Přístup k interním modelům v pojišťovnách

- Zdenek Roubal, Kamil Žák
- Seminář z aktuárských věd
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Přístup k interním modelům v pojišťovnách

A. Historie

B. Životní pojištění

C. Neživotní pojištění

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

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
- **Solvency margins are an <u>early warning</u> 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:

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

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.

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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 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.

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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.

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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

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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
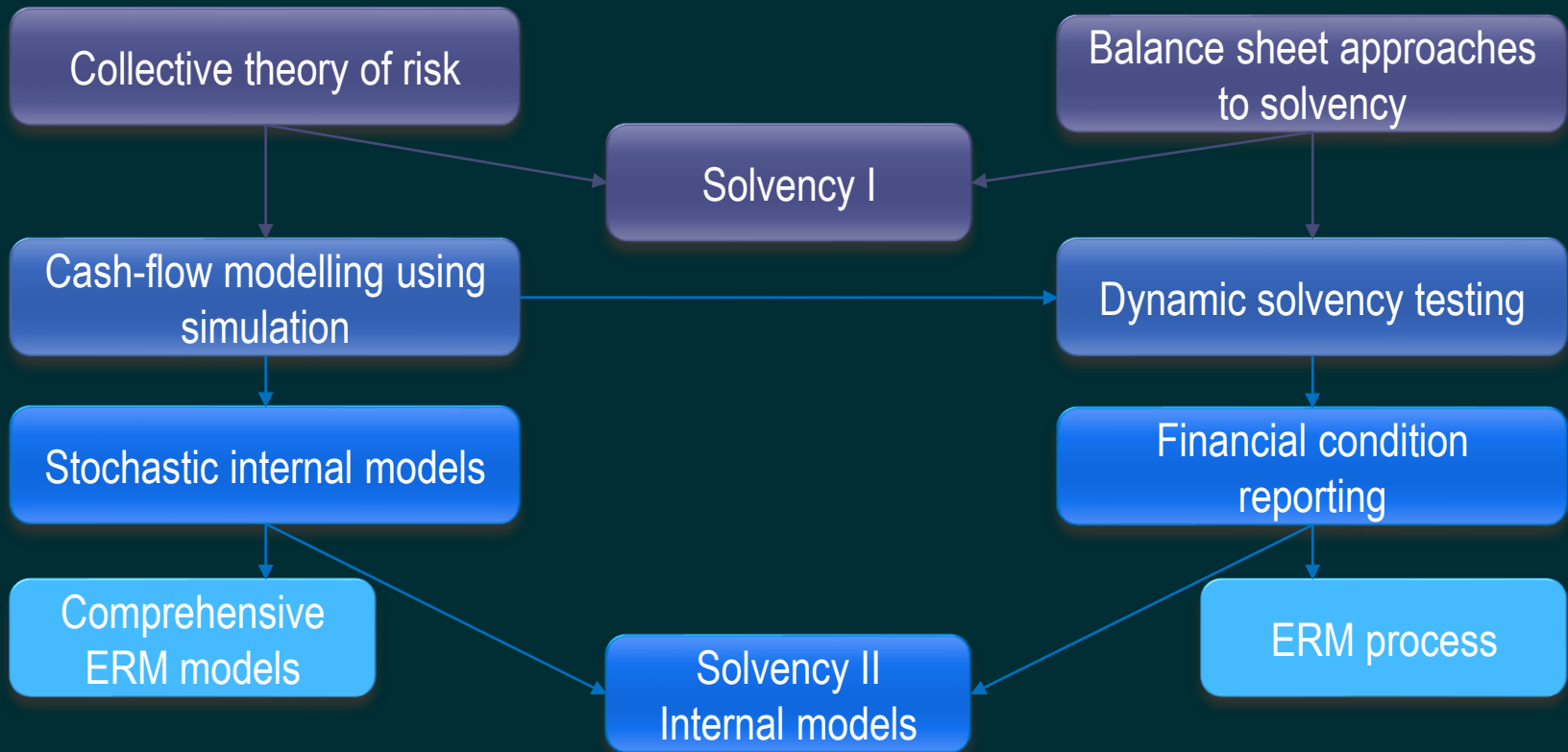
Přístup k interním modelům v pojišťovnách

