Independent assessment of technical provisions according to Czech legislation

Nezávislý pohľad na technické rezervy poisťovní podľa českej legislatívy

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pwc

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3. Case reserves in Health and Non-life portfolios
4. Proposed tax legislation – change in tax base for technical provisions
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Introduction

What is this presentation about

This presentation will provide you with information about hot topics discussed during statutory audit procedures in actuarial field:

Independent assessment of liability adequacy test (LAT) for life portfolio

Case reserves from external point of view

Overall actuarial audit of technical reserves in the Czech Republic

Audit of insurance companies and involvement of actuaries

Core audit

Audit partner and statutory auditor, audit managers and assistants take responsibility of overall audit engagement

Treasury

Involved in re/valuation of financial instruments (assets and liabilities)

Actuary

Involved in re/valuation of technical provisions and review of actuarial processes

IT

Risk assurance of IT infrastructure

Taxes

Corporate income tax return

Financial statements

Review of financial statements:

Statement of financial position

Statement of profit and loss

Statement of cash flow

Notes and disclosures to financial statements

Audit opinion

Audit documentation

To support assertions

- Occurrence & existence
- Completeness
- Accuracy
- Cut-off
- Rights and obligations
- Classification
- Presentations

from *ISA 315*

Actuarial valuation

Technical provisions revaluation under different reporting / accounting frameworks

Models validation

Methodology review

Adequacy tests

Review of financial statements and disclosures

Risk management

ORSA process

Risk appetite

Capital adequacy

External review

Public audit oversight board – external body

Quality review

ISA540 Auditing accounting estimates

Auditing Requirements

- Specialists vs Experts
- “reasonable estimate” vs “within a range of reasonable best estimates”

Vyhláška č. 502/2002 Sb.
ČÁST ČTVRTÁ - ÚČETNÍ METODY A JEJICH POUŽITÍ

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Technické rezervy

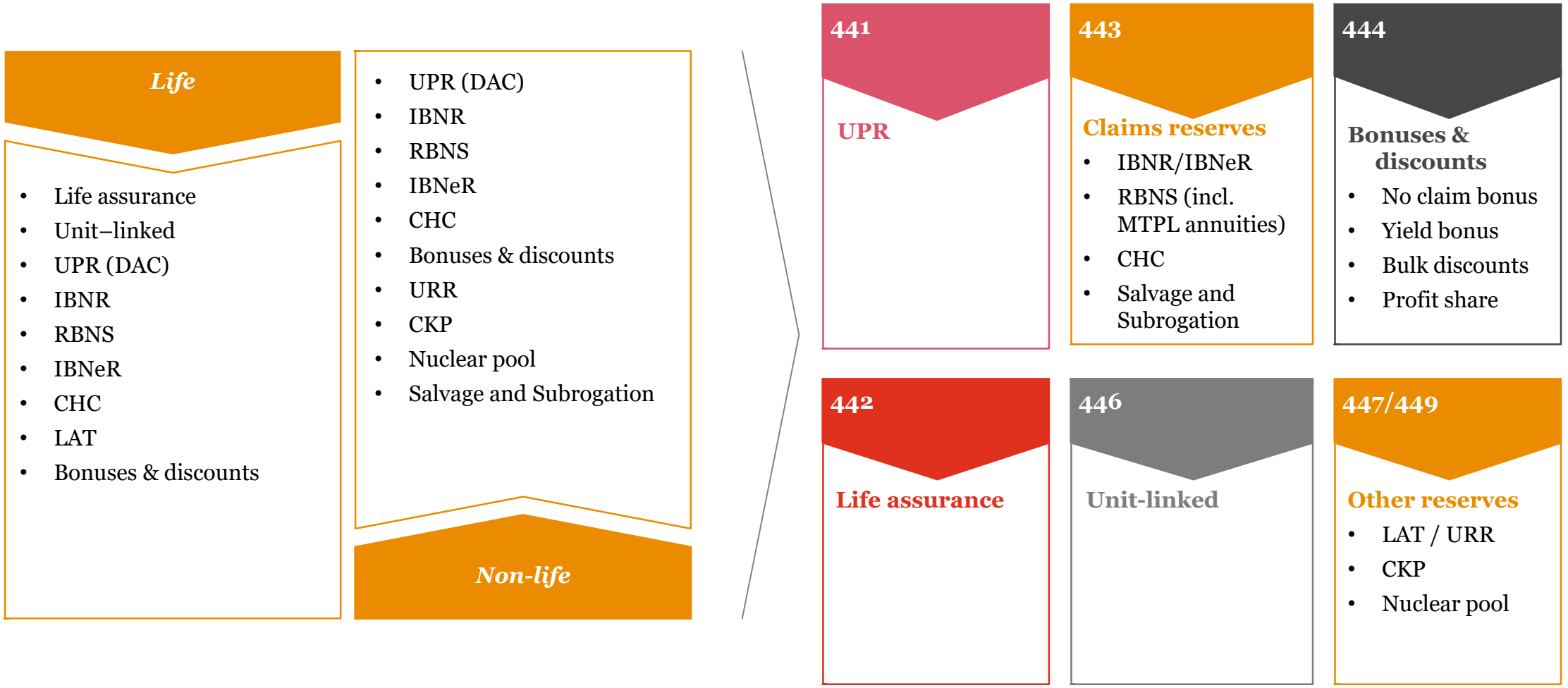
(1) Výše technických rezerv musí být v každém okamžiku dostatečná do té míry, aby pojišťovna byla schopna dostát svým závazkům, vyplývajícím z pojistných smluv, které lze rozumně předpokládat.

(2) Výpočet technických rezerv se provádí na základě uznávaných metod pojistné matematiky.

(3) Oceňovací rozdíly u technických rezerv se uvádějí v příslušné položce výkazu zisku a ztráty, ve které se uvádí tvorba nebo použití této rezervy, a v příslušné položce technické rezervy v pasivech.

Accounting reserves of insurance companies under Bill 502/2002 Sb.

