Internal Models in Insurance

- Zdeněk Roubal, Kamil Žák

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Internal Models in Insurance

A. History

B. Life Insurance

C. Nonlife Insurance

D. Validation

Historical development

Slides in this section are using presentation by Chris Daykin delivered at 39th ASTIN Colloquium, Helsinki, 2009

Solvency Studies in the 1980s

Solvency I established in 1973 / 1979

- **Define capital requirements** for insurance companies
- **Solvency margins are an early warning mechanism**
- **One year view –** what could happen to my balance sheet in one year

Some major themes in 80s:

- Capital requirements should reflect risk characteristics
- EU Solvency I requirements not sufficiently risk-based
  - **Nonlife:** maximum of 16/18% of premium, 23/26% of claims

- Insufficient attention had been paid to:
  - asset risk;
  - potential inadequacy of technical provisions;
  - business cycles and variability in profitability;
  - risk of reinsurance failure;
  - provision for the expenses of running off the business;
  - response mechanisms.

Solvency Studies in the 1980s

Emerging conclusions:

- analysing the balance sheet is not enough;
- strength of technical provisions needs to be considered;
- investment strategy is of key importance;
- a stochastic modelling approach is desirable;
- new business should be modelled (volume and profitability);
- for solvency control only 2 years' new business may be needed;
- modelling future cash-flows offers sufficient flexibility;
- for management purposes there should be dynamic responses.

Solvency Studies in the 1990s

Further progress

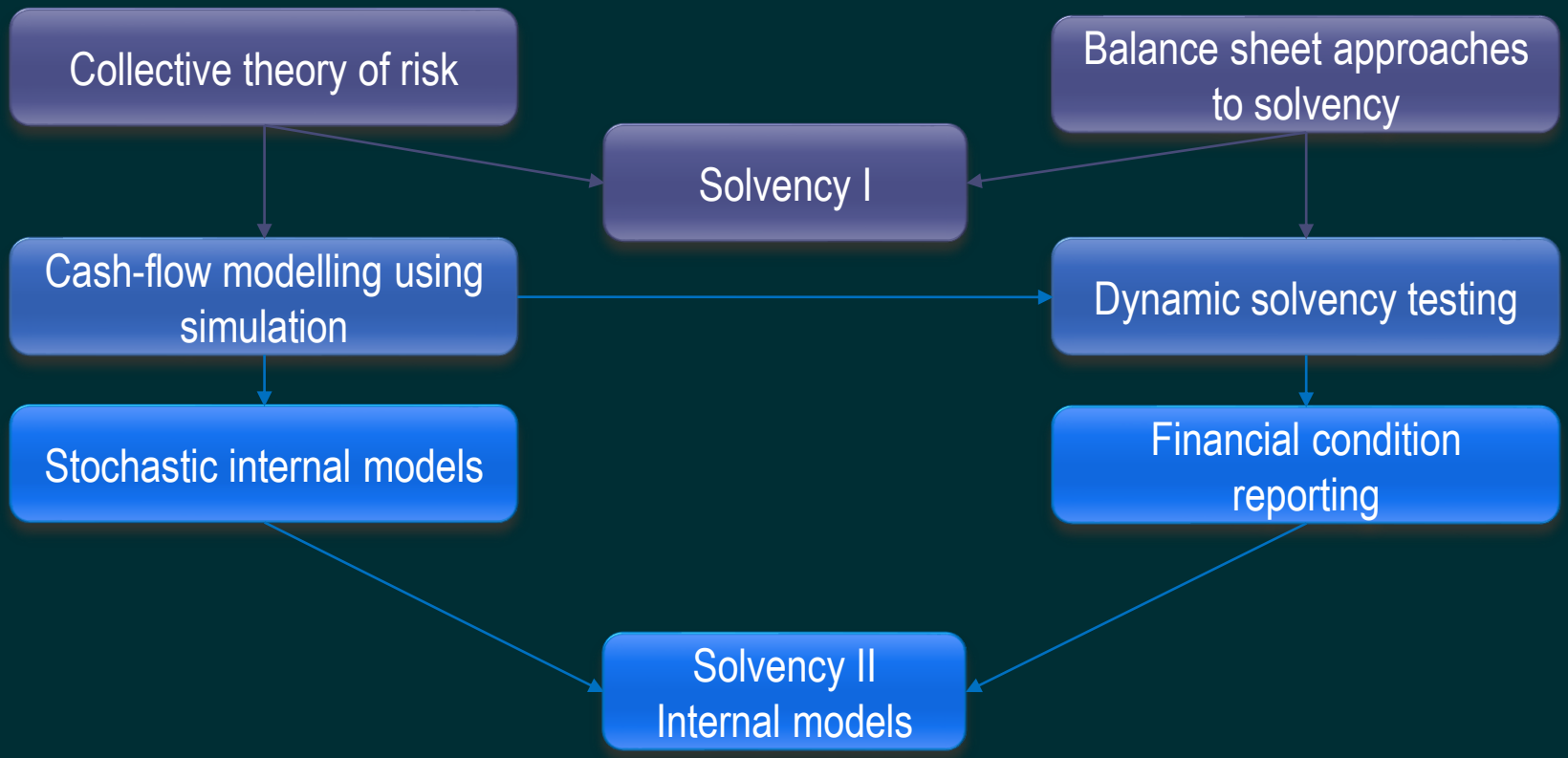
- Computer capacity limited scope for full internal models
- Concerns about number of assumptions and realism
- **Dynamic financial analysis** received a high profile in the Casualty Actuarial Society
  - A set of scenarios (favorable and adverse) to test the reaction of the company's surplus
- Some consulting firms began to develop models
- Awareness of the need to hold appropriate capital for risks
- **Regulators becoming interested in risk-based approach**
- A good internal model is a sign of sound risk management

Developments around the World

International Association of Insurance Supervisors

- Guidance Paper on the Use of Internal Models by Insurers – July 2007 – sets out some key principles about models:
  - should be a key strategic and **operational management tool**;
  - should confirm ability to meet liabilities with high confidence level;
  - should be **appropriate** to **nature, scale and complexity** of company;
  - should be subject to **regular feedback monitoring** and review;
  - should be carefully calibrated;
  - should be **embedded into risk strategy** of insurer;
  - should be approved by regulator before being used for solvency;
  - information should be supplied for reporting and public disclosure.

Evolution of Internal Models towards Solvency II



Internal Models in Insurance

A. History

B. Life Insurance
   A. What is internal model?
   B. Why is important?
   C. How is it created?
   D. Who is using it and how?
   E. What is the overall purpose?
   F. Does it really need to be so sophisticated?