A. Historie

B. Životní pojištění

    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. Neživotní pojištění

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

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Solvency II Internal Model

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

Internal Model

Product Pricing

Performance Management

Asset Liability Management

Investment decisions

Reinsurance

Internal Model components

Solvency / Economic Capital Requirement

Stress testing

Capital Allocation

Managing Risk Appetite

Strategic Asset Allocation

Hedging programs

Solvency II / Market Value Balance Sheet
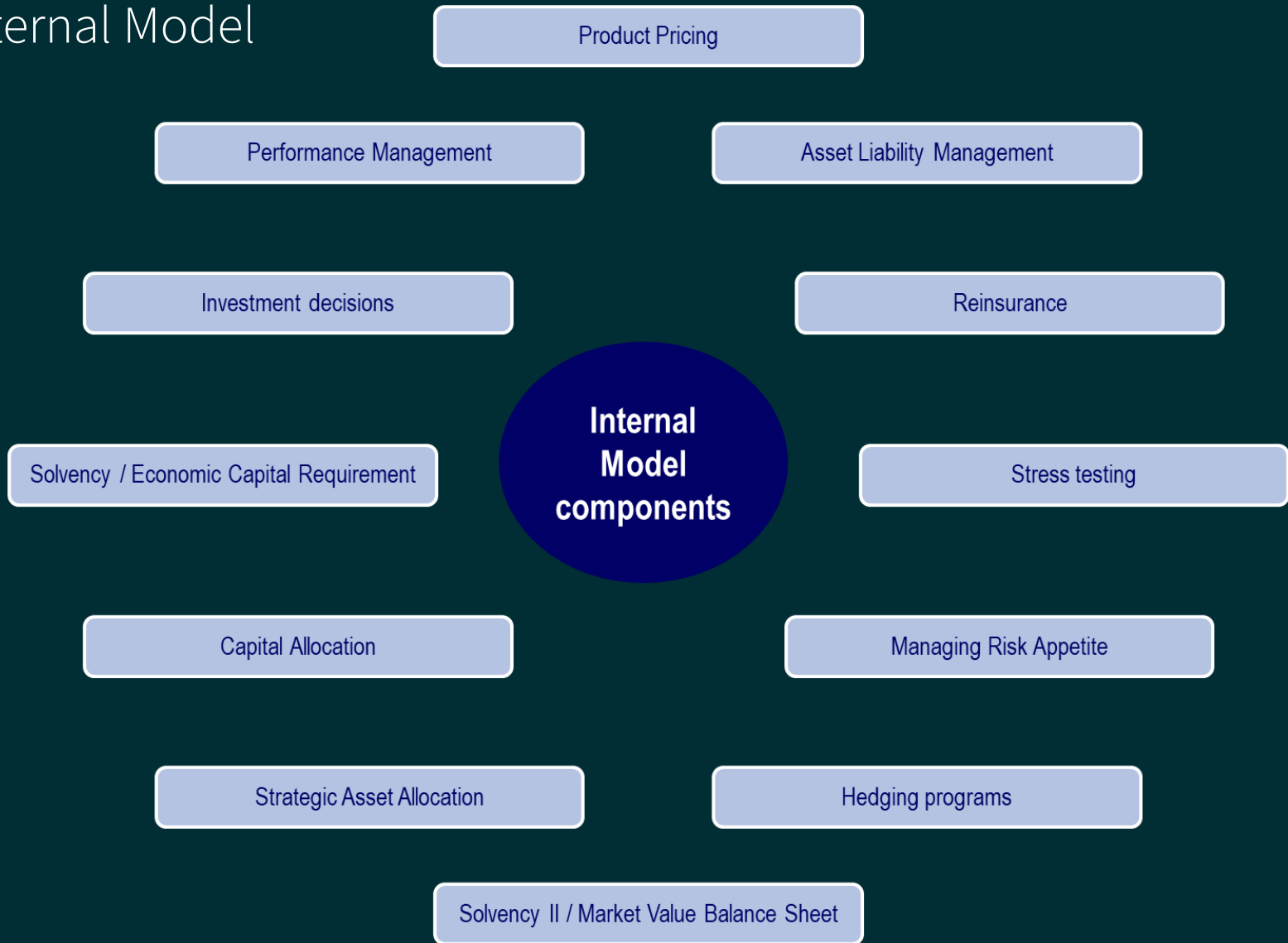
Standard Model