Actuarial scope within audit



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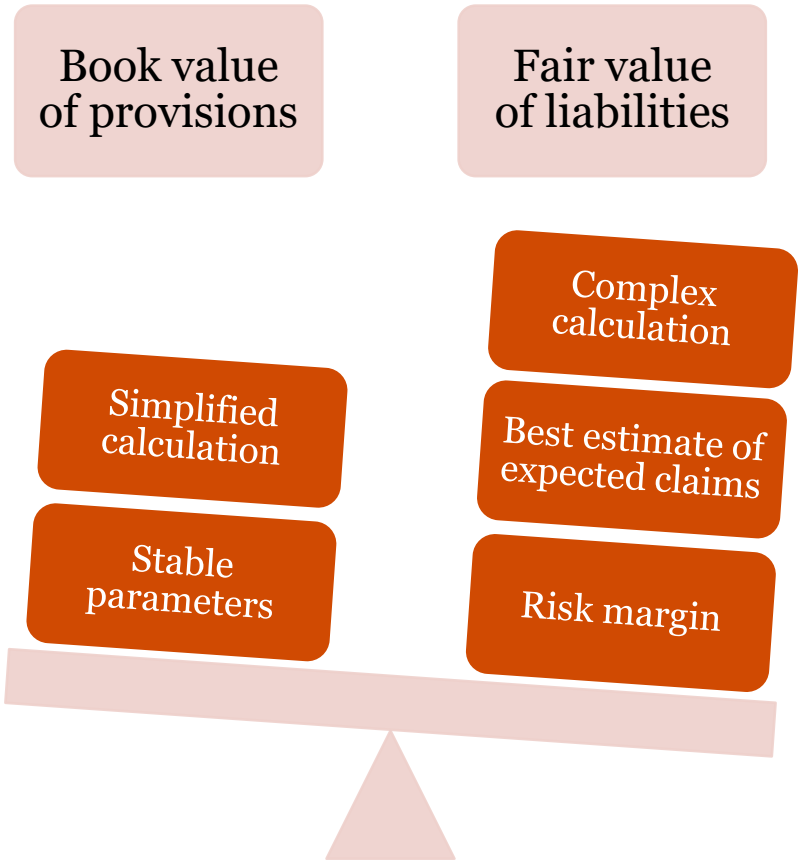
Liability adequacy test of life insurance contracts on Czech market

Test logic


Book value of provisions
Fair value of liabilities
Simplified calculation
Stable parameters
Complex calculation
Best estimate of expected claims
Risk margin

LAT methodology (CZ GAAP and IFRS)

General principle (definitions): "*An assessment of whether the carrying amount of an insurance liability needs to be increased (or the carrying amount of the related deferred acquisition costs or related intangible assets decreased) based on a review of future cash flows.*"

Deficiency reserve (DR)

DR = max(0; PV – Stat Res)

Present value of future cash flows (PV)*;

Statutory reserve (Stat Res);

**Unrealized gains/losses of the related HTM portfolio (UCG/L)*

Segmentation of portfolio

Portfolio A

Portfolio B

⋮

Portfolio XY

Usually divided by type of portfolio, e.g. life with participation, Unit & index link, riders to main policies, etc.

Aggregation of results

aggregated level

(i.e. assessed together)

vs

Non-aggregated level

(i.e. assessed separately)

in a company's general ledger and financial statements, including notes to financial statements.

Statutory reserve (Stat Res) tested in LAT

Sum of accounted value of technical provisions stemming from life portfolio @ valuation date

- Life premium reserve
- Unearned reserve
- Unit & index linked reserve
- Profit share and bonus reserve
- Case reserves*
- Other technical provisions**

less sum of accounted value of intangible assets stemming from life portfolio @ valuation date

- Deferred acquisition costs (DAC)
- Accumulated debt
- assets booked in a business combination or portfolio transfer**

** not common on CZ market to be included

*case reserves are usually tested for adequacy in run-off test (will be shown);
** not common on CZ market to be included

Important (hidden) implications:

- Testing for Recoverability of intangible assets (e.g. DAC, etc.)
- Testing for Onerous Service Contracts

Present value of future cash flows (PV)

‘based on model of discounted expected future cash flows’

Plus

Income

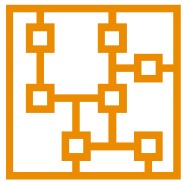
- Expected premium from policyholders
- Expected commission clawback (returns after lapses)
- Investment income

Minus

Outflow

- Paid claims main cover
- Paid claims on riders
- Maturities (if not main cover)
- Surrenders paid (including partial)
- Annuity payments

Minus



Expenses

- Maintenance, initial & investment expenses (fix vs variable)
- Commissions paid to intermediaries
- Change in reserves, DAC, etc.

Assumptions

- Contract boundaries
- Best estimate (BE) assumptions, Market value margins (risk adjustment)

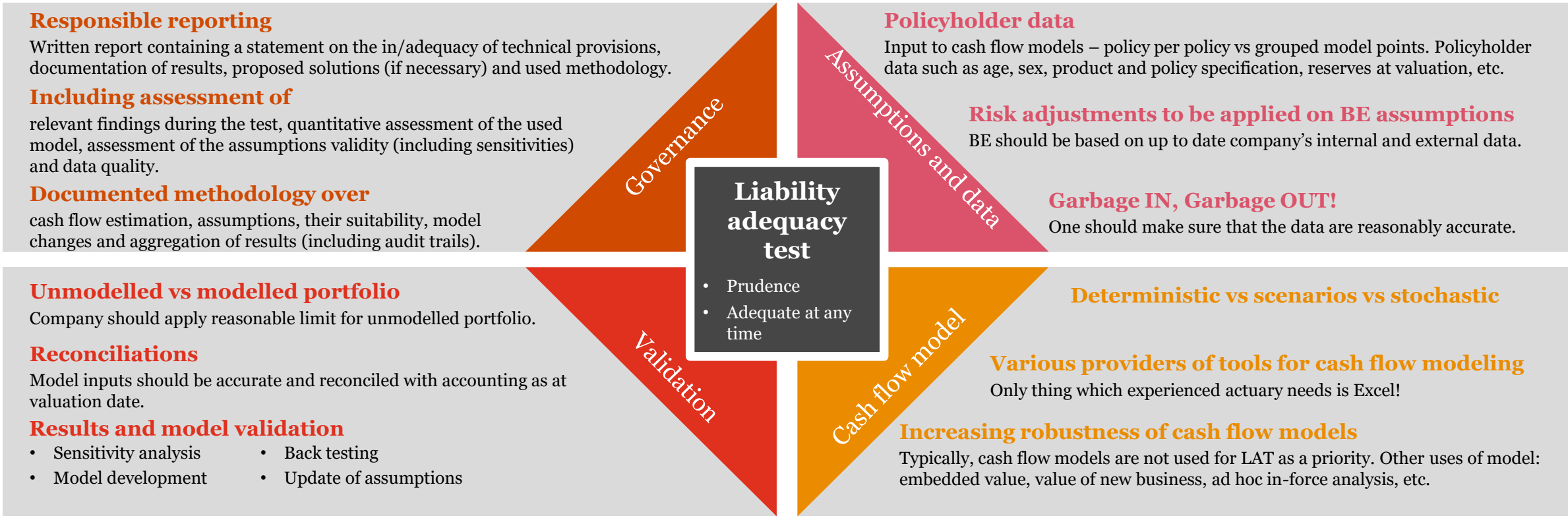
1. Economic
2. Non-economic

Options & guarantees

- Lump sum vs annuity
- Guaranteed investment income
- Guaranteed TIR for annuity
- Lapses, reductions, temporary waiver of premium, etc…

Life LAT model in a box

Actuarial responsibility



Responsible reporting

Written report containing a statement on the in/adequacy of technical provisions, documentation of results, proposed solutions (if necessary) and used methodology.

