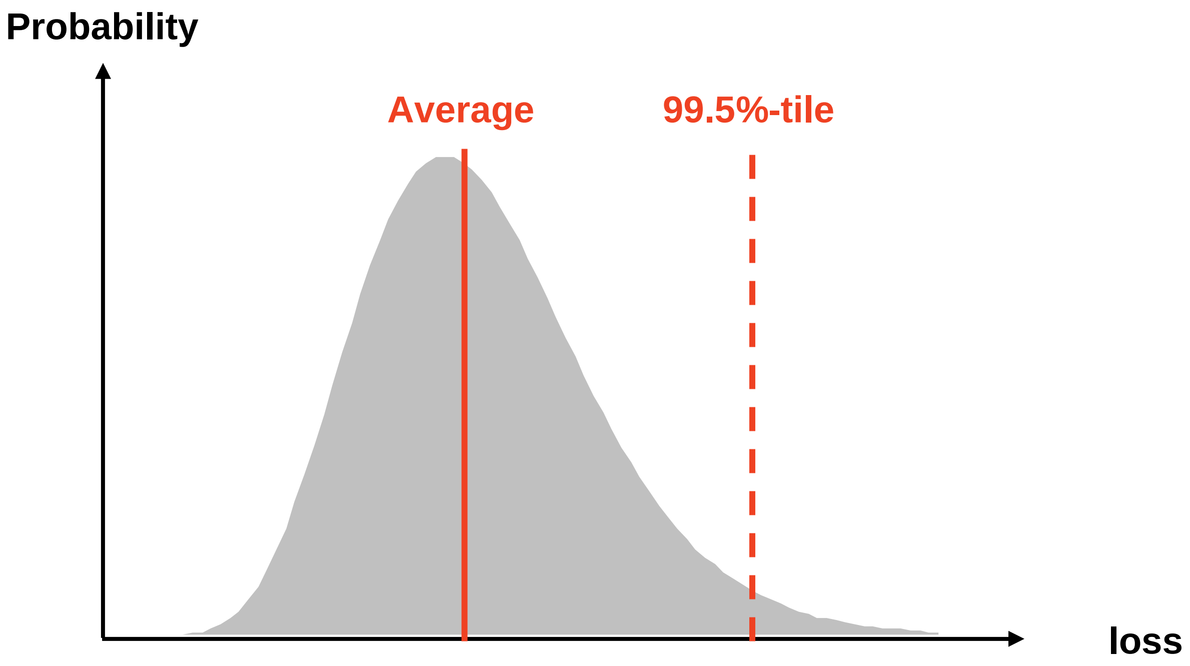
What do we want to achieve?

- Compliance
- Optimization of solvency capital
- State-of-the-art Enterprise Risk Management

Lessons to learn on biometric risks in the undertaking

- Standard formula
- Internal model

Reminder: Financial Loss Distribution Function



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Solvency II Standard Formula for Biometric Risk

CEIOPS Consultation No. Paper 49, 2 July 2009

- Scenario based stress test
- Capital requirement is the change in net asset value (assets minus liabilities) induced by stress scenario
- Stress scenarios
  - Mortality: Permanent increase in mortality rates of 15%
  - Longevity: Permanent decrease in mortality rates of 25%

History of Mortality Stress Scenario

Consultation Paper 49: 15% mortality increase

QIS4: 10% mortality increase

QIS3: 10% mortality increase

QIS2: 20% mortality increase

Explanation for Mortality Stress Scenario in CP 49

“3.9. The capital charge for mortality risk is intended to reflect the uncertainty in mortality parameters as a result of changes in the level, trend and volatility of mortality rates and capture the risk that more policyholders than anticipated die during the policy term.” *

“3.10. This risk is normally captured by increasing the mortality rates either by a fixed amount or by a proportion of the base mortality rates. The calibration (of the increase) should capture the impact of each of the above factors (level, trend and volatility).” *

* from: CEIOPS-CP-49/09

QIS4 Feedback on Mortality Stress Scenario

“3.12. … a gradual change to inception rates and trends would be more appropriate than a one-off shock for biometric risks.” *

“3.13. … the calibration was too strong and without sufficient granularity …the calibration was below the 99.5th percentile.” *

* from: CEIOPS-CP-49/09

QIS4 Evaluation of Internal Models wrt Mortality

"3.19. However an analysis of the mortality stress parameters provided by firms using internal models indicated that the standard formula parameter was relatively low. Based on a sample size of 21 internal model, the median stress was 22%, with an inter quartile range of 13% to 29%. This is significantly higher than the standard formula calibration of 10%." *

"3.20. CEIOPS therefore proposes to amend the calibration of the mortality stress to a permanent increase in mortality rates of 15%." *

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* from: CEIOPS-CP-49/09

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QIS3 Calibration of Mortality Stress