Model Development Cycle

STAGE 1: Origination	STAGE 2: Design	STAGE 3: Implementation	STAGE 4: Use & Review

1. Business case	2. Model Development Plan	3. Model Design	4. Model Validation	A. Findings remediation	B. Remediation validation	10. Ready for use

1. Business case
- Project Request Form
- Request for Modelling Simplification

Sign off

2. Model Development Plan
- Define requirements
- Model origination plan
- Feasibility & architecture plan

Sign off

3. Model Design
- Technical Model Documentation
- Executive summary
- Prototype

Sign off

4. Model Validation
- Pre-approval Validation report
- Findings documented

Sign off

A. Findings remediation
- Review Findings & create issue log
- Findings remediation planning
- Findings remediation

Remediation of Findings is ongoing process

REMEDIATE

B. Remediation validation
- Remediation validation
- Findings documented

Sign off

10. Ready for use
- Deploy changes
- Documentation assembled

5. Implementation	6. Translation Validation	7. Deployed	8. Use, monitor & review model	9. Periodical Validation

5. Implementation
- Functional Design
- System Build
- FAT
- UAT
- Test findings remediation

Model implemented

6. Translation Validation
- Translation Validation report
- Findings documented

Sign off

7. Deployed
- Deployment

8. Use, monitor & review model
- Calibration
- Back-testing
- Update monitoring dashboard
- Document model review
- Update issue log

9. Periodical Validation
- Periodical Validation report
- Findings documented

Sign off

Model (Re)Development

Model Change (Large/Significant)

Model Change (Small/Medium)

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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
  - …

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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