Including assessment of

relevant findings during the test, quantitative assessment of the used model, assessment of the assumptions validity (including sensitivities) and data quality.

Documented methodology over

cash flow estimation, assumptions, their suitability, model changes and aggregation of results (including audit trails).

Policyholder data

Input to cash flow models – policy per policy vs grouped model points. Policyholder data such as age, sex, product and policy specification, reserves at valuation, etc.

Risk adjustments to be applied on BE assumptions

BE should be based on up to date company's internal and external data.

Garbage IN, Garbage OUT!

One should make sure that the data are reasonably accurate.

Unmodelled vs modelled portfolio

Company should apply reasonable limit for unmodelled portfolio.

Reconciliations

Model inputs should be accurate and reconciled with accounting as at valuation date.

Results and model validation

- Sensitivity analysis
- Model development
- Back testing
- Update of assumptions

Deterministic vs scenarios vs stochastic

Various providers of tools for cash flow modeling

Only thing which experienced actuary needs is Excel!

Increasing robustness of cash flow models

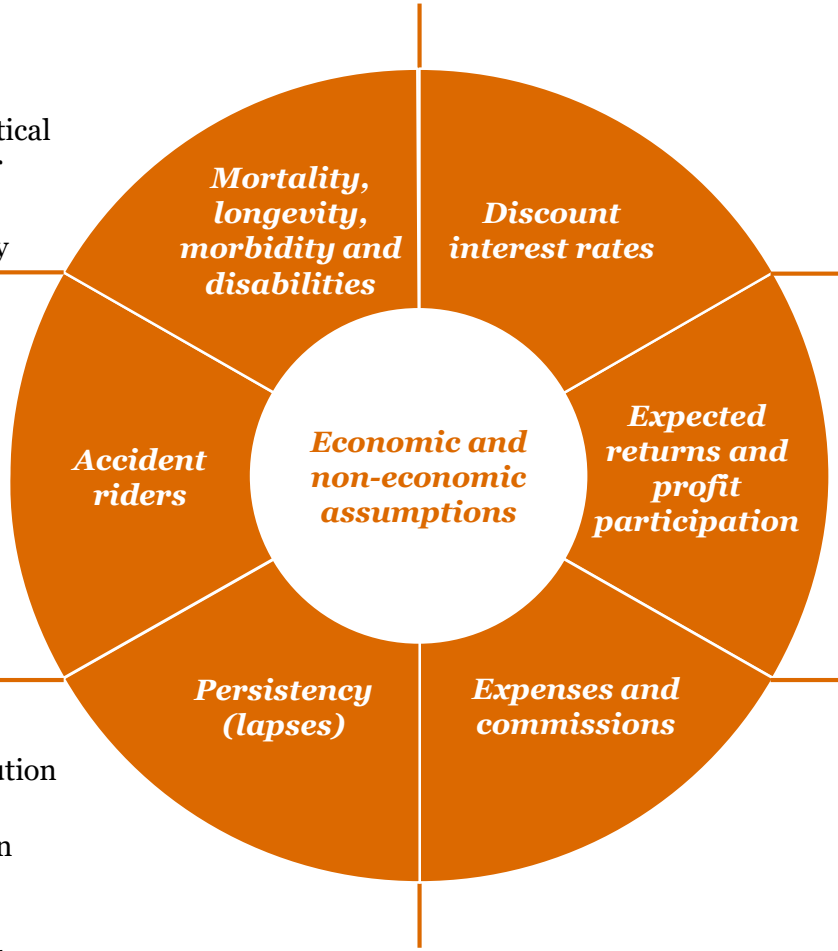
Typically, cash flow models are not used for LAT as a priority. Other uses of model: embedded value, value of new business, ad hoc in-force analysis, etc.

Assumptions (BE)

Regular monitoring

Demographic assumptions
- Portfolio analysis
- Experience ratio: count of real over count of theoretical deaths in selected policy year or policyholder age or overall (average selection coefficient 60 – 70%)
- Potential delays when comparing model with reality

Incidence rates
- Loss ratios estimation
- Comparing theoretical risk premium and benefits paid/incurred
- Portfolio analysis
- Benefits tracking and reporting



Persistency
- Rates by products groups, type of premium distribution channels
- Different approaches used (to be explored) based on portfolio analysis
- Dependent on policy year
- LAT results are usually most sensitive to change in lapses
- Partial withdrawals (usually based on proportion in reserves as %)

Economic assumptions
- Discounting: risk free rates (RFR) – usually derived from government bonds (intra / extrapolation often used)

Future investment return
- Generated by dynamic interaction of the asset and liabilities portfolio
- Reflect unrealized gains/losses (UCG/L) from assets

Profit participation
- Possible investment returns exceeding a guaranteed interest rate (GIR)
- Profits from mortality, expense and surrender usually not distributed to policyholders

Expenses
- Admin expenses - per policy expenses (renewal)
- Based on previous expense experience
- Including expense inflation

Commissions
- Rates by products and/or distribution channels
- Including clawbacks (as income)

Back testing model results!!!
Modelled vs Reality

If difference is relatively high; judgment or explanation is required (usually connected with prospective change in assumptions)

Lapse rates valuation

Method used – based on Kaplan-Meier's estimator of survival function

- A lapse of a policy is considered any termination of an insurance policy due to reasons other than occurrence of the insured random event or policy maturity
- Some observation of policy lapses might be censored due to death or the lapse might not yet be observed by the time of calculation for in-force policies
- Advantage of Kaplan-Meier method for censored data analysis → allows to estimate the survival function of the lapse time and to calculate its confidence intervals

- Kaplan-Meier estimator of survival function

$$\hat{S}(t) = \prod_{u \le t} \left[1 - \frac{\Delta \bar{N}(u)}{\bar{Y}(u)} \right],$$

where

$$\Delta \bar{N}(t) = \sum_{i=1}^{n} (\mathbb{1}(T_i \le t; T_i \le C_i) - \mathbb{1}(T_i < t; T_i \le C_i));$$

$$\bar{Y}(t) = \sum_{i=1}^{n} \mathbb{1}(T_i \ge t; C_i \ge t).$$

- T_i are i.i.d. random variables denoting failure times (lapses); $i = 1, \dots, n$.
- C_i are independent random variables denoting censoring time $i = 1, \dots, n$.