"1.16. For mortality risk, we had regard to information derived from a study published in 2004 by Watson Wyatt about the 99.5% assumptions over a 12 months time horizon that firms were proposing to make for their ICAS submissions in the UK. This indicated a range of between 10 and 35%, with an average of around 23%. However, it is thought that this assumption may cover both trend and volatility risk, as well as possibly cat risk." *

* from: CEIOPS-FS-14/07

QIS4 Correlation Table (excerpt)

	Mortality	Longevity	Catastrophe
Mortality	100%	-25%	0%
Longevity	-25%	100%	0%
Catastrophe	0%	0%	100%

Tail Correlations - Example

Surrender and Mortality

- Normal environment
  - Slightly increased mortality (e.g. heat wave)
  - No influence on lapse rates
- Rare event
  - Strong deterioration in mortality which is publicly noted (e.g. pandemic)

→ Value of the policy for the insured increased

→ Lower lapse rates

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Two Different Angles to Keep in Mind

The region around the mean

- It is important to know how the portfolio behaves in the region of sigma(x2) – first guess: relatively regular, “normal random”
- Economically important region

The region of the tails (1/100 and beyond)

- Far away from the mean – completely different behavior expected
- This is the region which is important for the capital allocation and avoidance of ruin

A Stochastic Model

$$\hat{q}_{x,t} = q^{BE}_{x,t} \times \underbrace{C_t}_{Mortality\ \ Trend} \times \overbrace{(1+I_t)}^{\text{Mortality Shock}}$$

x	age of the insured
t	time
$q^{BE}{}_{x,t}$	expected mortality
$\hat{q}_{x,t}$	real mortality

$$\begin{cases} C_t = \exp(X_t) \times C_{t-1} \\ C_0 = 1 \\ (X_i)_{i \in N} \quad \text{iid} \quad \rightarrow \mathcal{N}(\mu, \sigma) \\ (C, \varepsilon) \quad \text{independant} \end{cases}$$

$$I_t = \underbrace{F_t}_{Frequency} \times \underbrace{S_t}_{Severity}$$

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Pandemic History

31 pandemics since 1580 (according to the WHO)

Year	Name	Deaths	Lethality rate
1918-1919	Spanish flu	~ 50 million	2,50%
1957-1958	Asian flu	~ 2 million	~ 0,37% (US)
1968-1969	Hong Kong flu	~ 1 million	~ 0,19% (US)
1977	Russian flu	10 000 in US	?
2003	SARS	299 in HK	up to 71% in HK

Modeling Approach: Frequency * Severity

- **Frequency: 7.4%** per annum based on **31 influenza** epidemics over the last **420 years**
- **Severity: exponential curve calibrated with** 5 historical data points which are the **5 last pandemic events**

$$q_{total} = q_{central} \times \left(1 + F \times S \right)$$

$$P\left(F=1 \right) = 7,4\%$$

$$P\left(F=0 \right) = 1 - P\left(F=1 \right)$$

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Modeling the Portfolio (1/2)

Define scope

- Lines of business to be modeled
- Segmentation
- Level of granularity

Decide which results have to be computed

Setup a model office

Modeling the Portfolio (2/2)

