Přístup k interním modelům v pojišťovnách

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Internal Model

- What is internal model?
- Why it is hot topic these days?
- Why is important?
- How is it created?
- Who is using it and how?
- What is the overall purpose?
- Does it really need to be so sophisticated?

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

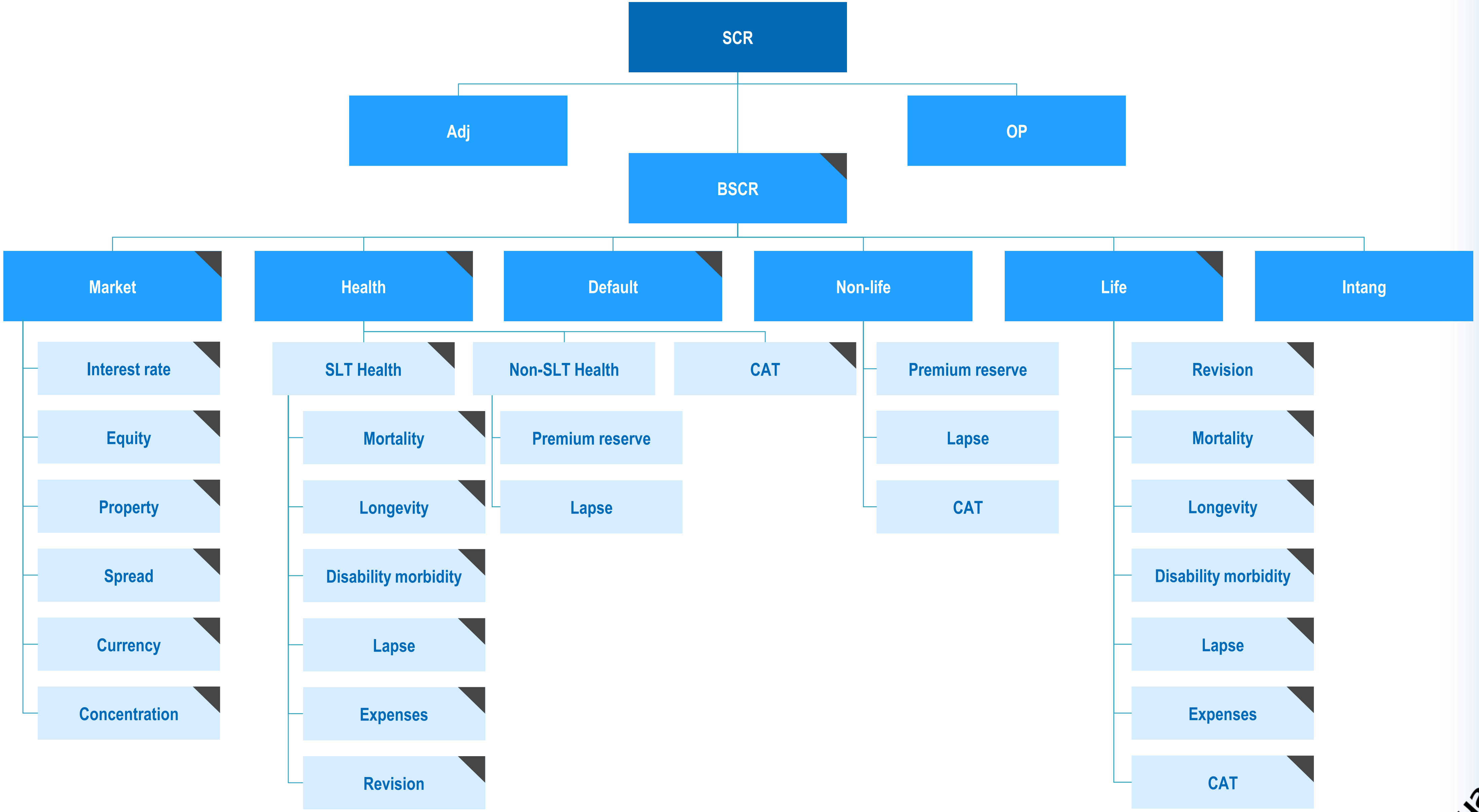
- Use test
- Statistical quality standards
- Calibration standards
- Profit and loss attribution
- Validation standards
- Documentation standards