C. Nonlife Insurance

D. Validation

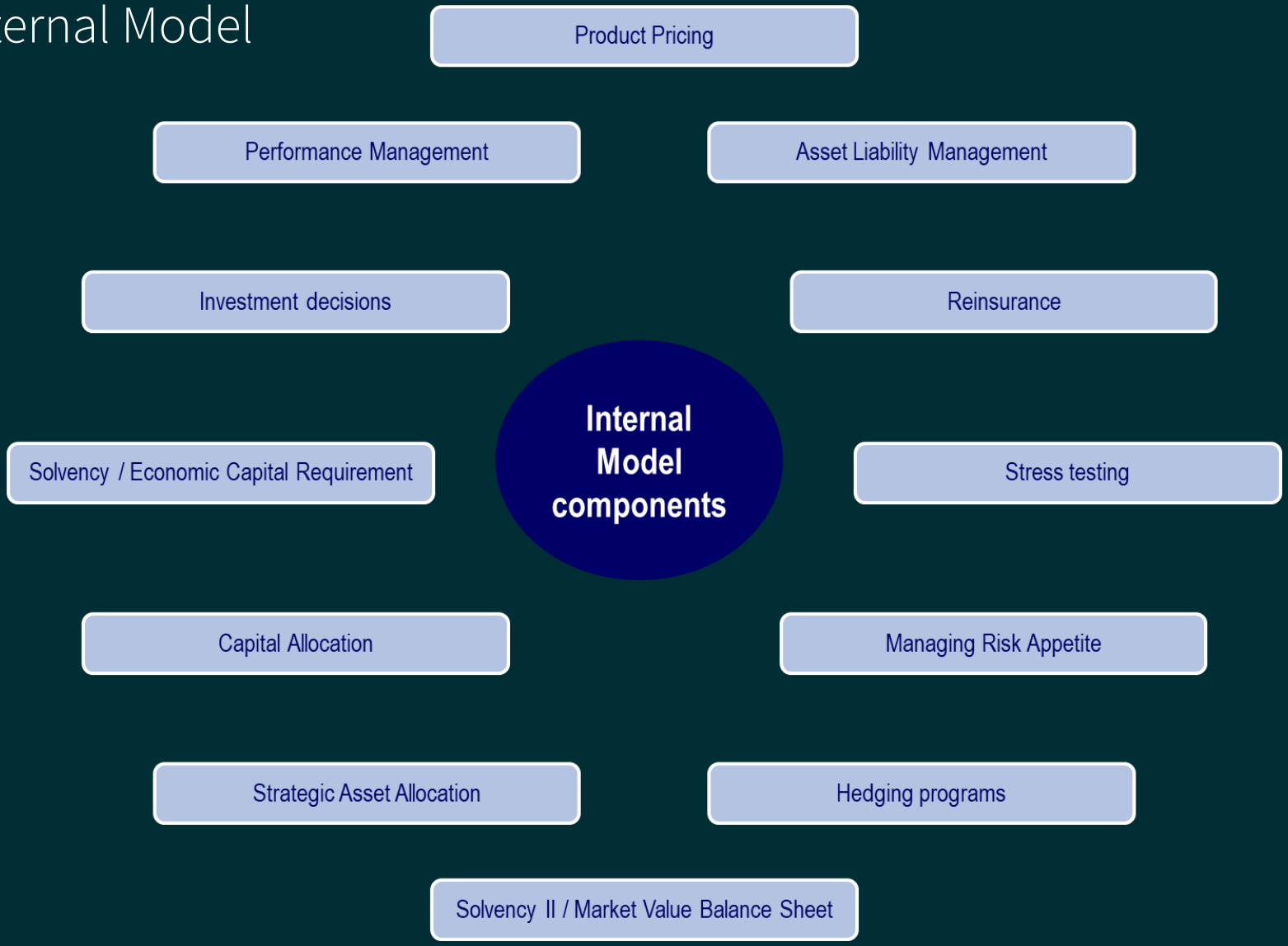
Solvency II

- Internal model definition
  - Solvency II directive (2009/138/EC)
    - An internal model is a set of processes and procedures that occur within an insurance company. It includes components such as an actuarial model and scenario generators. It cannot be bought “of the shelf” and must be created within the company. It is only when the mathematical part is integrated into the thinking of management and used in running the business that it can be considered an internal model for Solvency II purposes.
- External model

Solvency II Internal Model

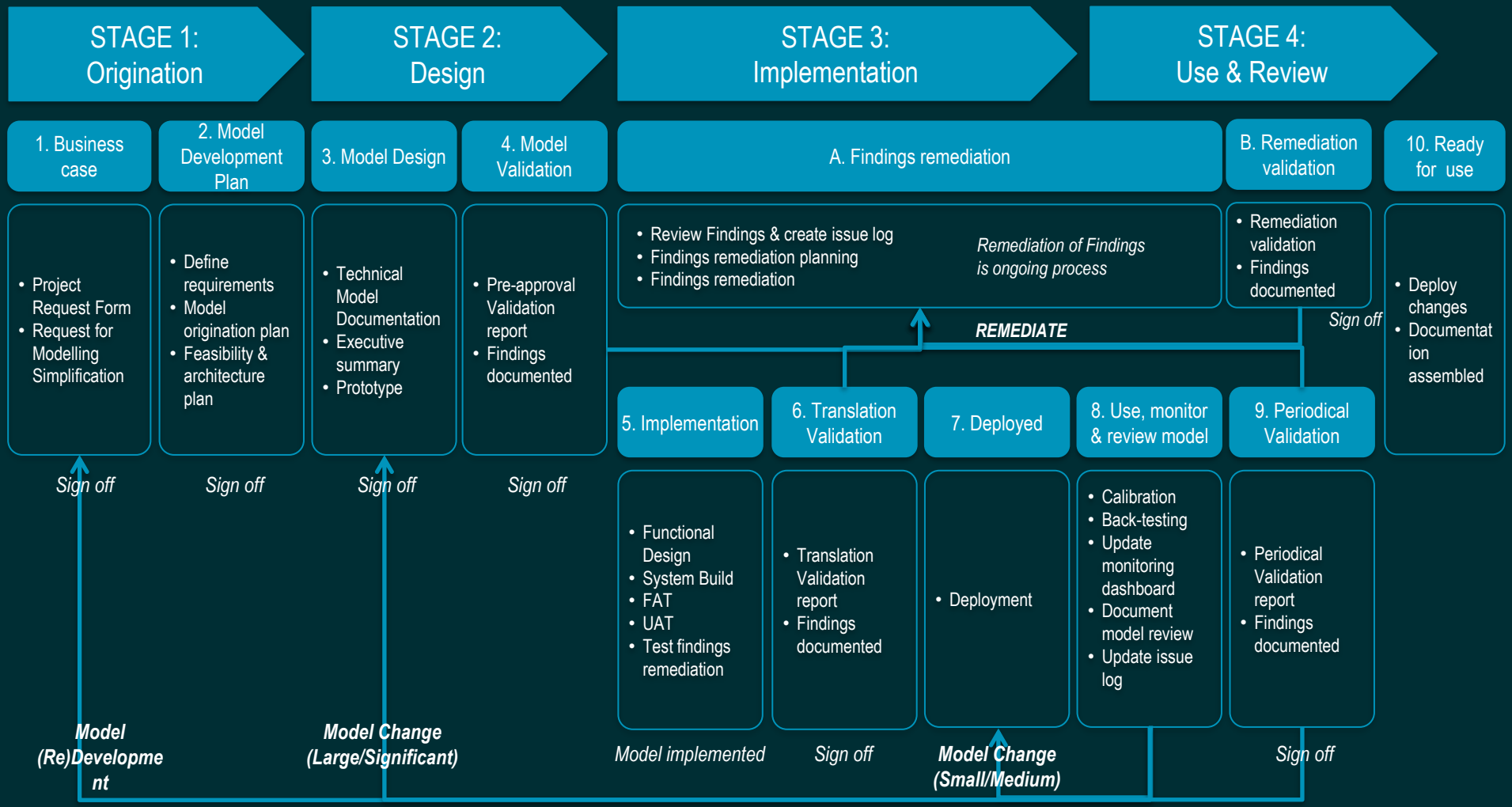
- Use test
- Statistical quality standards
- Calibration standards
- Profit and loss attribution
- Validation standards
- Documentation standards