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Internal Model Rules

- ## Rule #1
  - GIGO
    - Data quality

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

Break

Přístup k interním modelům v pojišťovnách

A. Historie

B. Životní pojištění

C. Neživotní pojištění

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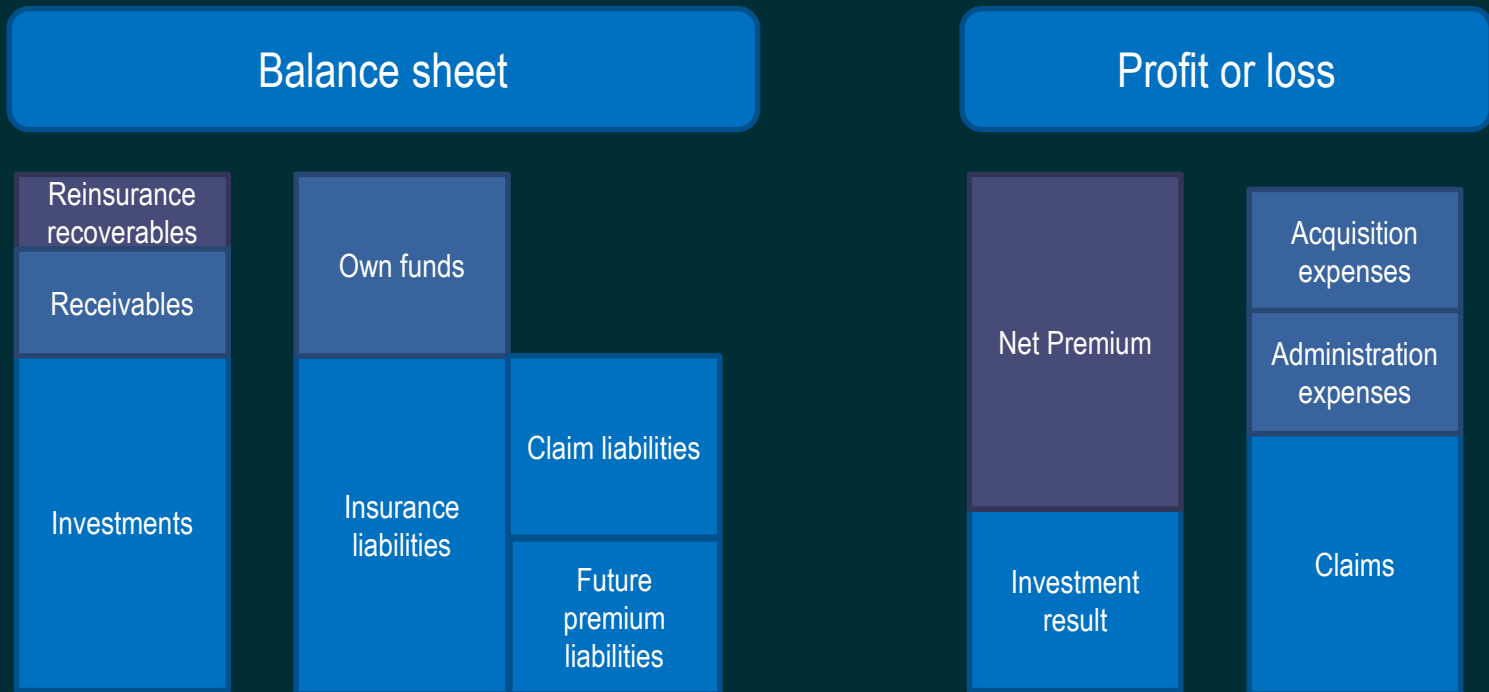- C. Reserving risk
- D. Premium and CAT risk
- E. Case study
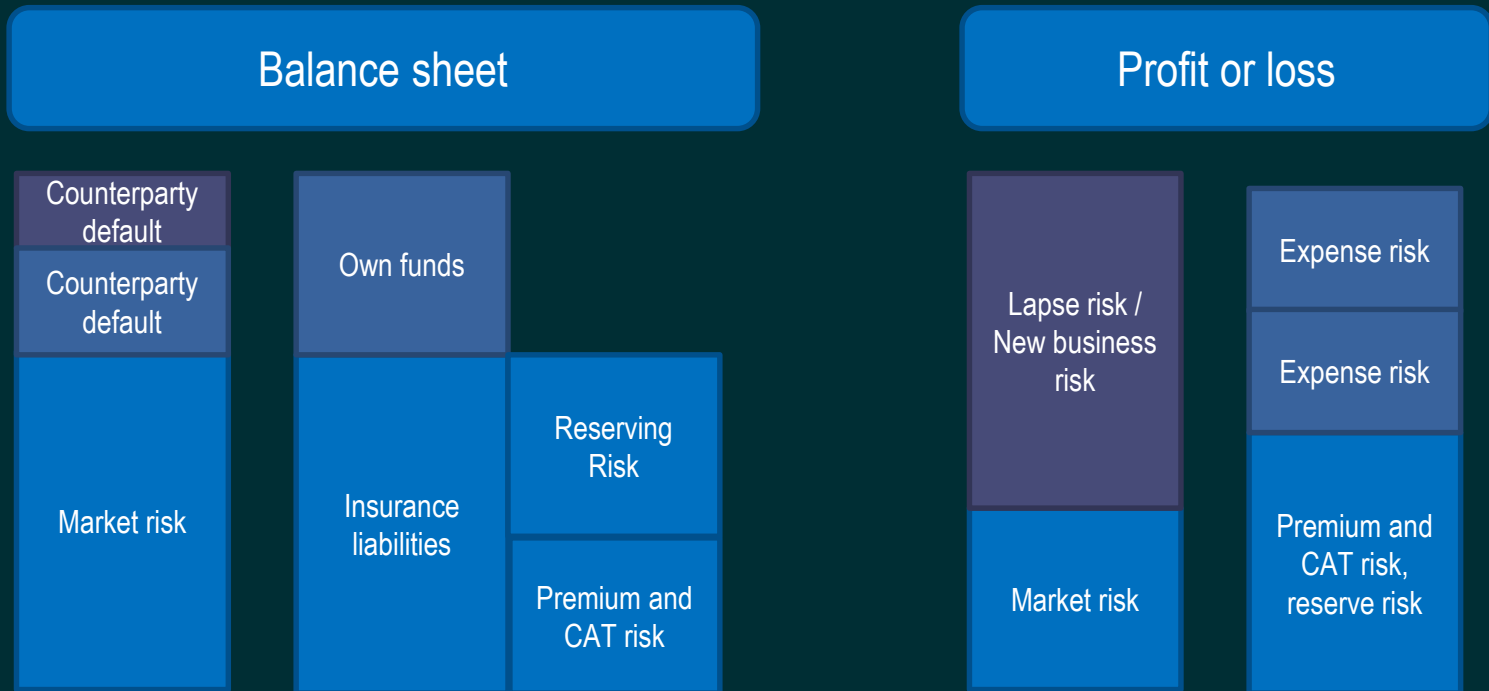
Risks of the non life insurer