- $\hat{S}(t) = 1 - \hat{F}(t)$, $\hat{F}(t)$ distribution function of time of lapse .
- $\Delta \bar{N}(t)$ represents the number of events (in our application lapses) occurrence at time t.
- $\bar{Y}(t)$ number of observations that are active at time t, i.e observations for which no event occurred and have not been censored.
- CDF associated with estimated survival function can then be used to estimate probabilities of lapses in individual policy years.

Lapse rates valuation

Method used – based on "frequency" of lapses

Simple frequency *analysis*

$$i_{n,monthly} = \frac{Decrem_n - Claims_n}{Count_n - Claims_n}$$

$Decrem_n$ count of all decrements in policy month n

$Claims_n$ count of all decrements in policy month n as a consequence of claim (e.g excluding lapses)

$Count_n$ count of in-force policies at the beginning of policy month n

Weighted frequency *analysis*

$$i_{n,yearly} = \frac{Decrem_n}{Premium_n}$$

$Decrem_n$ sum of premium of all lapsed policies in policy year n

$Premium_n$ sum of premium of all in-force policies in policy year n

- *Usually the weighted average of available history is used to stabilize and update at the same time.*
- *Average weighted by number of policies.*
- *Higher weight put on more recent data in rate.*

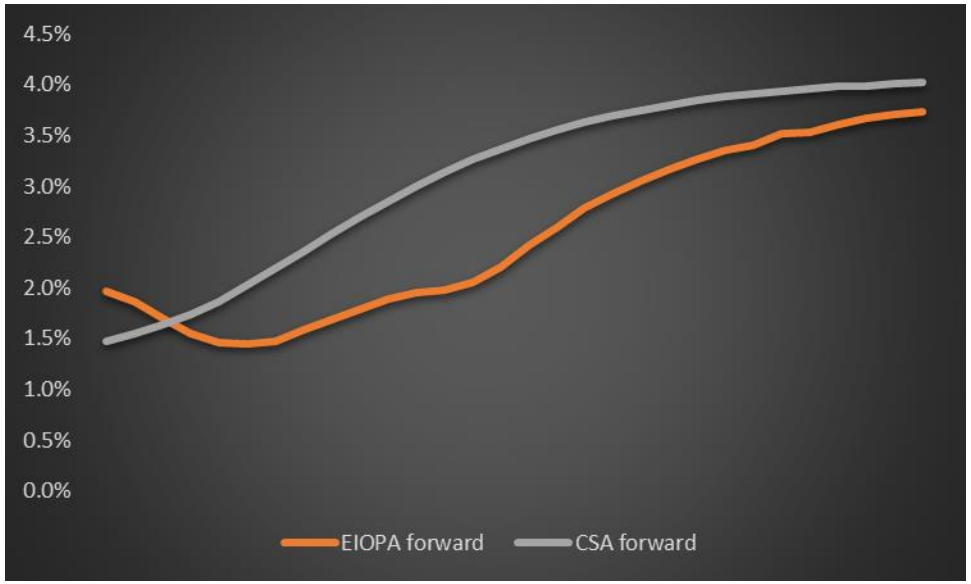
❖ Lapse rates dependent not only on policy year? **Logistic regression**

Risk free rates (RFR)

Market approach

- RFR published by CSA is used in most cases
- EIOPA mainly for Solvency II valuation or as sensitivity
- Own RFR assessment based on externally provided CZ interest rate swaps (from group, bank reports, etc.)
- RFR based on CZ government bonds without smoothing
- Other extrapolation method used: Smith-Wilson, Nelson-Siegel, bootstrap, etc.
- Interpolation in first year (for monthly rates): cubic splines, etc.

RFR published by CSA vs EIOPA 31.12.2018



CSA

- Derived from CZ government bonds
- Nelson-Siegel-Svensson method

EIOPA

- Derived from interest rates swaps, ultimate forward rate, volatility and credit risk adjustment

Term structure models (forward rates)

Nelson–Siegel model

$$y(t) = \beta_1 + \beta_2 \frac{1-e^{\frac{-t}{\lambda}}}{\frac{t}{\lambda}} + \beta_3 \left(\frac{1-e^{\frac{-t}{\lambda}}}{\frac{t}{\lambda}} - e^{\frac{-t}{\lambda}} \right)$$

One should estimate four parameters: $\beta_1, \beta_2, \beta_3$ and λ.

m observed yields with different maturities: $t_1, t_2, \ldots, t_m$.

Regression problem with constraints

$$\beta_1 > 0, \beta_1 + \beta_2 > 0, \lambda > 0.$$

Nelson–Siegel-Svensson model

$$y(t) = \beta_1 + \beta_2 \frac{1-e^{\frac{-t}{\lambda_1}}}{\frac{t}{\lambda_1}} + \beta_3 \left(\frac{1-e^{\frac{-t}{\lambda_1}}}{\frac{t}{\lambda_1}} - e^{\frac{-t}{\lambda_1}} \right) + \beta_4 \left(\frac{1-e^{\frac{-t}{\lambda_2}}}{\frac{t}{\lambda_2}} - e^{\frac{-t}{\lambda_2}} \right)$$

One should additionally estimate two other parameters: β_4 and λ_2.

m observed yields with different maturities: $t_1, t_2, \ldots, t_m$.