Internal Model



Standard Model

Model Development Cycle



Risk Factors & Risk Drivers

- Risk Factor
  - Selection
  - Modelling
- Risk Drivers
  - Projections

- Modelling horizon
  - 1 year (SII)

Example: Mortality Risk

- Standard formula
- Hypothetical Internal model
  - Volatility
  - Trend / Level
  - Catastrophe

Example: Market Risk

- Risk Factors
  - Interest rates
  - Credit spreads
  - Equity indices
  - Real Estate indices
  - Inflation
  - …

Dependencies

- Standalone risk x Company risk

- Correlation matrix applied on results
- Correlation applied on risk factors

Monte Carlo

- Stochastic
  - Which variables / risk factors
- Nested Stochastics
- Optimization
  - Replicating portfolios
  - Modelpoints
  - Convergence

Practical Comments

- Calibration
- Future of Internal Models
  - Regulatory x Own use
- Model developer x Model operator
- Understanding the results

Internal Model Rules

- Rule #1
  - GIGO
    - Data quality
- Rule #2
  - Model is a model is a model is a model …
    - Precision
    - Runtime
    - Reliance

Internal Models in Insurance

A. History

B. Life Insurance

C. Nonlife Insurance

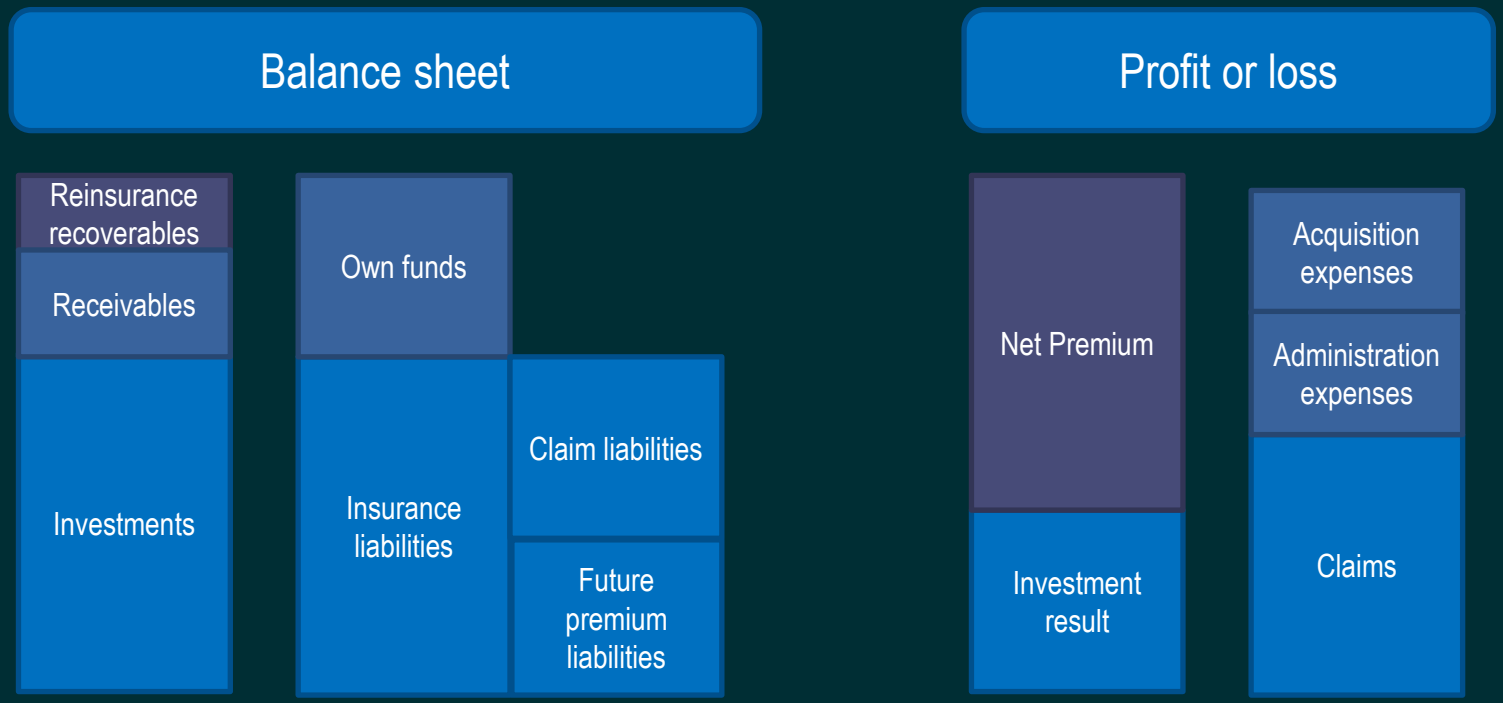
   A. Risks of the non life insurer
   B. Non life underwriting risk
   C. Reserving risk
   D. Premium and CAT risk
   E. Case study