Internal Model

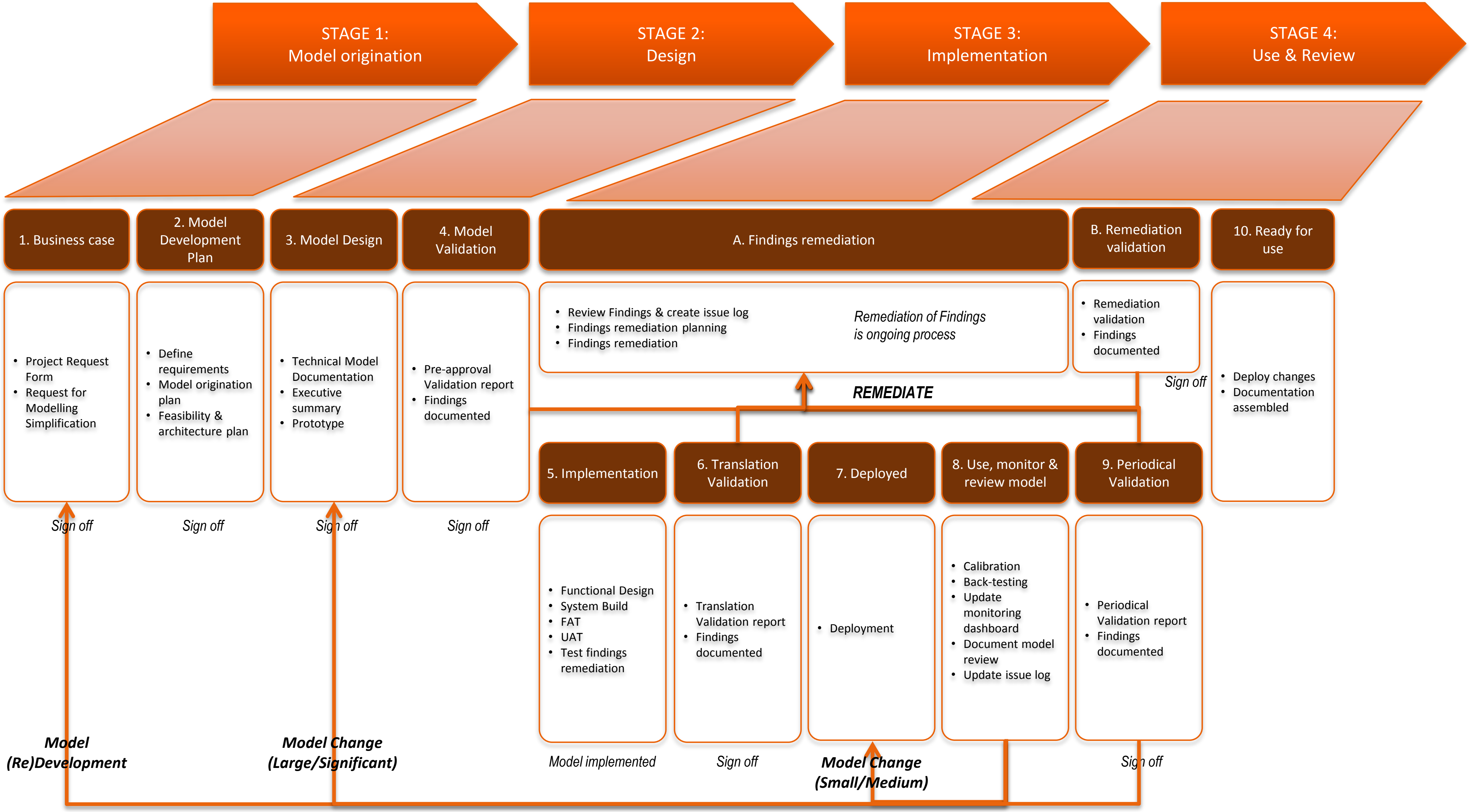
Internal Model components

- Product Pricing
- Performance Management
- Asset Liability Management
- Investment decisions
- Reinsurance
- Solvency / Economic Capital Requirement
- Stress testing
- Capital Allocation
- Managing Risk Appetite
- Strategic Asset Allocation
- Hedging programs
- Solvency II / Market Value Balance Sheet

Standard Model



Model Development Cycle



Risk Factors & Risk Drivers

- Risk Factor
  - Selection
  - Modelling
- Risk Drivers
  - Projections
- Modelling horizon
  - 1 year

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

- Stand alone 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
- Rule #2
  - Model is a model is a model is a model …
    - Precision
    - Runtime
    - Reliance

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Break

The Internal Models in Non-life Insurance

Zdeněk Roubal

Agenda for this part

Historical development

Risks of the non life insurer

Non life underwriting risk

Reserving risk

Premium and CAT risk

Case study

Historical development

Solvency Studies in the 1980s

Some major themes:

- Capital requirements should reflect risk characteristics
- EU Solvency I requirements not sufficiently risk-based (maximum of 16/18% of premium, 23/26% of claims)
- Solvency margins are an early warning mechanism
- 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

- Adaptation of classical risk theory to introduce cycles
- Transition formula for modelling cash flows:

$$U = B + I - \Delta X - C - D$$

- where **B** is earned premium income (including loadings)

  I is net investment income

  X is claims paid and outstanding

  C is cost of administration, reinsurance, etc.