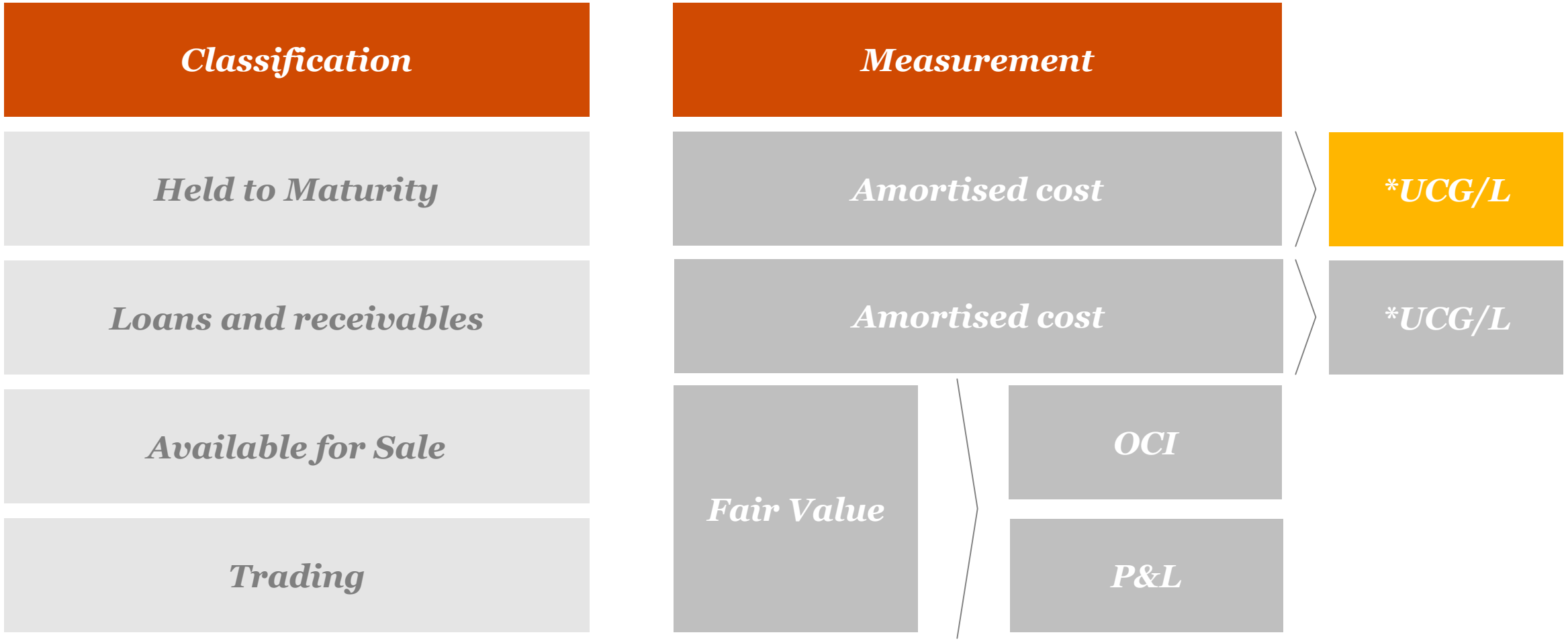
Regression problem with constraints

$$\beta_1 > 0, \beta_1 + \beta_2 > 0, \lambda_1, \lambda_2 > 0.$$

Possible solution: fix λ values (make grid of different values) and run a least squares algorithm to obtain parameter estimates or non-linear regresion

Classification & Measurement of financial assets

of insurance companies under Bill 502/2002 Sb., applicable from 1.1.2018



*off balance sheet items

Risk adjustments (Market value margins)

Recommended by guideline n.3 from Czech Society of Actuaries (CSA)

- To address adverse developments.
- Should be made based on risk analysis and risk appetite given the adequacy of Company's technical provisions.
- If such analysis is not available, one may use provided ones.
- Expert judgment should be applied.
- Selection of decreasing or increasing effect on BE assumptions based on negative impact on fair value of liabilities.

Riziko	Navržená přirážka na nepříznivý vývoj jako % základního předpokladu
Úmrtnost	10 %
Invalidizace, nemocnost	10 %
Rušení pojistných smluv bez výplaty odkupného	25 %
Rušení pojistných smluv s výplatou odkupného	10 %
Náklady	10 %
Nákladová inflace	10 %
Úrokový výnos (použije se pro diskontování peněžních toků a pro projekci budoucích plnění, především podílů na zisku)	25bp (pokud nejistota ve výnosu není již zachycena v časové hodnotě opcí a garancí)

Audit approach

Frequently discussed areas with local insurance companies

Model opinion has two building blocks: **model** & **evidence** assessment.

Methodology review

- Technical reserves methodology documentation;
- Technical documentation on liability adequacy test methodology;
- Management process and model approval;
- Documentation of LAT outcomes with potential further consequences.

To ensure appropriateness of methodology applied.

Assumptions & data review

- Completeness and accuracy of underlaying data;
- Experience analysis;
- Accuracy & completeness of input data;
- Assumption methodology documentation and approval;
- Impacts of potential changes in assumptions.

To ensure up to date data and best estimate assumptions are applied.

Cash flow model validation on a policy level

- Instead of full cash flow on whole portfolio;
- Recalculation of all relevant model formulas;
- Consistency with required regulation;
- Input data quality.

To ensure reasonability of cash flow construction.

Validation, reporting and use of results

- Transparency with accounted figures;
- Trends in cash flows should be relatively stable if no model change occurred;
- Sensitivity analysis;
- Reliability of model should be back tested (expectation vs reality).

To ensure stability of results.

Requirements on disclosure of life LAT assessment

Differs based on underlying accounting principles

Bill 502/2002 Sb.

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(1) *Účetní jednotka v příloze v účetní závěrce uvede alespoň informace*

- ***e)*** *k položce "C.6. Ostatní technické rezervy" o výši těchto rezerv, je-li významná, jednotlivě,*
- ***n)*** *o použitých metodách výpočtu jednotlivých technických rezerv,*

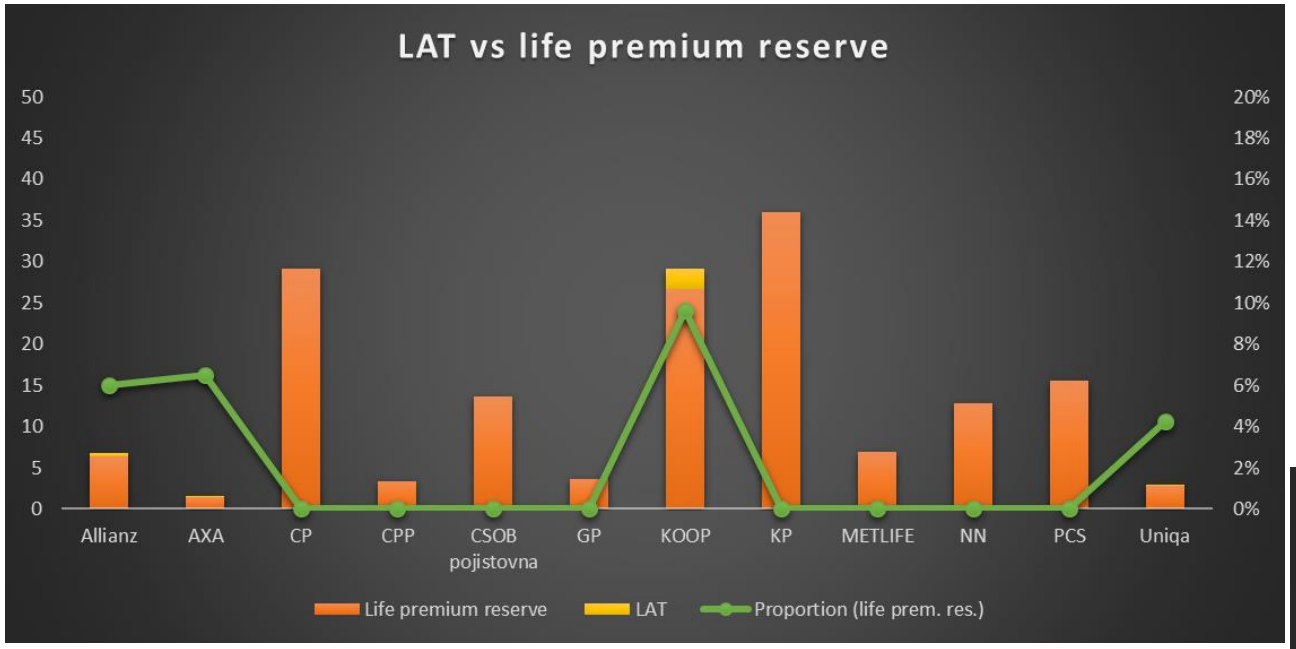
  - similar disclosure within CZ market;
  - short methodology description.