D. Validation

Risks of the non life insurer

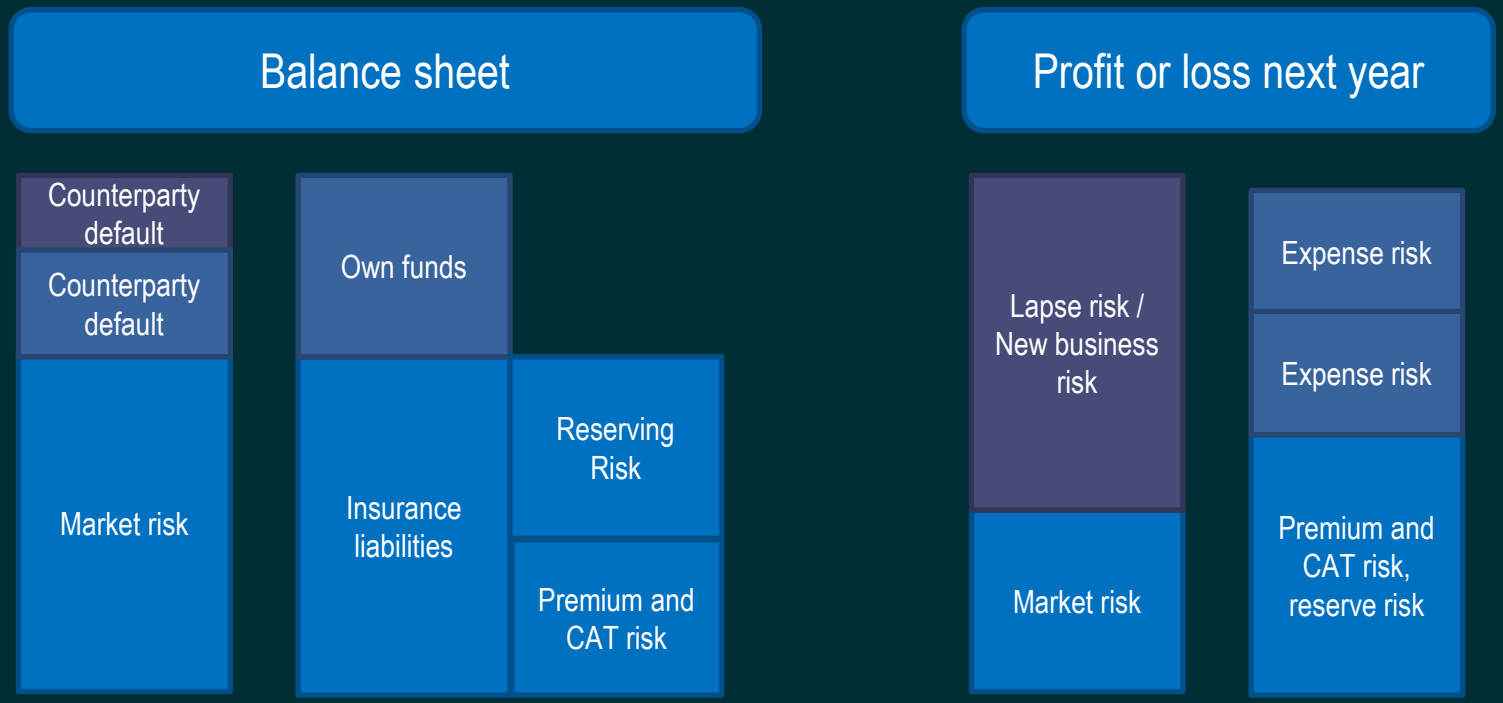
Risks of the nonlife insurer

What are the risks the non life insurer is exposed to in the next year?



Risks of the nonlife insurer

- Simplified view



Non life underwriting risk

Standard formula in SII

Standard aggregation – premium and reserve risk, CAT risk, Lapse risk

$$SCR_{nl} = \sqrt{\sum_{i,j} Corr\ NL_{i,j} SCR_i SCR_j}$$

Internal models function in principle very similarly, SCR representing specific solvency capital requirement arising from the part of the model

The difference comes next: Solvency II formula: $SCR_{nl\ prem\ res} = 3 \cdot \sigma_{nl} \cdot V_{nl}$

V_{nl} … sum of volume measures per segment, which are based both on premium and reserves adjusted for geographical diversification

$$\sigma_{nl} = 1/V_{nl} \cdot \sqrt{\sum_{s,t} CorrS_{s,t} \cdot \sigma_s \cdot V_s \cdot \sigma_t \cdot V_t}$$

σ_s … standard deviation of the segment based on aggregation of premium and reserve risk via premium and reserve volume measures and premium and reserve risk standard deviations

Premium and reserve risk are not distinguishable in SII

Standard formula in SII

- More risk sensitive than the past Solvency I regime

  x

- Difficult to determine the risk per premium / reserving type
- One size fits all approach

- SII allows USPs – undertaking specific parameters for standard deviation of the reserve and premium risk – “small internal model”
- Additional country specifics – Czech Republic – annuities

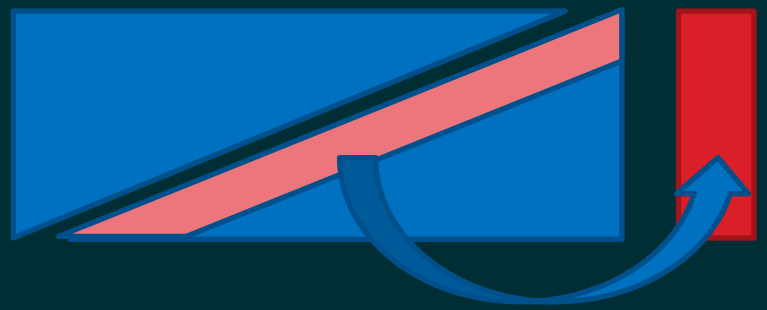
- The reason for the development of the internal model

Reserving risk

Reserving risk

- Risk of bad „best“ estimate and risk that real claims will differ from those expected

- Small claims
  - Variability given by the analytic formulae (Mack Chain ladder) or simulation (bootstrapping)
  - Ultimate view (Mack) x 1 year view
  - For analytical results some additional assumptions necessary
  - Both approaches may be interesting for the company



- Large claims and special cases
  - Unknown claims ~ general individual claims model
    - Poisson x exponential type distribution
  - Known claims ~ run off consideration

- Cash flow modelling (annuities)

Reserving risk

PRACTICAL IMPLEMENTATION – WHAT TO TAKE CARE OF

- Selection of the threshold for large claims
  - to make the triangle of small claims stable
  - consistent exclusion for both payments and reserves
- Additional reserves (large, CAT claims, annuities generally excluded)
  - cause additional variability, which may not be quantified by the used method
- Reconciliation of the data and consideration of exclusions (CAT risk)
- Reconciliation of the results to the other uses
- Diagnostic of the used model
  - commonly used paid and incurred triangles, option of underlying process for the bootstrapping
- Documentation
- Sensitivity
  - method chosen, simulation number, dependencies between the LoBs

Premium and CAT risk

Premium risk

- Risk that the future premium will not cover relevant expenditures (claims, expenses)

- Exposure only estimated
  - To make the internal model applicable, it should be based on available figures ~ plan
  - Consideration of the premium cycle –understanding what the company does with the pricing
  - Change in the UW limits, sums insured etc.