  D is dividends, bonuses, etc.

In the slides we are using presentation by Chris Daykin delivered at 39th ASTIN Colloquium, Helsinki, 2009.

Solvency Studies in the 1980s

Solvency Working Party of the Groupe Consultatif

- Reviewed EU solvency régime
- 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.

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Solvency Studies in the 1980s

1988

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

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.

Solvency Studies in the 1990s

Further progress

- Computer capacity limited scope for full internal models
- Concerns about number of assumptions and realism
- DFA received a high profile in the Casualty Actuarial Soc.
- 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

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

Developments around the World

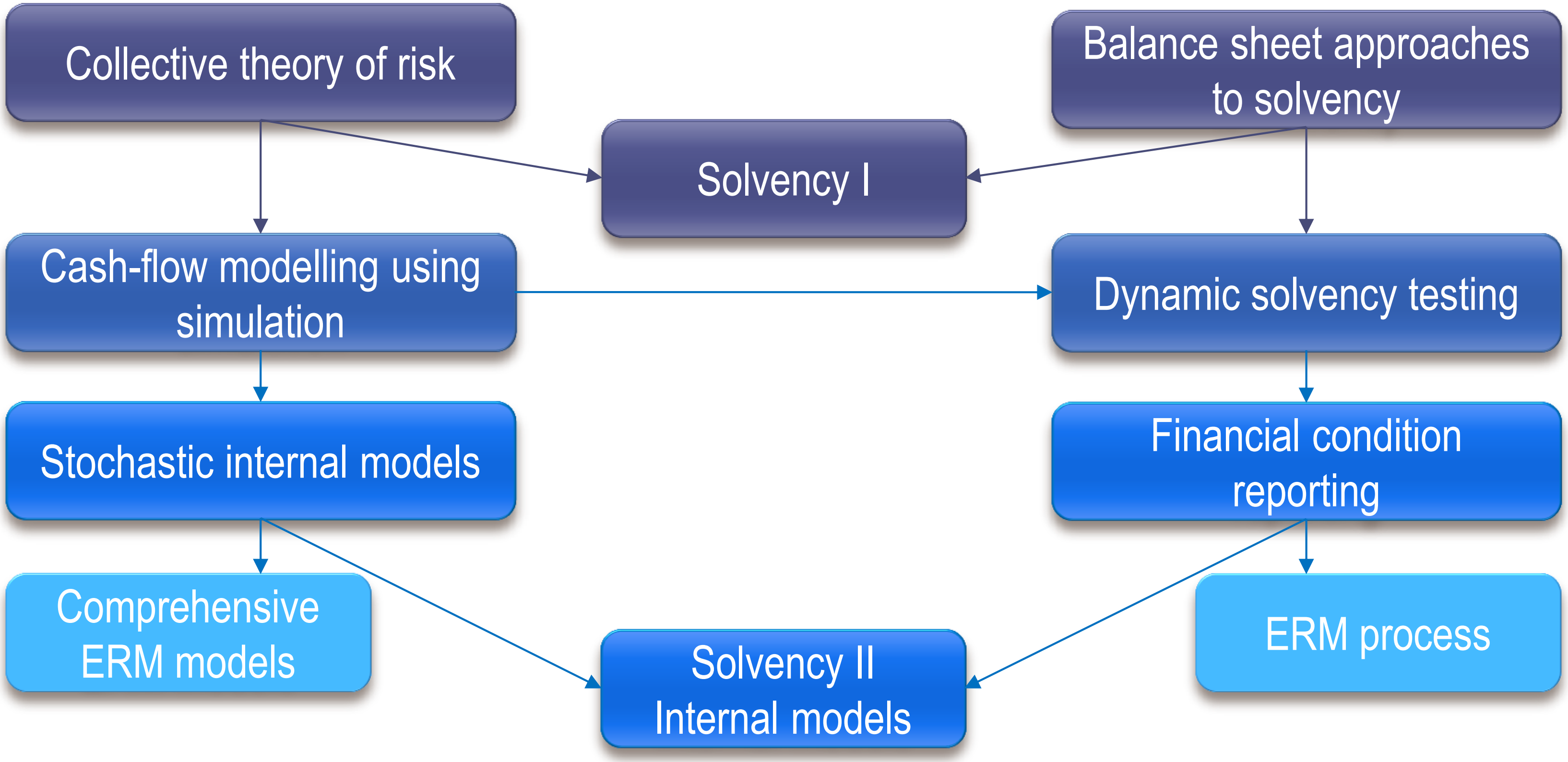
International Association of Insurance Supervisors