Setup of portfolio for each line of business

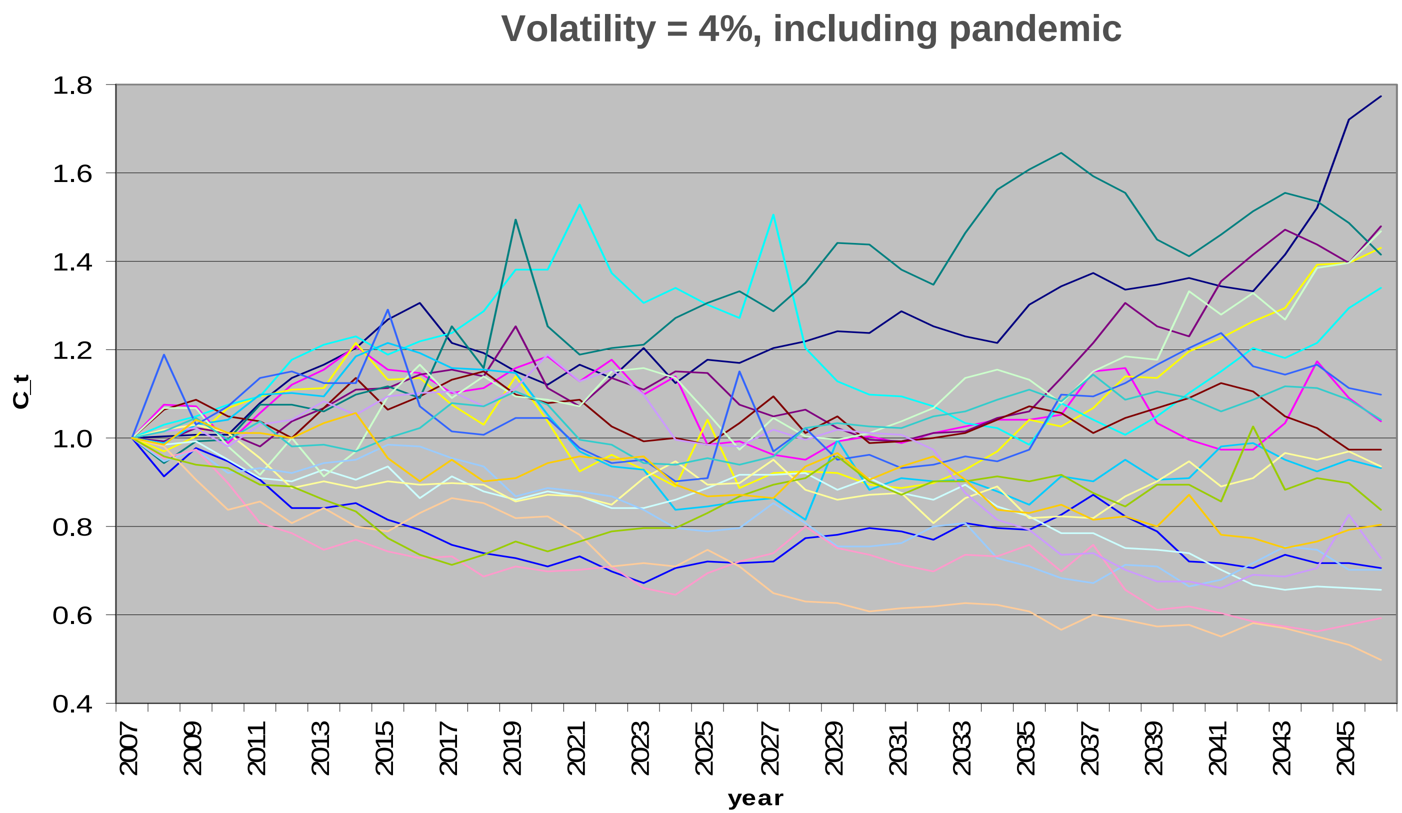
- Reduce size as much as necessary for reasonable runtimes, but
- Maintain as much as possible of the characteristics and behaviour
- Calibrate against other available sources
- Consider refined calibration for the future (e.g. match sensitivity to a selected set of scenarios)

Run the scenarios through the model

- Set of x thousand indexed randomly generated scenarios, including change in mortality trend and pandemics

Merge results across all lines of business

Mortality Trend Risk and Pandemic



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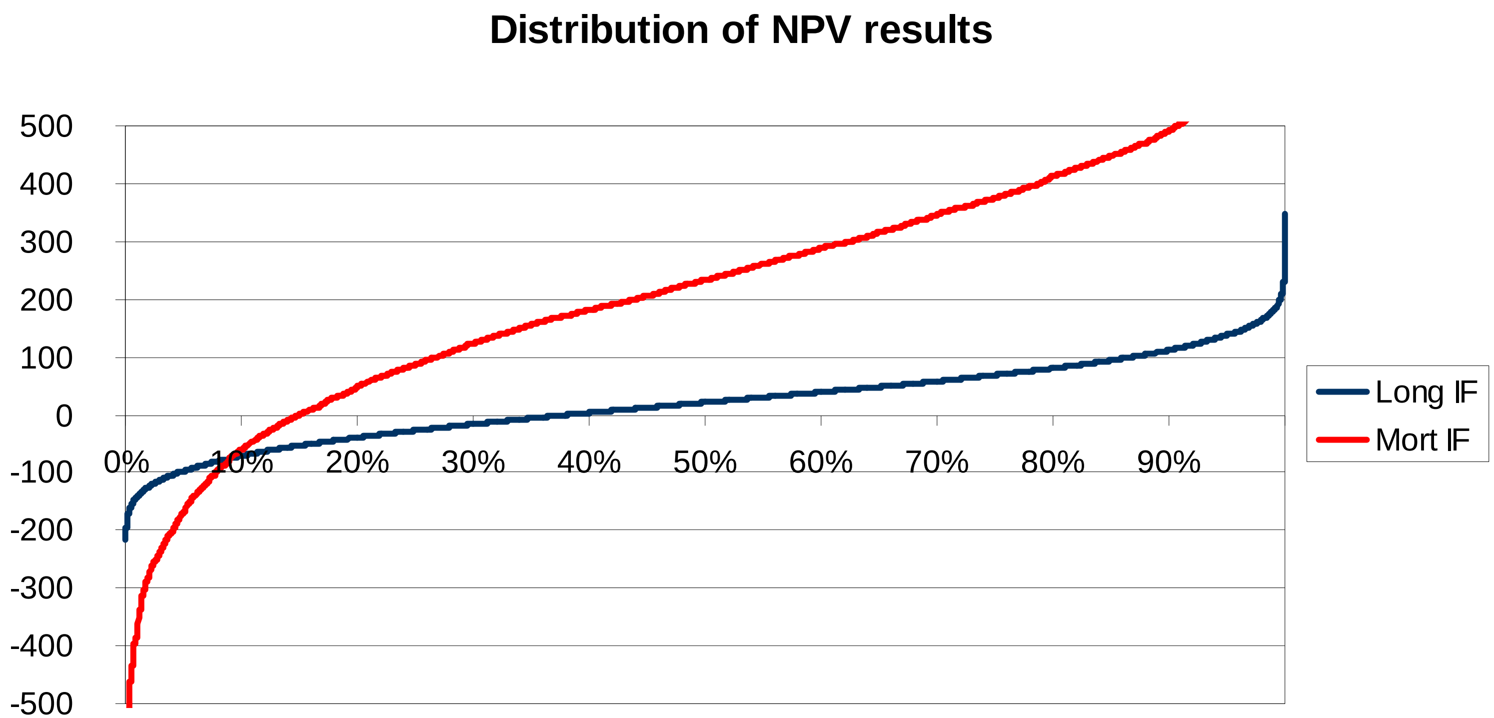
An example of Simulation Output