- Claims - small
  - Aggregate x frequency/severity model
  - Difficult to fit the specific distribution to individual claims
  - Experience distribution function, limited number of simulated points

Premium risk

- Claims - large
  - CAT risk generally excluded, only individual claims modelled
  - Threshold selection – too few x too many („peak over threshold“ methods)
  - Frequency x severity model
  - Severity can be modelled as a proportion of the sum insured instead of explicit amount
    - Reflects better exposure and potential loss limits, may be more demanding on data
  - Special model for annuities (case study)
  - Special model for the specific conditions of the reinsurance contract for annuities (case study)
- Can there be small claims for Lob with ~ 200 claims?

CAT risk

- Event loss tables based on the portfolio
  - Exposures in different regions
  - Commonly developed by reinsurance brokers as a support for their business
  - Importance of geolocation
  - 1 in 200 – Region x Country
    - 1997 floods est. loss 35 mld. CZK
    - 2002 floods est. loss 65 mld. CZK
- Even standard formula got quite demanding in terms of data
  - Exposures per zones
  - CZ – double digit PSČ

Impacts of Reinsurance

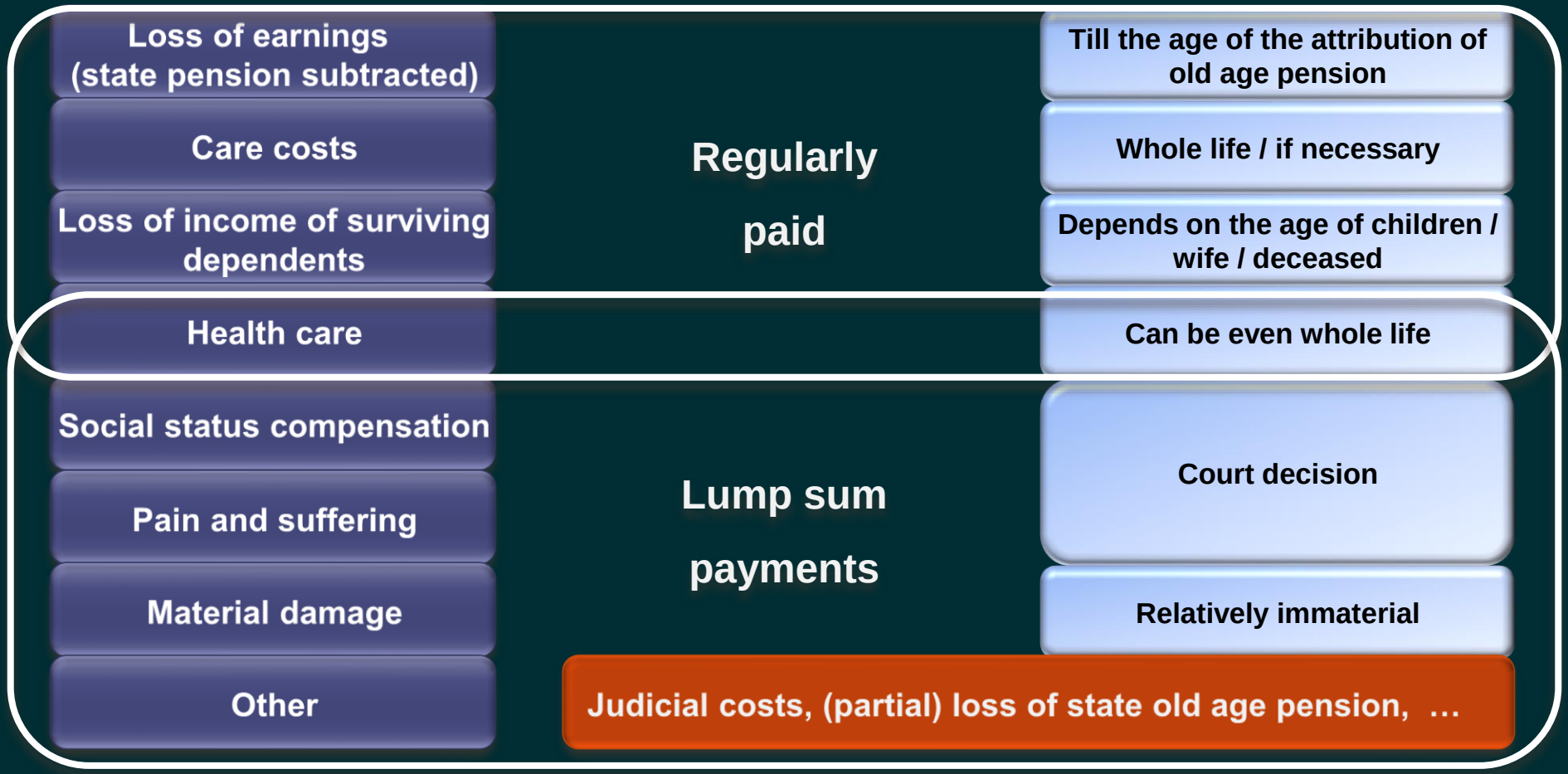
- Determine net amounts
  - Net to gross ratios – different for premium / paid claims / reserves
    - Different for reserving and premium risk
  - Individual modelling of reinsurance on claims – only if individual claims modelled
- Complexity of the structures
  - Order of layers (50% quota, 10 mil. CZK Excess – what goes first)
  - Reinstatements