IFRS 4 disclosure

- *An insurer shall disclose information that identifies and explains the amounts in its financial statements arising from insurance contracts, e.g.:*

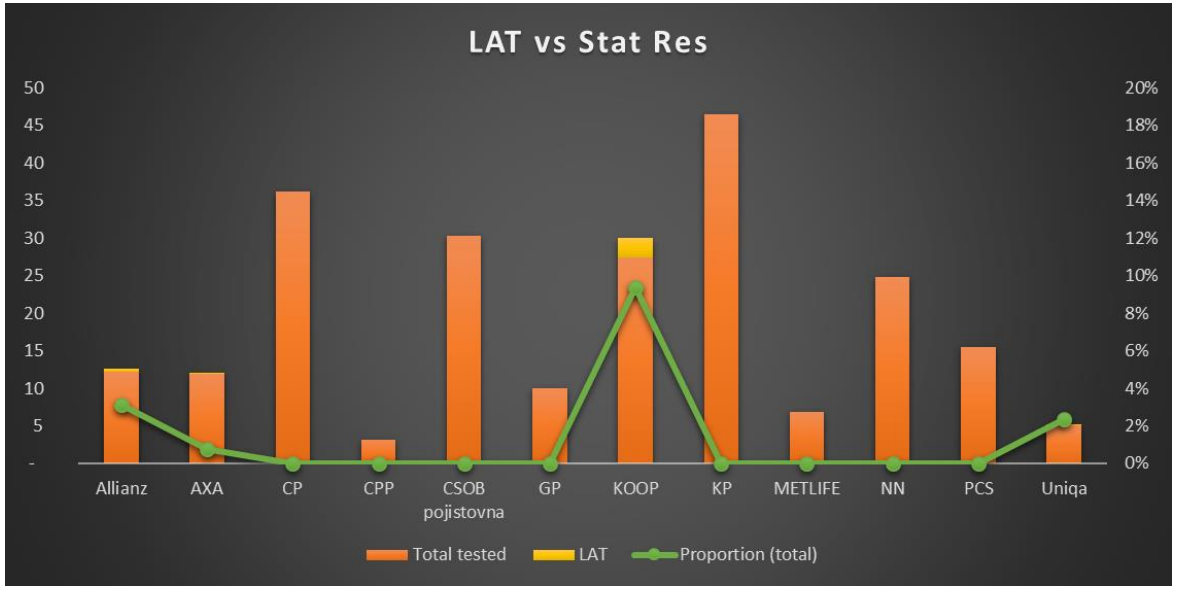
  - its accounting policies for insurance contracts and related assets, **liabilities**, income and expense;
  - the process used to **determine the assumptions** that have the greatest effect on the measurement of the recognized amounts (if practicable, also quantified disclosure of those assumptions);
  - the **effect of changes in assumptions** used to measure insurance assets and insurance liabilities.

Market overview



- Comparison of booked life additional adequacy reserves stemming from life portfolio with life premium reserves in company's balance sheets
- Mostly stemming from traditional contracts with high TIR
- Impact of segmentation and aggregation
- More loss making contracts potentially shown under IFRS 17

- Comparison of booked additional adequacy reserves stemming from life portfolio with life technical reserves less intangible assets in company's balance sheets (as presented at the beginning)
- CZ GAAP: create additional reserve while there is still DAC balance
- IFRS: firstly impair intangible assets and then create additional reserve in value of remaining deficiency



Data downloaded from available external annual reports (2018) of selected insurance companies

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Case reserves in Health and Non-life portfolios

Standard actuarial methods for IBNR valuation

Concept of methods used to evaluate BE of claims reserves

Distance = 600 km
Speed= 200 km/h

→ Expected time of travel b/w points A and B = 3 h

A **B**

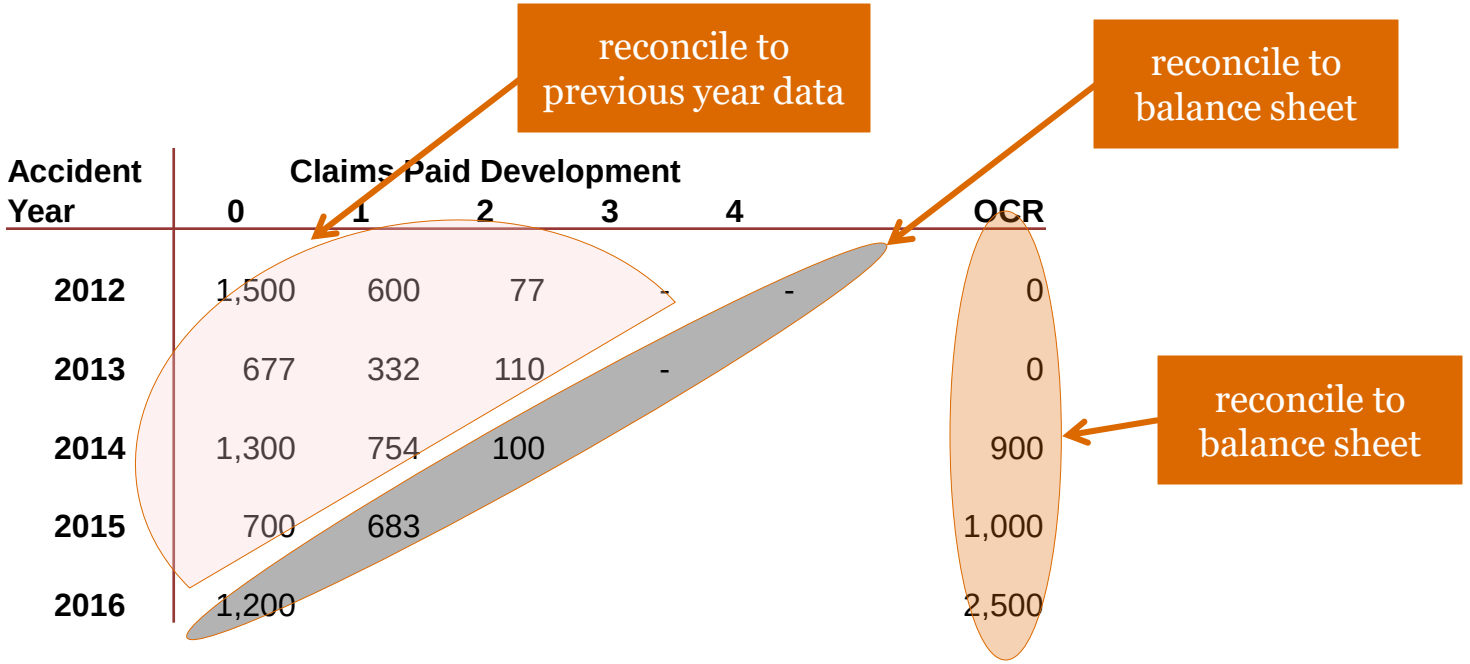
Because of bad weather, when the train has reached the midpoint between A and B, it turns out that the actual speed was 150 km/h. How long would it take the train to reach point B?