Risks of the nonlife insurer

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

Balance sheet

- Reinsurance recoverables
- Receivables
- Investments
- Own funds
- Insurance liabilities
- Claim liabilities
- Future premium liabilities

Profit or loss

- Net Premium
- Investment result
- Acquisition expenses
- Administration expenses
- Claims

Risks of the nonlife insurer

- Simplified view

Balance sheet

| Counterparty default |
| Counterparty default |
| Market risk |

Own funds	
Insurance liabilities	Reserving Risk
	Premium and CAT risk

Profit or loss

Lapse risk / New business risk	Expense risk
	Expense risk
Market risk	Premium and CAT risk, reserve risk

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

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

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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
  - (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)

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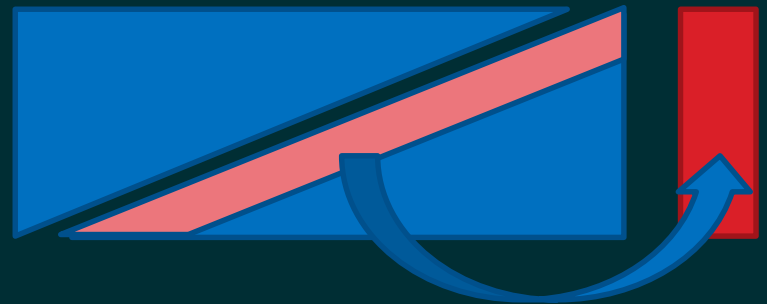
Reserving risk