- 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

Evolution towards Solvency II



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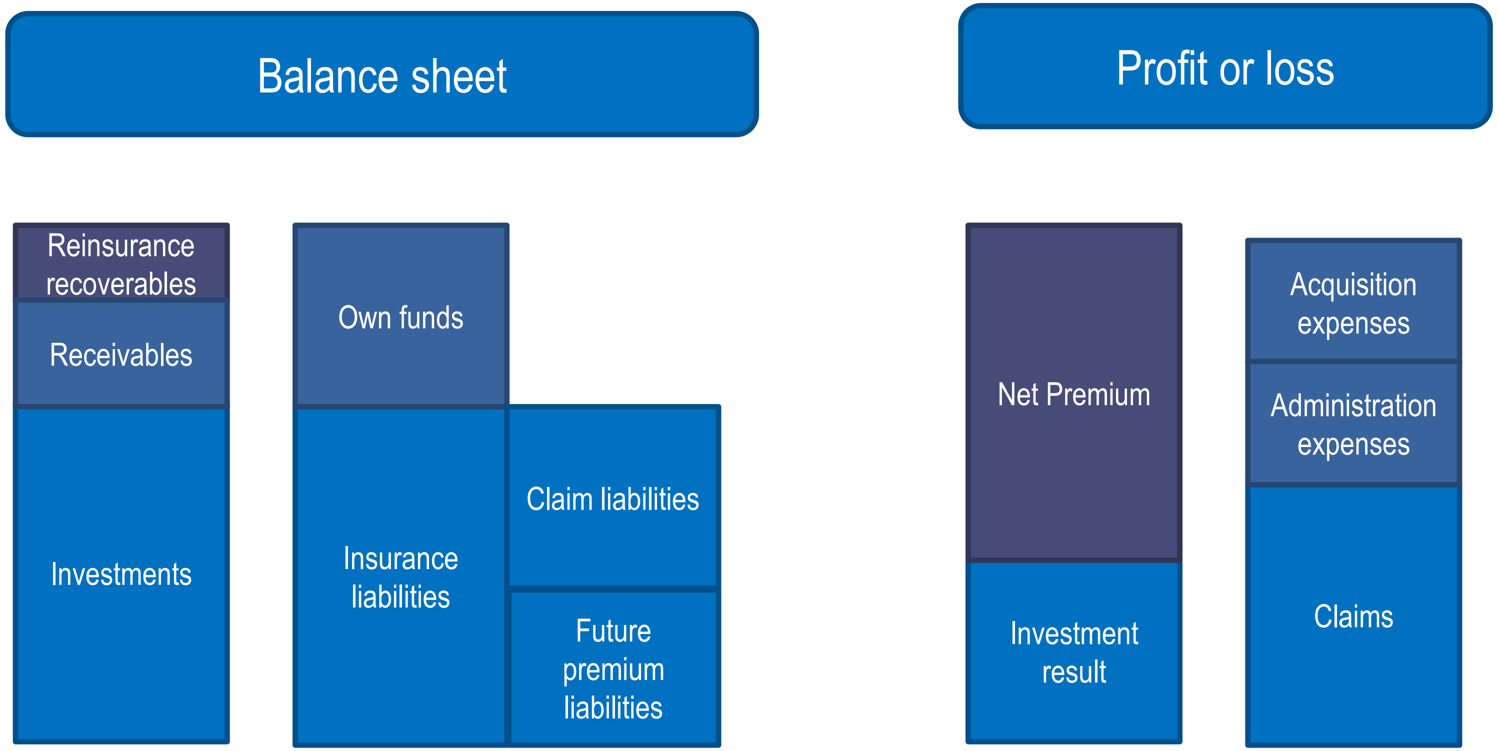
Risks of the nonlife insurer

