Přístup k interním modelům v pojišťovnách

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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?
Internal model definition

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
STAGE 1: Model origination

1. Business case
   • Project Request Form
   • Request for Modeling Simplification

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

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

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

STAGE 2: Design

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

STAGE 3: Implementation

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

6. Translation Validation
   • Translation Validation report
   • Findings documented

7. Deployed
   • Deployment
   • Calibration
   • Back-testing
   • Update monitoring dashboard
   • Document model review
   • Update issue log

8. Use, monitor & review model
   • Remediation validation
   • Findings documented

STAGE 4: Use & Review

9. Periodical Validation
   • Periodical Validation report
   • Findings documented

10. Ready for use
    • Deploy changes
    • Documentation assembled

Model Change (Large/Significant)

Model Change (Small/Medium)

REMEDIATE

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
▲ ...

SAV – 27.3.2015
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
Internal Model Rules

- Rule #1
  - GIGO

- Rule #2
  - Model is a model is a model is a model ...
  - Precision
  - Runtime
  - Reliance
The Internal Models in Non-life Insurance

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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.

In the slides we are using presentation by Chris Daykin delivered at 39th ASTIN Colloquium, Helsinki, 2009.
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.
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.
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
Canada
Dynamic Capital Adequacy Testing (DCAT)
- Scenario testing rather than stochastic simulation.

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.

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

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 towards Solvency II

- Collective theory of risk
- Cash-flow modelling using simulation
- Stochastic internal models
- Comprehensive ERM models
- Solvency I
- Dynamic solvency testing
- Financial condition reporting
- Solvency II Internal models
- Balance sheet approaches to solvency
- ERM process

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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 non life 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
- Premium and CAT risk, reserve risk

Expense risk
- Premium and CAT risk, reserve risk
- Market 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:

\[ SCR_{nl, prem \ res} = 3 \cdot \sigma_{nl} \cdot V_{nl} \]

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

\[ \sigma_{nl} = 1/V_{nl} \cdot \sqrt{\sum_{s,t} CorrS_{s,t} \cdot \sigma_{s} \cdot V_{s} \cdot \sigma_{t} \cdot V_{t}} \]

\( \sigma_{s} \) ... 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
Standard formula in SII

▲ More risk sensitive than the current regime

▲ 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
  ▲ 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
  ▲ 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 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 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

Loss of earnings (state pension subtracted)
Care costs
Loss of income of surviving dependents
Health care
Social status compensation
Pain and suffering
Material damage
Other

Regularly paid

Till the age of the attribution of old age pension
Whole life / if necessary
Depends on the age of children / wife / deceased
Can be even whole life
Court decision
Relatively immaterial

Lump sum payments

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

Distribution of cumulative annuity payments:
- Insurer's payments
- Insurer's payments due to indexation
- Reinsurer's payments
- XL priority
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
- Severity of lump sum payments
- Financial rates
- Payout pattern of lump sum payments
- Existence and severity of the care cost
- Severity of annuity component
- Correlations
- Probability of partial disability
- Culpability
- Material damage
- Sex of the injured
- Probability of partial disability
Děkuji za pozornost,
Zdeněk Roubal