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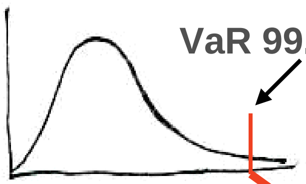
Portfolio Analysis (focus mortality)

Internal Model



Product mix

- Mortgage insurance
- Death benefits
- TCI

Underwriting policy

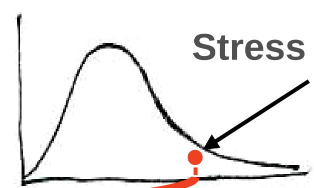
- Medical selection
- Individual / group policy

Portfolio profile

- Age
- Gender
- Sum at risk

= ?

Standard Model



Reinsurance

Example Based on a French Portfolio

Portfolio characteristics

- death benefit, group cover
- 51,000 lives
- 45% males, 55% females
- Ages from 18 to 65
- Sum at risk from EUR 10,000 to EUR 1,300,000 per life

Mortality table

- French table TH00-02/TF00-02 (male/female)

Portfolio Volatility – experimental output

Internal simulation tool (on 1 year)

- Economic capital:
  Claims quantile (99.5%) – (Premium - Costs)
- Solvency II standard model capital as explained in CP49.

Portfolio Volatility – experimental output

Analysis

- Difference between Solvency II standard model and internal model
  - Results presented in percentage of Solvency II standard model capital
- Changes on 2 parameters
  - Gender distribution
  - Sums at risk

Portfolio Volatility – experimental output

Gender

- Basis case (BC): Starting portfolio
- Case 1: Portfolio with females only
- Case 2: Portfolio with males only
- Case 3: Portfolio with 55% males and 45% females

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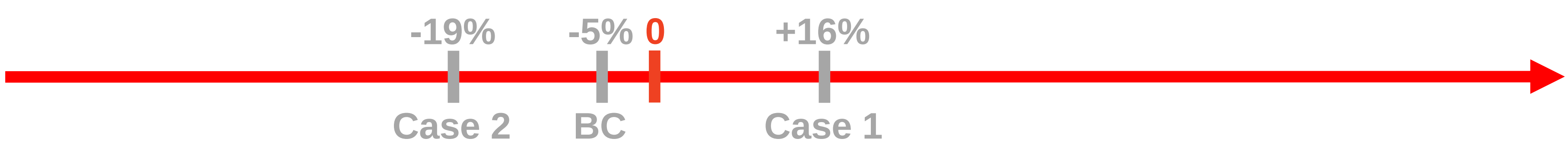
Portfolio Volatility – experimental output

Sums at risk

- Basis case (BC): Starting portfolio
- Portfolio is presented by bands of sums at risk
- Case 1: All insured in a band are moved to the next higher band except for highest band
- Case 2: All insured in a band are moved to the next lower band except for lowest band



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Portfolio Volatility – experimental output

Results

- Simple simulation on death benefit policies
- Must be adapted to each portfolio

Optimization of capital

- Based on various parameters
- Including biometric risks
- Dynamic approach is needed

Conclusion

There is more to learn about the biometric risks in a portfolio then the standard formula can reveal.

Enterprise Risk Management can benefit from an internal model which is embedded into the activities of the insurance undertaking.

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