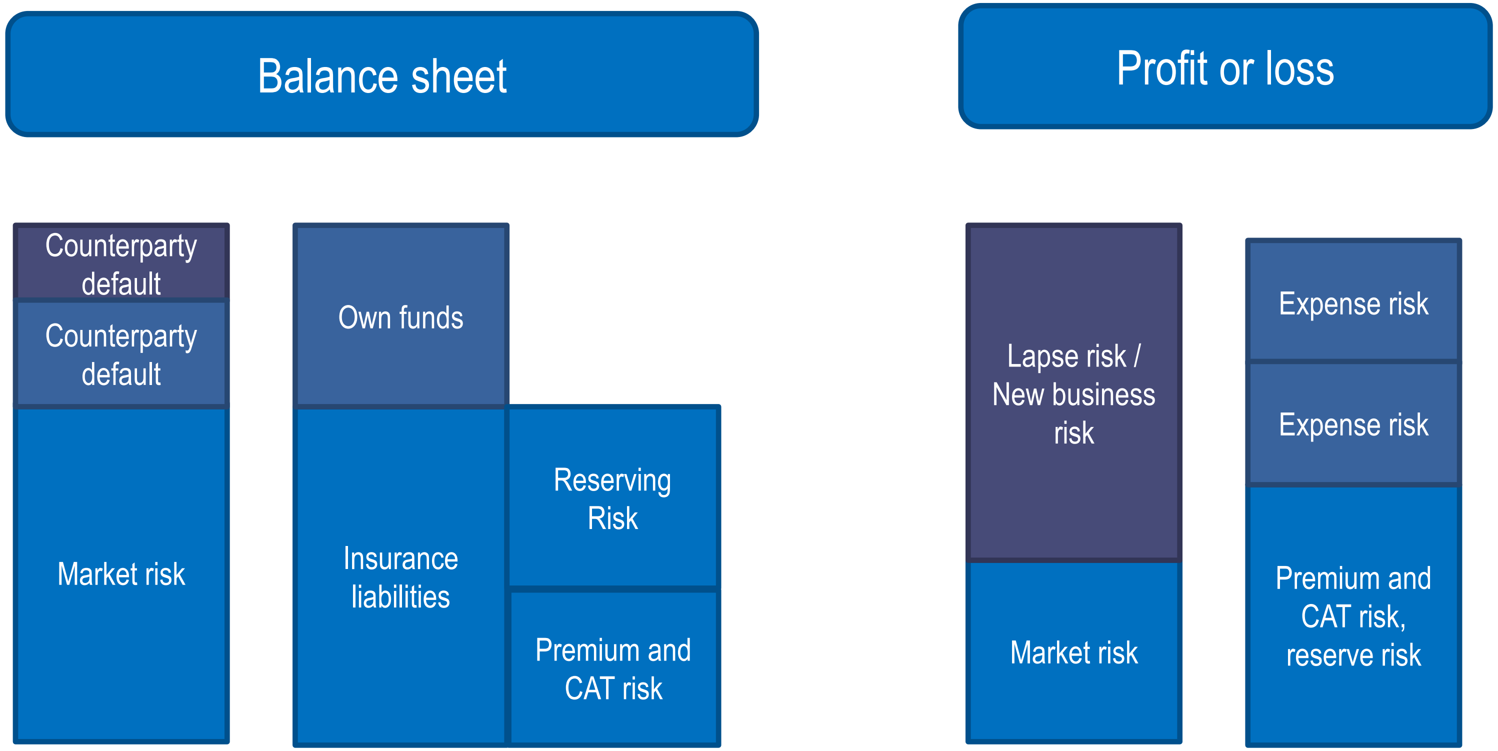
Risks of the non life insurer

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



Risks of the non life 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 fo the model

The diifference comes next:

$$SCR_{nl\ prem\ res} = 3 \cdot \sigma_{nl} \cdot V_{nl}$$

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 segement based on aggregation of premium and reserve risk via premium and reserve volume measures and premium and reserve risk standard deviations

Standard formula in SII

- More risk sensitive than the current regime

x

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

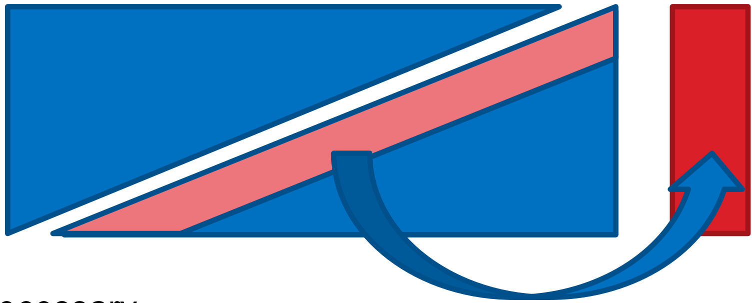
- SII allows USPs – undertaking specific parameters for standard deviation of the reserve and premium risk – “small internal model”
- Additional country specifics – Czech Republic – annuities