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

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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
  - Threshold 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
  - 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
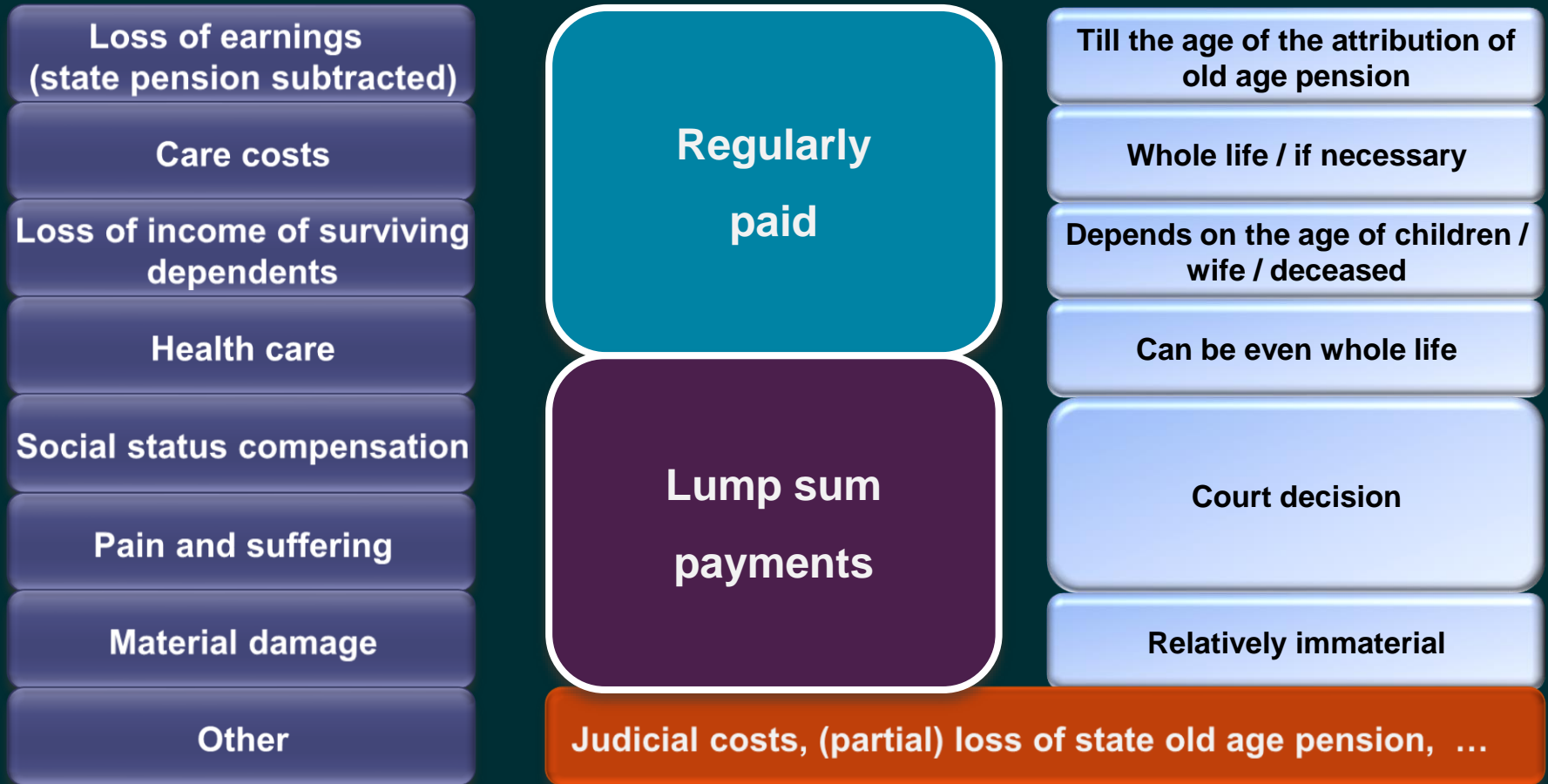
Impacts of Reinsurance

- **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

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Case Study – annuities in the Czech Republic

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Bodily injury claims in the Czech republic

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

Judicial costs, (partial) loss of state old age pension, …

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Example – fixed own retention