General considerations

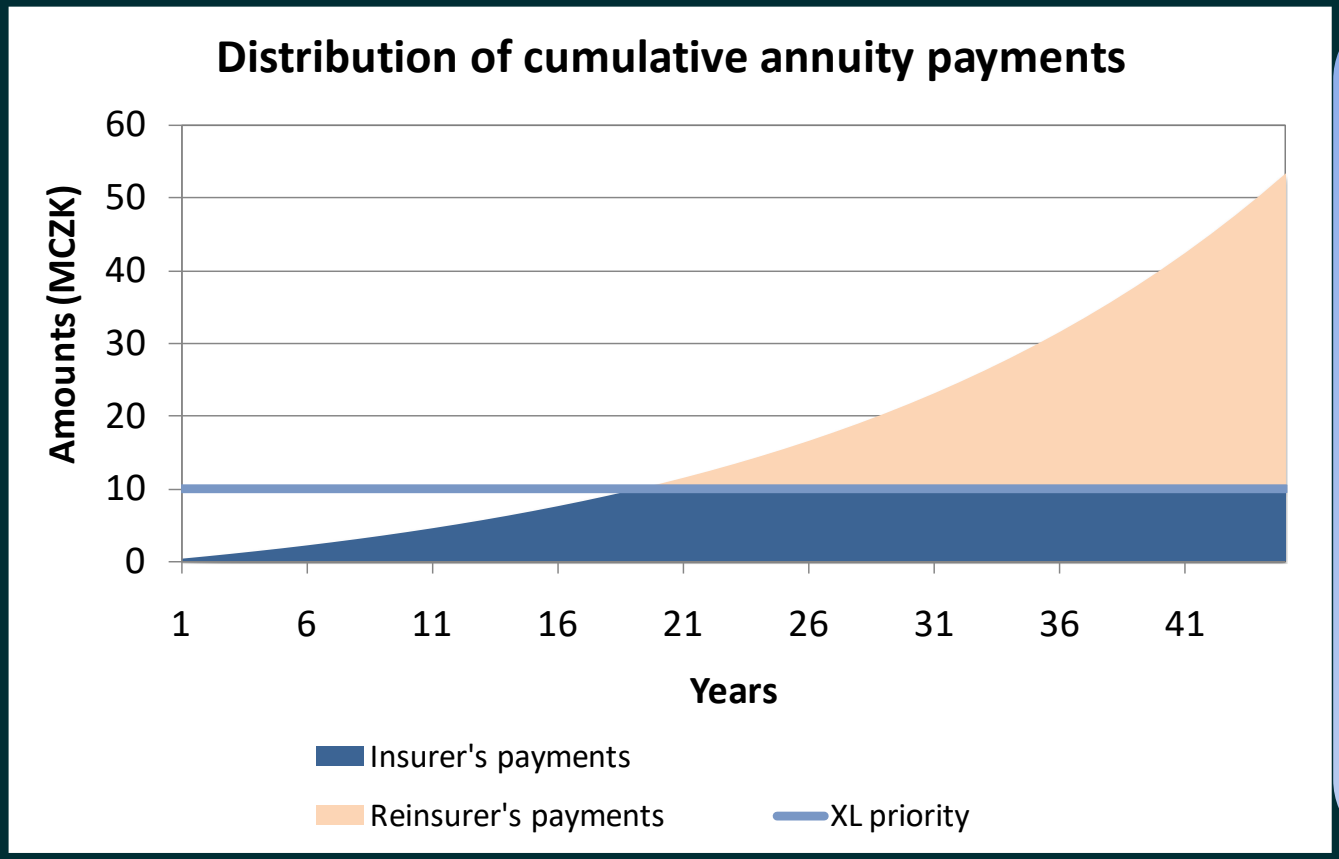
- Input data validation
- Division into LoBs
- Simulation number and random seed
- Dependencies – how to estimate correlation factors/copula, especially on 99.5% confidence level
  - Practical and judgmental approach taken ~ 25 / 50 / 75%?
- Validation of results and sensitivity testing
  - Premium should be consistent with the plan
  - Claims should be consistent with the plan
  - Same reinsurance variables should be consistent with the plan

Case Study – annuities in the Czech Republic

Bodily injury claims in the Czech republic



Example – fixed own retention



Nominal amounts:

Insurer: 10 MCZK

Reinsurer: 43 MCZK

Present value:

Insurer: 6,7 MCZK

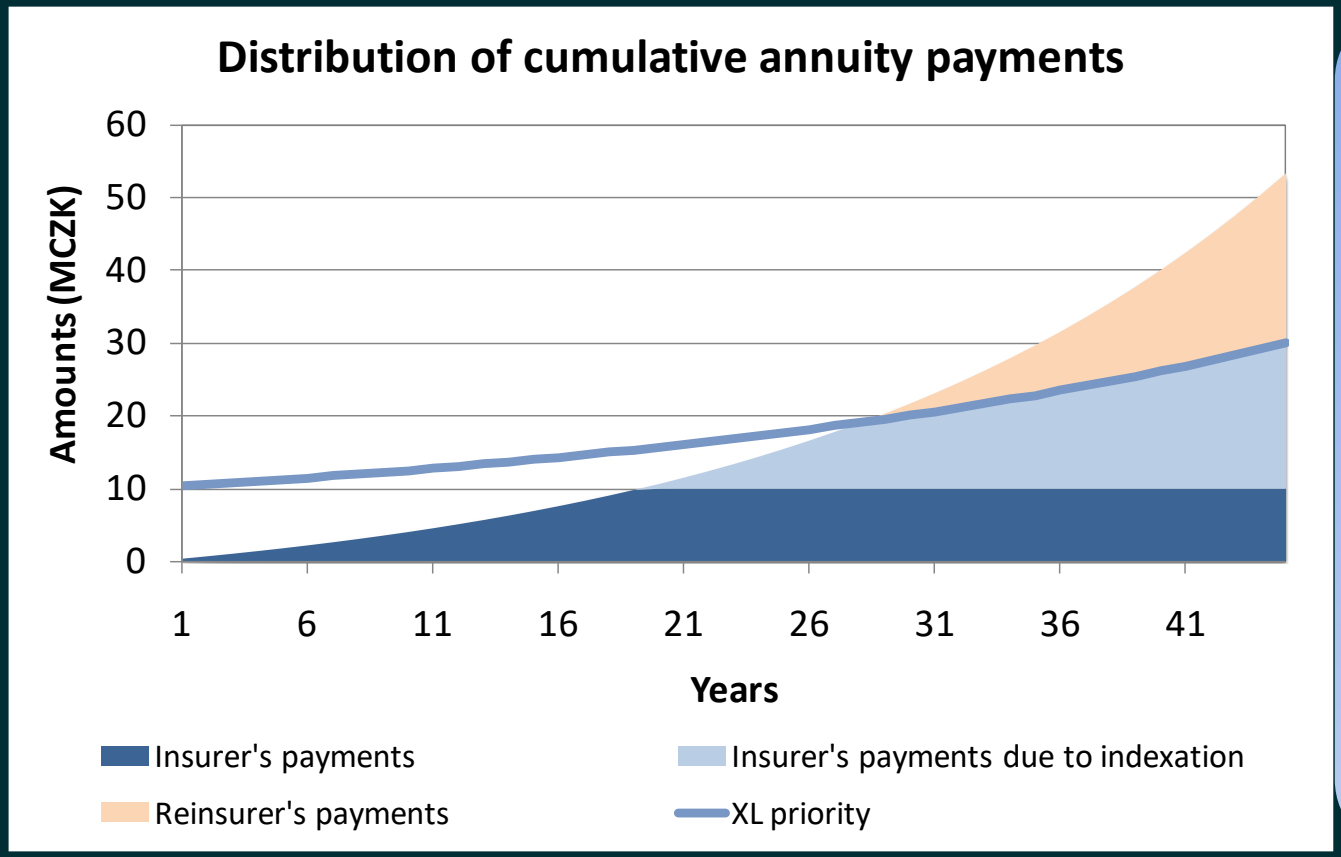
Reinsurer: 10,3 MCZK

Total: 17 MCZK

Reserve:

Gross: 27 MCZK

Example – indexed own retention



Nominal amounts:

Insurer: 30 MCZK

Reinsurer: 23 MCZK

Present value:

Insurer: 12,3 MCZK

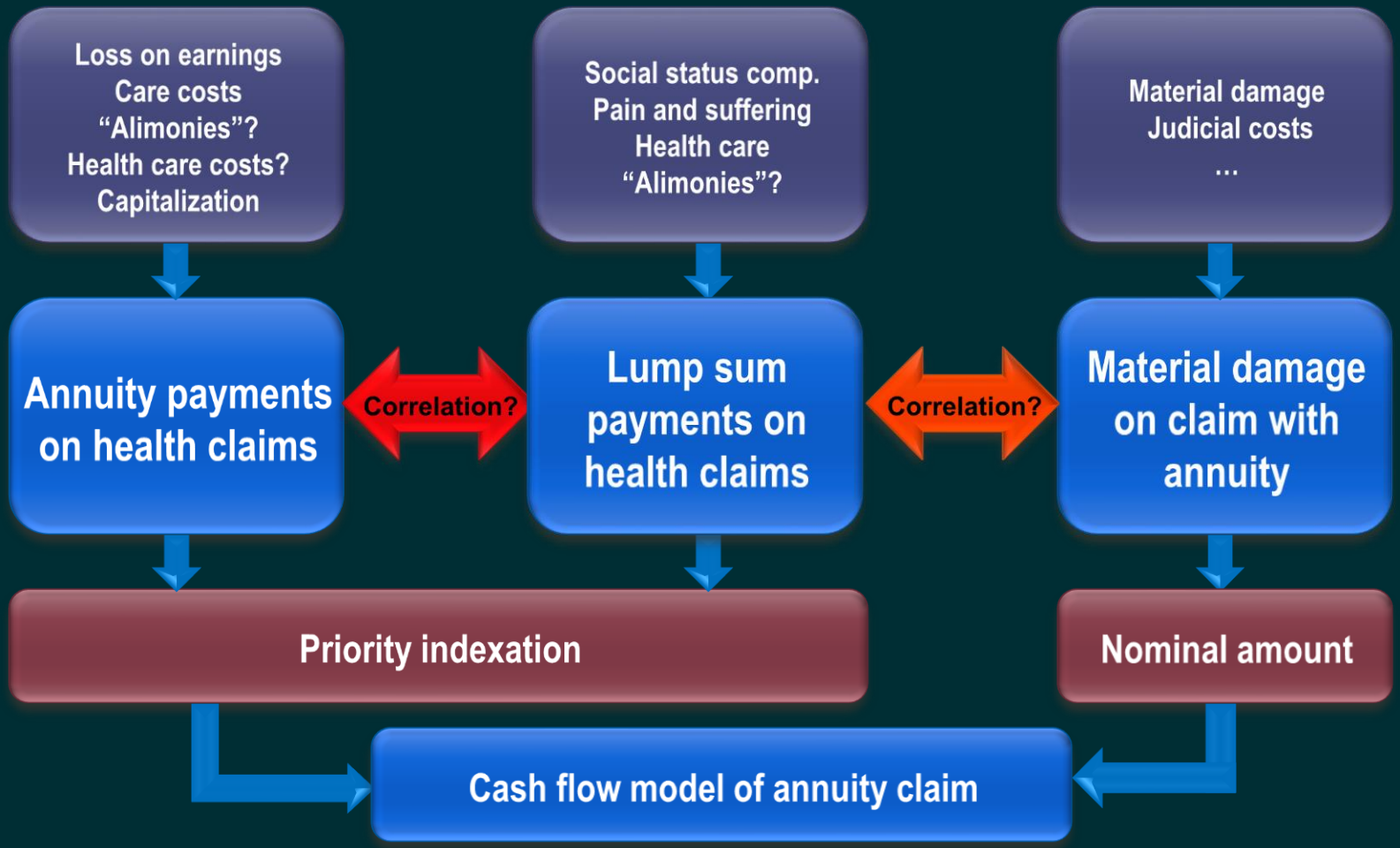
Reinsurer: 4,7 MCZK

Total: 17 MCZK

Reserve:

Gross: 27 MCZK

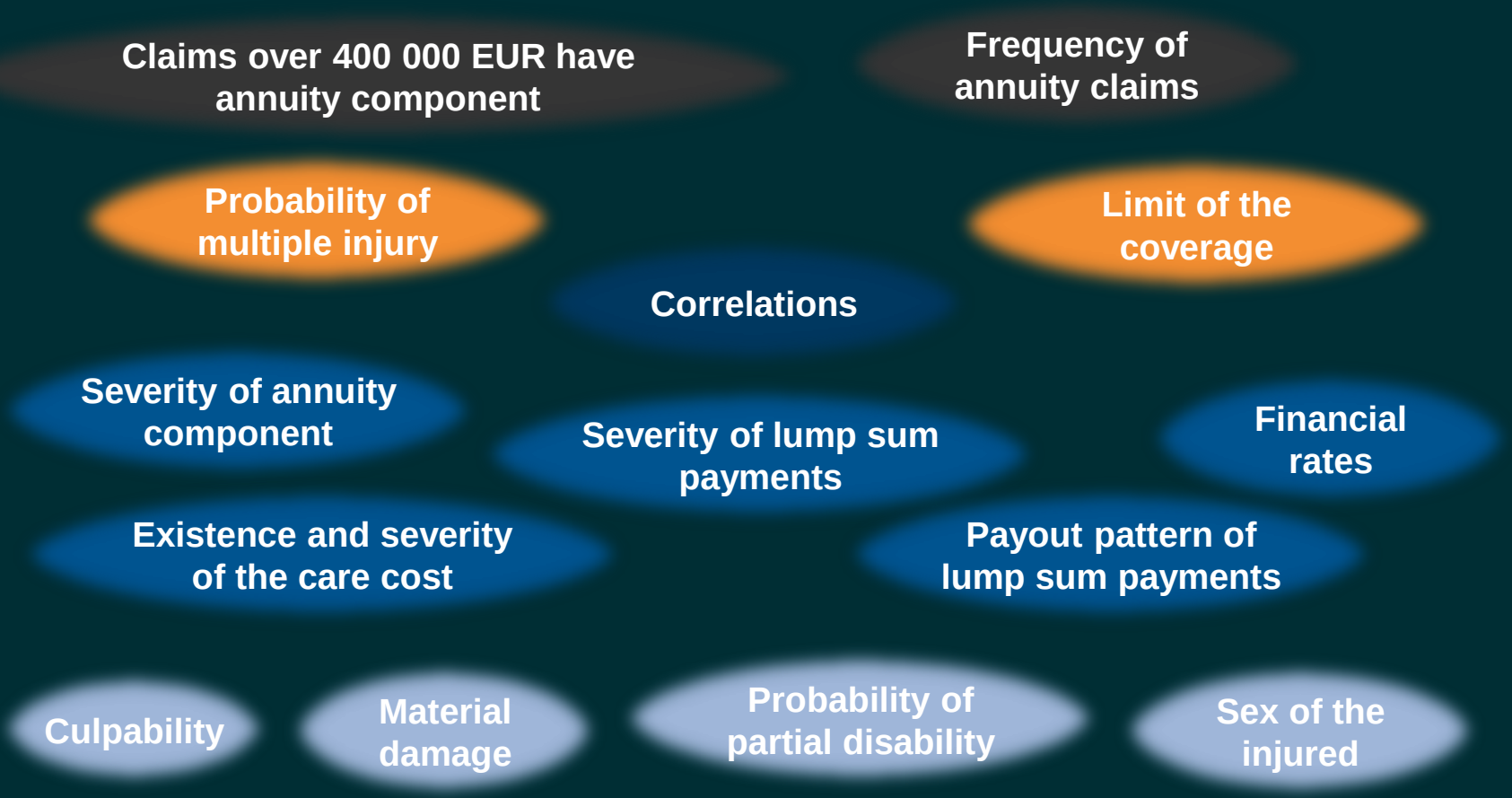
Model scheme



MTPL Reinsurance model

Reinsurance pricing	• **Projects the fair value of the recovery from the reinsurer for different retentions**
Capitalization strategy	• **Helps to define the approach for the capitalization of annuities**
Asset liability management	• **Projects future cash outflows for significant claims**
Net position of reserves	• **Estimates the share of the reinsurer on the reserves**
MTPL pricing (limits)	• **Helps to price product by introducing sensitivity of claims to policy limits**
Internal model verification	• **Can be used to verify the results of internally developed model**

Assumptions - significance



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   A. Process and purpose
   B. Selection of validation tests

Validation – process and purpose

- Guarantee that the internal model provides an adequate and robust assessment of risks faced by the company
- Various “intensity” – initial / ongoing / special model use
- Validator independent from the modeler
- Areas governed
  - Data and their quality
  - Parameterization/assumption setting
  - Model design
  - Output
  - Model governance
  - Documentation

Selection of validation tests

- Plausibility
  - Ensure that the parameterisation is consistent with model logic
    - Parameterisation assessment
    - Consistency of best estimates of technical provisions to reality
    - Comparison of the model outputs to plan
    - Analysis of the change (movement in SCR drivers)
    - Analysis of the reinsurance structure
- Stability
  - Assess the minimum / safe number of simulations
- Sensitivity
  - Identify key assumptions and asses time consistency

Selection of validation tests

- Backtest / P&L attribution
  - Compare the model projection (past, for the current year) with reality
- Capital allocation
  - Comparison of the expected and real capital allocation
- Stress test and scenario analysis
  - Use of scenarios shall challenge the “tail” of the model
  - How well the model is able to capture extreme events
- Reverse stress test
  - Preparation of the realistic scenario which would cause the loss as high as is the capital requirement determined by the internal model
- Various process and data quality tests

Thank You!

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Zdenek Roubal

zroubal@koop.cz

Kamil Žák

kamil.zak@cpp.cz

Česká společnost aktuárů

www.actuaria.cz

BACKUP

Developments around the World

Canada

Dynamic Capital Adequacy Testing (DCAT)

- Scenario testing rather than stochastic simulation.

Australia

General Insurers – permitted choice between:

- Internal model based Method (in-house model);
- prescribed method (formulaic).
- Trend to introduce models as part of holistic ERM

USA

Dynamic Financial Analysis

- DFA Handbook produced by CAS in 1995
- The process by which the actuary analyzes financial condition of an insurance enterprise
- **A set of scenarios** (favorable and adverse) **to test the reaction of the company's surplus**
- Up-and-running model that can easily be implemented and adjusted to individual needs.

UK

Individual Capital Assessment (ICA)

- Individual Capital Adequacy Standards from January 2005
- 99,5% Value at Risk measure.
- One year of additional underwriting.
- Diversification benefits.

Switzerland

Swiss Solvency Test (2006)

- **Risk based capital model**
- Many principles accepted internationally
- Components of the standard model can be substituted by the internal one

Solvency Studies in the 1980s

Solvency Working Party of the Groupe Consultatif

- Reviewed EU solvency regime
- Inadequate attention to run-off risk and investments
- Recommended use of internal models instead of formula
- Capital requirements should relate to company risks:
  - type of business;
  - profitability of premium rates;
  - investment allocation and strategy;
  - reinsurance programme.

Solvency Studies in the 1990s

1996

- Simulation not regarded as proper mathematics
- **Problems with classical approach:**
  - restrictive assumptions to make mathematics tractable;
  - divergence from real world;
  - artificial problem settings.
- **Cash-flow modelling offers scope for taking into account:**
  - inflation and investment volatility (and correlations);
  - fluctuations and cycles in claims experience;
  - reserving uncertainties.