- 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
  - (SAV: Tomáš Petr:Riziko rezerv v neživotním pojištění; Zdeněk Roubal: Rezervování v neživotním pojištění, …)
- Small claims
  - Variability given by the analytic formulae (Mack Chain ladder) or simulation (bootstrapping)
  - Ultimate view 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
  - 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 results to the other uses
- Reconciliation of the data and consideration of exclusions (CAT risk)
- Diagnostic of the used model (commonly 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

- 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.
- Small claims
  - Aggregate x frequency/severity model
  - Difficult to fit the specific distribution to individual claims
  - Experience distribution function, limited number of simulated points
- Large claims
  - CAT risk generally excluded, only individual claims modelled
  - Treshold selection – too few x too many (common 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
  - 1in 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

Impact 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 mnodelled
- Complexity of the structures
  - Order of layers (50% quota, 10 mil. CZK Excess – what goes first)
  - Reinstatements

General considerations

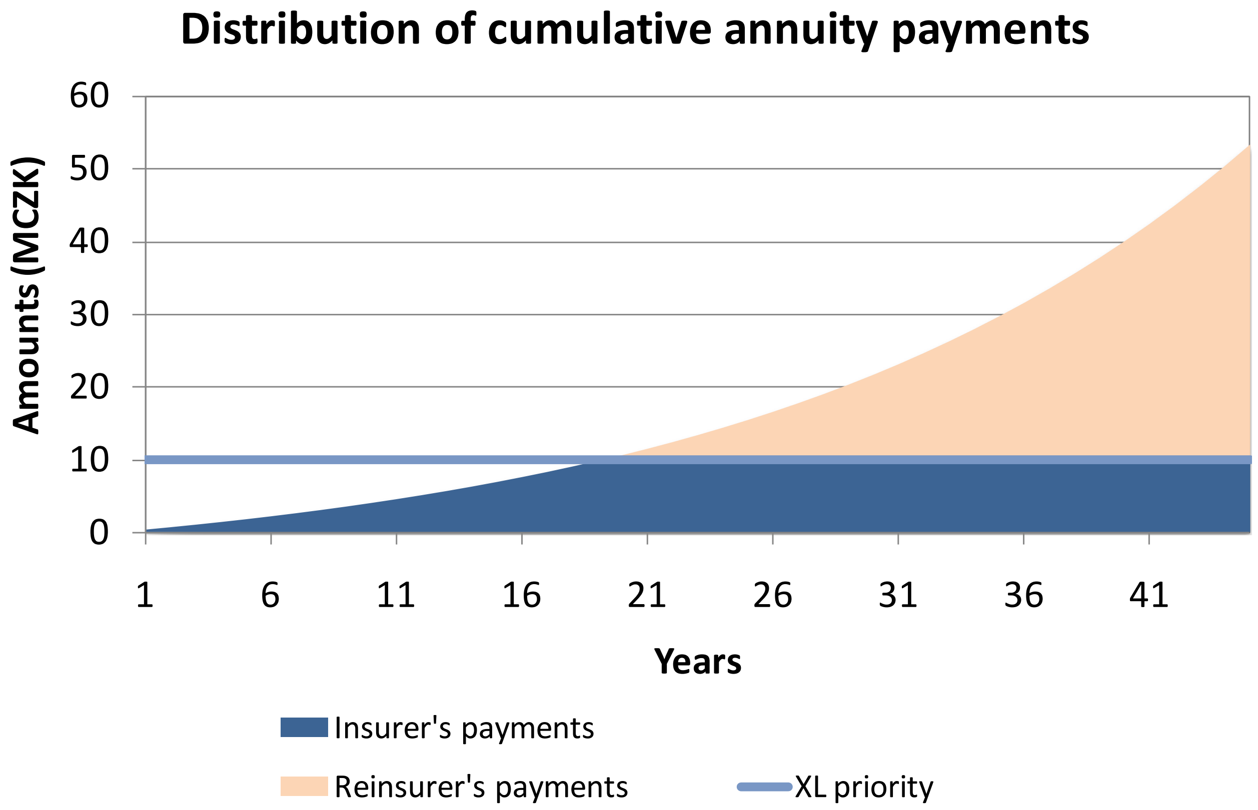
- Input data validation
- Division into LoBs
- Simulation number and random seed
- Dependencies – how to estimate correlation factors/copula, especially on 99.5% confidence level
  - Practical and judgemental approach taken ~ 25 / 50 / 75%?
- Validation of results and sensitivity testing
  - Premium 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