Method	Comments	Expected time of travel
Chain ladder	Credibility factor = 100%	600/150 = 4 h
Expected losses	Credibility factor = 0%	3 h
BF	Taking into account the actual experience and the initial expectation	3 h 30 m

Data and its impact on loss reserving

Data checks

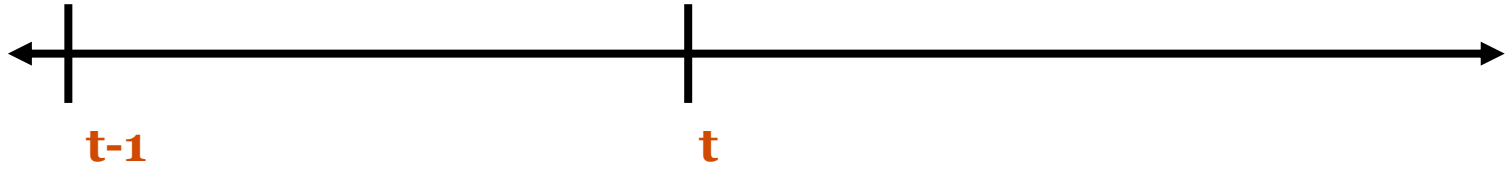
- Reconciliation/ random checks/ logical checks
- First step in audit procedures



Run-off

Quality of claims reserving vs target run-off in practice

- **Back-testing (LAT)** **vs.** **LAT (future projection)**



(D): RBNS run-off result = (A) – (B) – (C); as at 31.12.201X:

- (A): RBNS as at 31.12.201X-1
- (B): Claims paid in 201X, reported in 201X-1 or sooner
- (C): RBNS as at 31.12.201X for claims reported in 201X-1 or sooner

Often expressed as a % of opening reserve.

(E): IBNR run-off result = (A) – (B) – (C) – (D); as at 31.12.201X:

- (A): IBNR as at 31.12.201X-1
- (B): Claims paid and reported in 201X, incurred in 201X-1 or sooner
- (C): RBNS for claims reported in 201X, incurred in 201X-1 or sooner
- (D): IBNR as at 31.12.201X for claims incurred in 201X-1 or sooner

Disclosures

Accounting run-off

Pojistné odvětví	2018
Pojištění motorových vozidel	-16 176
Pojištění motorových vozidel – odpovědnosti	403 828
Pojištění požáru a jiných majetkových škod	72 914
Pojištění odpovědnosti	23 572
Úrazové a zdravotní pojištění	-433
Životní pojištění	38 205
Cestovní pojištění	10 709
Ostatní	5 703
Celkem	**538 322**

	2018
RBNS	6 963 367
IBNR	1 957 962
Celkem	**8 921 329**

Pojistné odvětví	2018
Pojištění motorových vozidel	4 470
Pojištění odpovědnosti za újmu způsobenou provozem vozidla	302 160
Pojištění průmyslu	89 563
Pojištění podnikatelů	156 564
Pojištění majetku obyvatelstva	24 939
Cestovní pojištění	4 099
Ostatní	0
Celkem	**581 794**

Pojistné odvětví	2018
Úrazové pojištění	166 856
Zdravotní pojištění	8 927
Pojištění motorových vozidel – Kasko	56 135
Pojištění přepravy	8 188
Pojištění požáru a jiných majetkových škod	40 869
Pojištění motor. vozidel – odpovědnosti	55 293
Všeobecné pojištění odpovědnosti	8 147
Pojištění přerušení provozu	3 517
Pojištění právní ochrany	50
Cestovní pojištění	24 079
Insolvence, kauce	1 121
Celkem	**373 182**

	2018
RBNS	2,920,243
IBNR	813,553
Total	**3,733,796**

	2018
RBNS	4 070 192
IBNR	1 272 988
Celkem	**5 343 180**

	2018
RBNS	12 022 152
IBNR	2 610 094
Celkem	**14 632 246**

Pojistné odvětví	2018
Pojištění motorových vozidel – odpovědnosti	708 527
Pojištění motorových vozidel – ostatní druhy	73 660
Pojištění proti požáru a jiným majetkovým škodám	- 37 419
Pojištění odpovědnosti za újmu	138 755
Ostatní	26 807
Celkem	**910 330**

*Annual reports Kooperativa poj., Allianz poj., Uniqa poj., ČPP.