Distribution of cumulative annuity payments
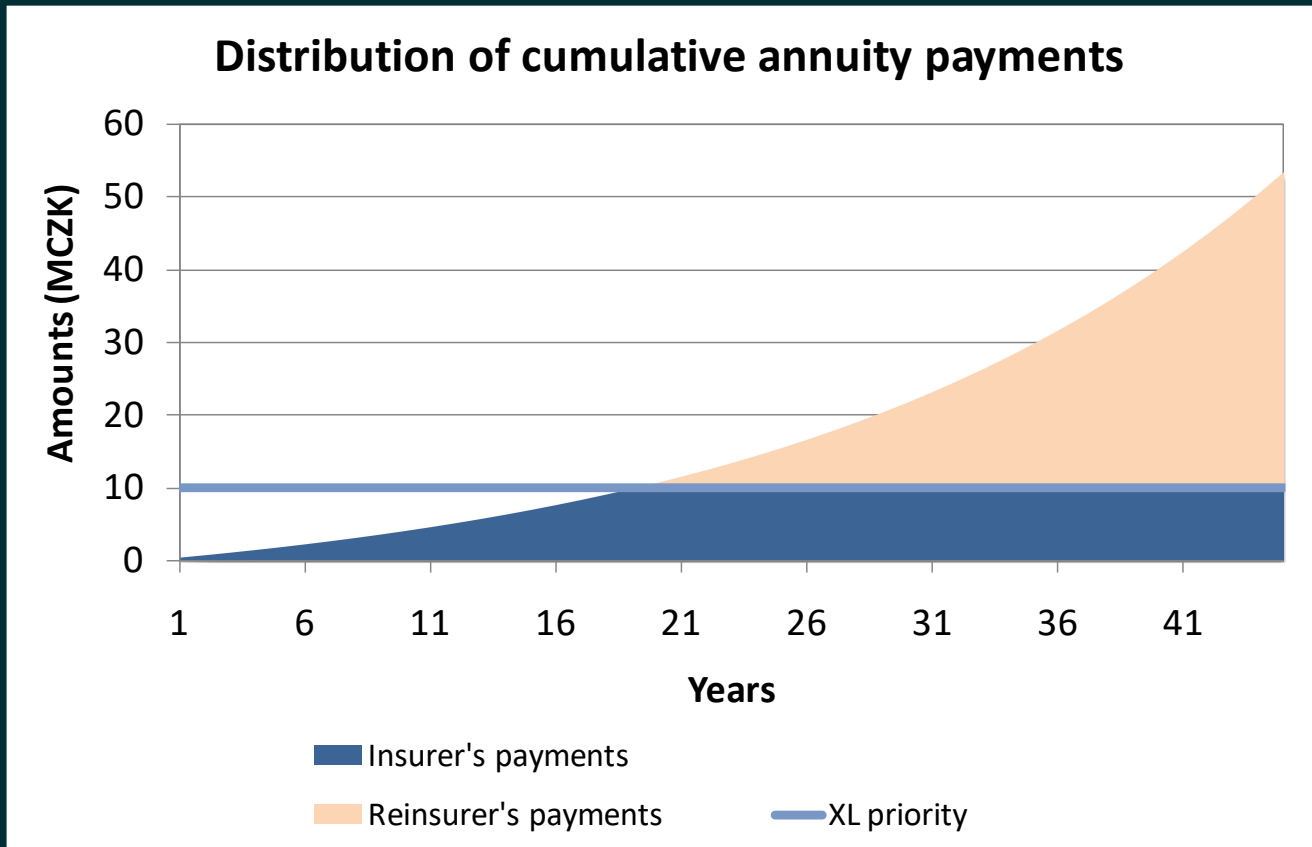
Nominal amounts:

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

Distribution of cumulative annuity payments

Amounts (MCZK) — Years

Legend:
- Insurer's payments
- Insurer's payments due to indexation
- Reinsurer's payments
- XL priority
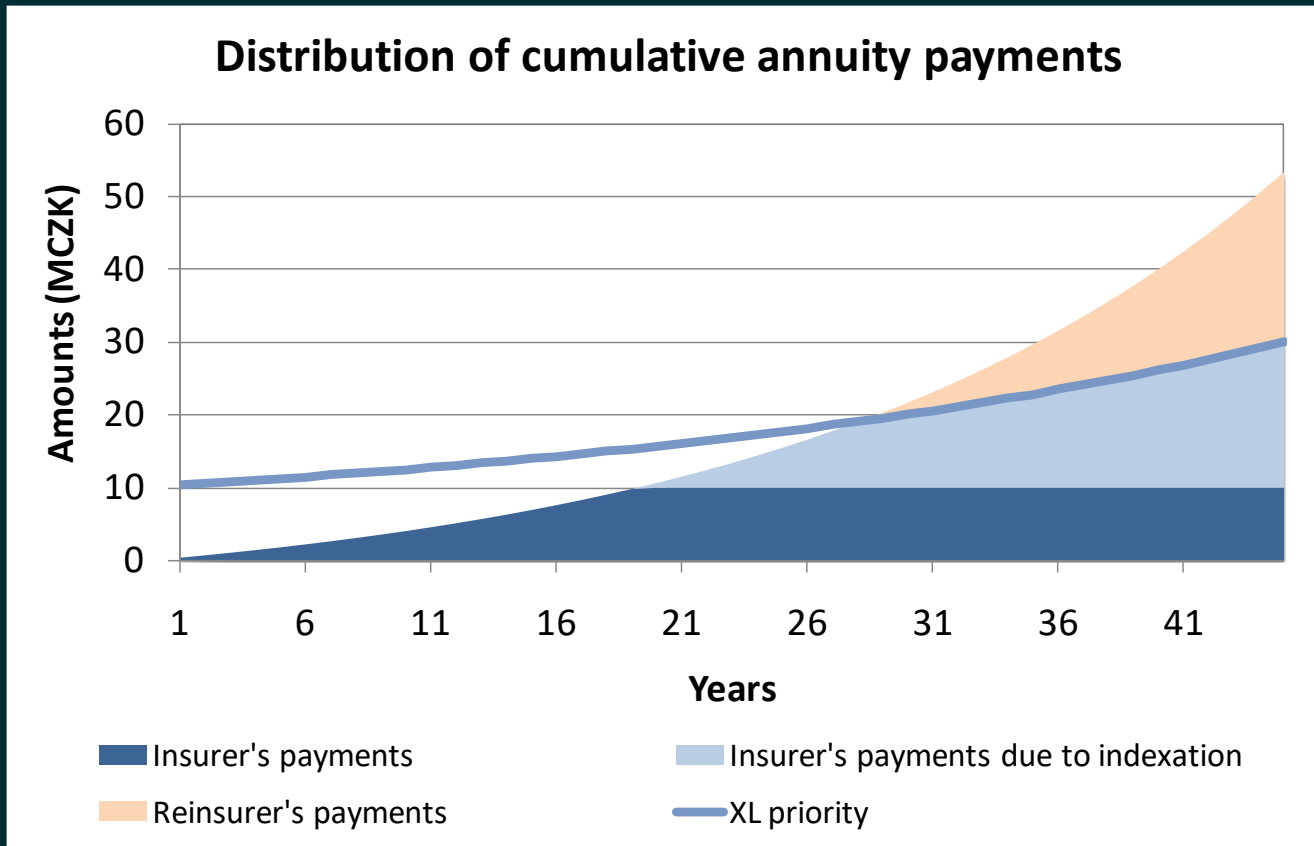
Nominal amounts:

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

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Assumptions - significance

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

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Děkujeme Vám za pozornost.

Zdenek Roubal   Kamil Žák

zdenek.roubal@ceskapojistovna.cz   kamil.zak@cpp.cz

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Česká společnost aktuárů

www.actuaria.cz