Type of claim	Payment	Duration / basis
Loss of earnings (state pension subtracted)	Regularly paid	Till the age of the attribution of old age pension
Care costs	Regularly paid	Whole life / if necessary
Loss of income of surviving dependents	Regularly paid	Depends on the age of children / wife / deceased
Health care	Regularly paid	Can be even whole life
Social status compensation	Lump sum payments	Court decision
Pain and suffering	Lump sum payments	Court decision
Material damage	Lump sum payments	Relatively immaterial
Other	Judicial costs, (partial) loss of state old age pension, …	

Example – fixed own retention



Nominal amounts:

Insurer: 10 MCZK

Reinsurer: 43 MCZK

Present value:

Insurer: 6,7 MCZK

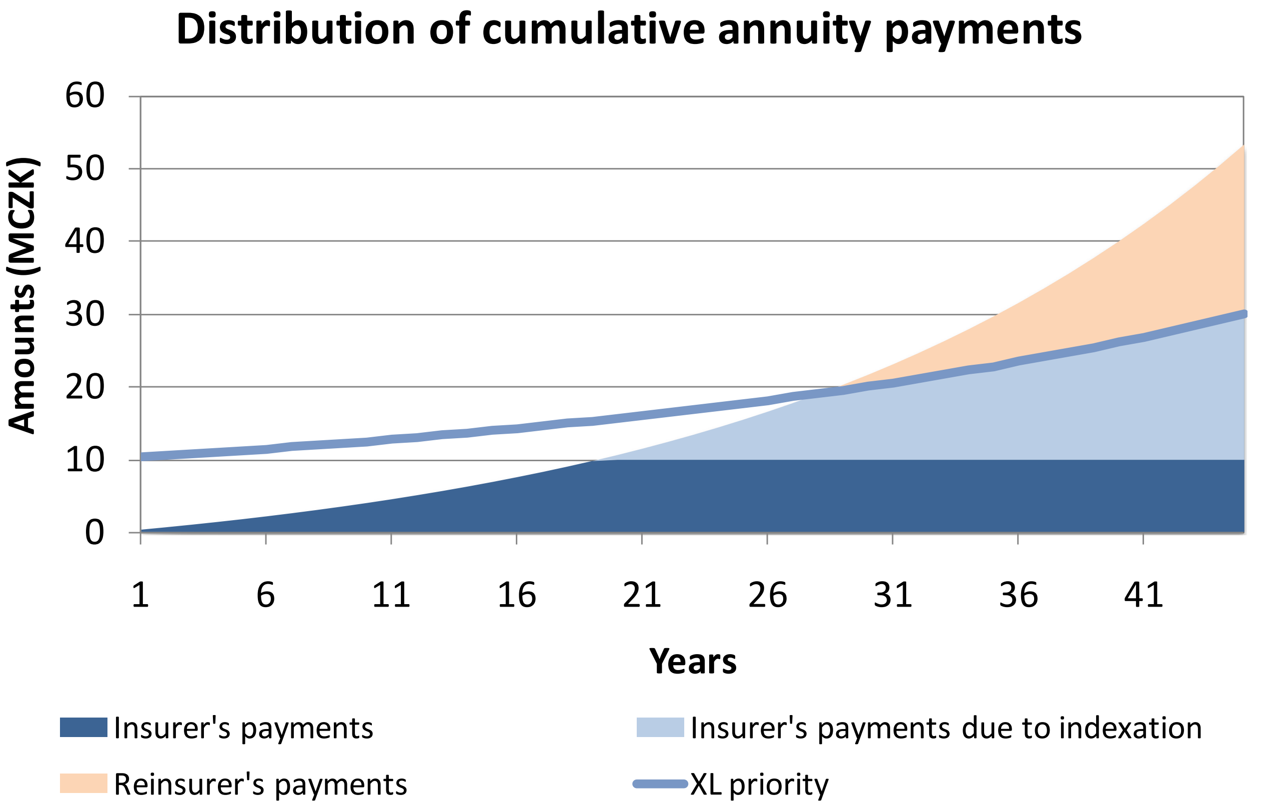
Reinsurer: 10,3 MCZK

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

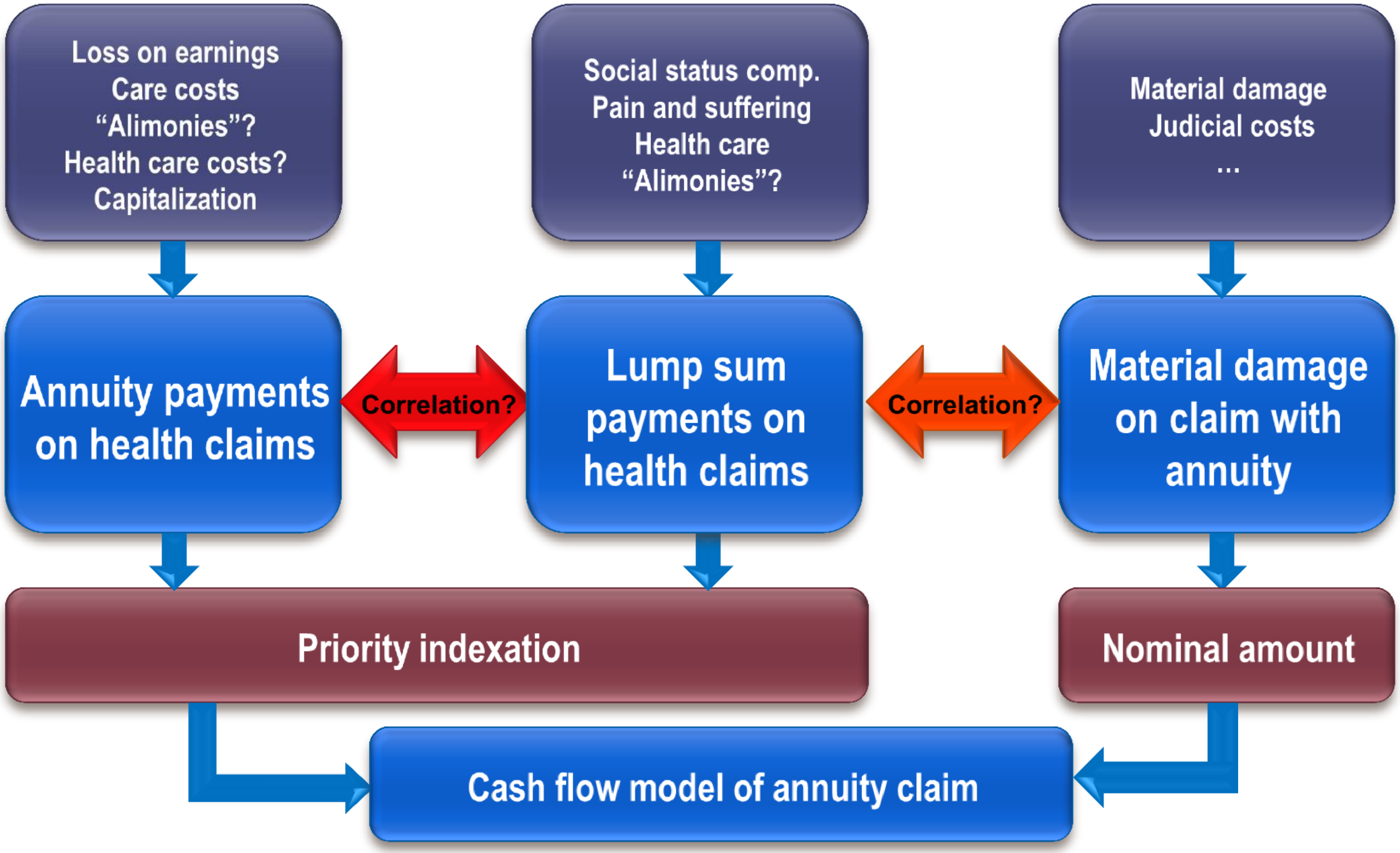
Reinsurer: 4,7 MCZK

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

Claims over 400 000 EUR have annuity component

Frequency of annuity claims

Probability of multiple injury

Limit of the coverage

Correlations

Severity of annuity component

Severity of lump sum payments

Financial rates

Existence and severity of the care cost

Payout pattern of lump sum payments

Culpability

Material damage

Probability of partial disability

Sex of the injured

Děkuji za pozornost,
Zdeněk Roubal