Scenarios and Stress Testing
For risk management, regulation, models and fun
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Scenarios: Possible, internally consistent events, parameterized by a set of risk factors

- **Forecast Scenarios**
- **Stress Scenarios**
- **Synthetic Scenarios**
- **Reverse Scenarios**
- **Historical Scenarios**

**Company-Specific Scenarios**

- **Single-Event Scenarios**
- **Multi-Event Scenarios**
- **Global Scenarios**

**Sensitivities**

\[ \{E \mid P(E) < \alpha \} \]

\[ \{E \mid \text{Capital}(E) < 0 \} \]

\[ X \sim \text{LN}(x, \alpha, \beta) \]

**Set of Events**

**Events**

**Implicit Events**

**Single Event**
Uses of Scenarios

- Crisis Management
- Recovery and Resolution Planning
- Contingency Planning
- Strategic Analysis
- Communication on Risks
- Defining Risk Appetite
- Simulation / Training
- Scenario-based Planning

- Extreme Events
- Assessing Unquantifiable Events
- Impact of Uncertain Events
- Emerging Risks
- Setting Capital Requirements
- Reverse Stress Testing
- Model based Models
- Model Enhancement
- Materiality Assessment
- Impact of Regulation and Financial Policies
- Systemic Exposure Analysis
- Model Assessment
- Assessing Concentration Risks

- ORSA
- Incentivizing Risk Culture
- Defining Risk Appetite

- Impact of Uncertain Events
- Assessing Financial Soundness
- Crisis Management
- Extreme Events
- Recovering and Resolution Planning
- Contingency Planning
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Scenario Analysis
The importance of valuation

- The quantification of the impact of a scenario depends strongly on the valuation standard being used.
- Illustrative Example: Solvency Ratios pre- and post stress test of a financial risk event for Solvency I, QIS 5 (using liquidity premia, matching adjustments etc.) and market-consistent

### Solvency Ratios

- Solvency I ratios barely react to the stress test
- QIS 5 solvency ratios react more but dampeners mitigate effects of stress events
- In a market consistent framework, the impact of the scenario is strongest

The relative declines in solvency ratios as well as the relative solvency ratios between Solvency I, QIS 5 and market consistent valuation under a realistic financial market event.
Scenario Analysis

Scenario Analysis

Regulatory uses: Swiss Solvency Test 2007

Drastic drop of interest rates
Equity fall -60%
Real estate -50% and i.r. +1%
Stock market crash (1987)
Nikkei crash (1990)
European currency crisis (1992)
US interest rate crisis (1994)
Spreads widening - LTCM (1998)
Stock market fall (2001/2002)

10 year Yield

High spread risk, which materialized in 2008+
Very high risk to falling interest rates, which is materializing since the 1990s
Scenarios for Modelling

Historical data set with approximately 1’000 storm events in the last 100 years is enriched by:

- track sampling: 9 “daughter tracks” from one “mother track”
- pressure sampling: 9 additional pressure samples
- uncertainty modelling: each event loss sampled five times

Generates 500’000 potential events

**Historical tracks**

**Conceivable tracks**

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**Track sampling**

**Pressure sampling**

**Uncertainty modelling**

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**Generation of possible events**

**Value distribution** | **Vulnerability**
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**The exposure of a portfolio towards an event is the event loss**

**Where situated?** | **How well built?** | **How covered?**
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- Sums insured
- Cover limits
- Deductibles
- Exclusions
- etc.

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**Example Hurricane “Charley” Aug 2004**

Source: Swiss Re
Scenarios: Pandemics

Megadeaths by microorganisms

The 1918 flu pandemic infected 500 Mio people and killed between 50 - 100 Mio of the infected. It caused a cytokine storm (overreaction of the immune system) which led to younger adults between ages 20 to 40 to die disproportionately while children and older people with weaker immune systems were less affected. Globally approx. 30% of all people were infected, and a total of 3%-6% of the world population died.

Deaths per 100’000 in each age group for the US population for 1911-1917 and for 1918

A scenario has to be specified properly for it to be useful. Assuming a multiplicative mortality increase might lead to an impact that is positive (due to annuitants dying) while in reality the impact for most life insurers would be negative.
Our galaxy consists of ~100bn stars and the number of planets is likely an order of magnitude higher, many of which must have the condition for life. However no signs of intelligent life have been detected yet (the Fermi paradox). One solution to the Fermi paradox is that self-replicating von Neumann machines destroy all life in order to inhibit competition. Alien civilizations then either are careful and do not emit signals or are being destroyed, e.g. by relativistic impactors (Relativistic Kill Vehicles) or by other means of planetary and solar destruction.

A 1kg mass impacting at 99% speed of light would release an energy of ~132 megatons or twice the largest hydrogen bomb ever exploded. The detection time would be very limited if the RKV travels close to the speed of light. Even if detected, it would be futile to destroy it since even vapour or small particles would be highly destructive.
Scenarios: Autonomous Cars

Moral Dilemmas
Self-driving networked cars will pose unique challenges to insurers. The programming has to cope with situations where the losses will have to be minimized and which require potential moral judgment. In addition, the type and number of accidents will change radically, requiring changes in the business model of insurers. Scenarios help to think about possible consequences, risks and opportunities.

Scenario 1: Car A has to choose between crashing into different pedestrians and has make a value judgment.

Scenario 2: Car A will crash into child unless car B rams into A, killing driver B.

Scenario 3: Ruritania requires producers of self-driving cars to assign lower values to certain minorities.
Scenarios: Tambora Eruption

**Tambora Eruption 1815**
- 100 km$^3$ of debris ejected into atmosphere (~10 times Vesuvius)
- Immediate local devastation, estimated deaths 70,000+
- Lung infections due to sulfur acid and ashes

**1816 Summer Temperature Anomaly**
- Snow in June 1816 in North America
- Disruption of the Indian monsoon
- Global cooling, failed crops in Europe and North America and Yunnan,
- Flooding and low temperatures in Europe
- Typhus epidemics in Ireland 1816 – 1819 (40,000+ victims)
- Most livestock died during winter 1816/17 in the US

**1818 return to normal climate situation**
- Cholera pandemic in India, China, and Indonesia: 1817 to 1824
- Doubling of mortality in Switzerland
- Catastrophic collapse of ice dam in Switzerland in 1818 (Gietro Glacier)
Thank you

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