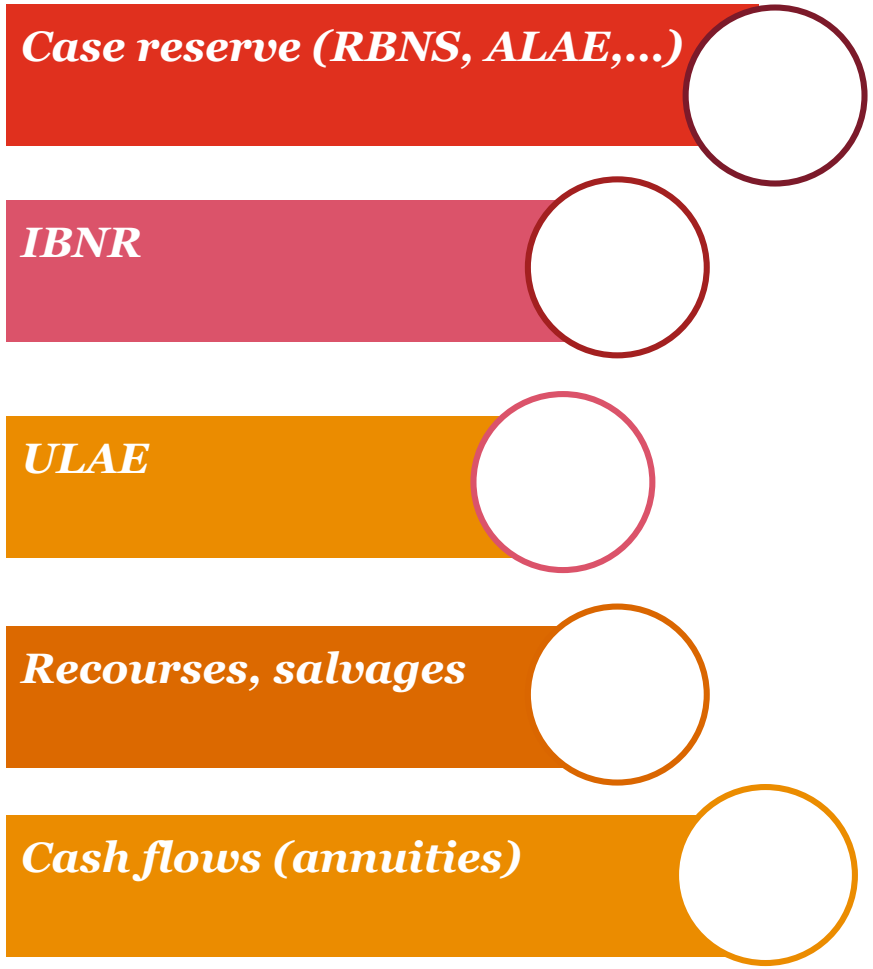
Disclosures

Run-off per accident years

V milionech Kč, k 31. prosinci 2018	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Celkem
Odhad kumulované hodnoty pojistných událostí ke konci škodního roku	13 113	15 228	11 532	11 536	12 090	10 539	10 139	10 784	11 190	11 673	
Za 1 rok	12 978	15 079	10 899	11 447	11 672	10 724	9 828	10 408	11 285		
Za 2 roky	12 835	14 927	10 756	11 178	11 326	10 251	9 534	9 893			
Za 3 roky	12 654	14 605	10 465	10 898	11 115	10 013	9 171				
Za 4 roky	12 420	14 073	10 143	10 427	10 561	9 548					
Za 5 let	12 195	13 966	9 976	10 262	10 448						
Za 6 let	12 100	13 754	9 825	10 126							
Za 7 let	11 967	13 670	9 695								
Za 8 let	11 891	13 635									
Za 9 let	11 858										
Odhad kumulované hodnoty pojistných událostí	**11 858**	**13 635**	**9 695**	**10 126**	**10 448**	**9 548**	**9 171**	**9 893**	**11 285**	**11 673**	**107 332**
Kumulované výplaty pojistných událostí	11 609	13 296	9 254	9 655	10 027	8 757	7 992	8 530	8 533	6 406	94 059
Přijatá zajištění											1 295
Rezervy na pojistná plnění nezahrnuté ve škodním roce											1 495
Částka vykázaná ve výkazu o finanční situaci	**249**	**339**	**441**	**471**	**421**	**791**	**1 179**	**1 363**	**2 752**	**5 267**	**16 063**

*Annual report Česká pojišťovna

Projection techniques



Case-by-case	Basic chain ladder (DFM)	Mack chain ladder
Average cost per claim	Expected Loss ratios	Bornhuetter-Ferguson
Cape cod	Frequency severity	Bootstrap

Mack chain ladder (CHL)

Distribution free model (does not require assumptions on distribution)

Background:

- $X_{i,j}$ paid claims in development year j with accident year i, n # periods;

$$C_{i,j} = \sum_{k=1}^{j} X_{i,k};$$

- $C_{i,j}$ random variable, observations for $\mathbf{i + j \leq n + 1}$;
- R_i claims reserve $\mathbf{i = 2, \dots, n}$ (assuming no tail)

$$R_i = C_{i,n} - C_{i,n+1-i};$$

$$D_n = \{X_{i,j} : i + j \leq n + 1\}.$$

Assumptions:

- $\{C_{i,1}, \dots, C_{i,n}\}$ independent for different $\mathbf{i}$.
- $E[C_{i,j+1} | C_{i,1}, \dots, C_{i,j}] = f_j C_{i,j};$
- $\mathbf{Var}[C_{i,j+1} | C_{i,1}, \dots, C_{i,j}] = \sigma_j^2 C_{i,j};$

$$\mathbf{2 \leq i \leq n; 1 \leq j \leq n - 1.}$$

Characteristics:

$$E[C_{i,n} | D_n] = C_{i,n-i+1} f_{n-i+1} \cdots f_{n-1};$$

Uncorrelated & unbiased estimators

$$E[\hat{f}_{n-i+1} \cdots \hat{f}_{n-1}] = f_{n-i+1} \cdots f_{n-1};$$

$$for\ i = 2, \dots, n.$$

Model:

$$\hat{f}_j = \frac{\sum_{i=1}^{n-j} C_{i,j+1}}{\sum_{i=1}^{j} C_{i,j}};$$

$$\hat{\sigma}_j^2 = \frac{1}{n - j - 1} \sum_{i=0}^{n-j-1} C_{i,j} \left(\frac{C_{i,j+1}}{C_{i,j}} - \hat{f}_j \right)^2;$$

$$\hat{C}_{i,n} = C_{i,n-i+1} \hat{f}_{n+1-i} \cdots \hat{f}_{n-1};$$

$$E[\hat{C}_{i,n}] = E[C_{i,n}];$$

$$\hat{R} = \sum_{i=2}^{n} \hat{C}_{i,n} - C_{i,n+1-i};$$

$$\mathbf{2 \leq i \leq n; 1 \leq j \leq n - 1.}$$

Mack CHL

Mean square error of prediction (MSEP) of $\widehat{C}_{i,n}$ ($\widehat{R}_i$) given D_n

$$msep_{C_{i,n}|D_n}\left(\widehat{C}_{i,n}\right) = E\left[\left(\widehat{C}_{i,n} - C_{i,n}\right)^2 | D_n\right] =$$

$$Var\left(C_{i,n}|D_n\right) + \left(\widehat{C}_{i,n} - E\left[C_{i,n}|D_n\right]\right)^2$$

Conditional Process Variance

$$\widehat{Var\left(C_{i,n}|D_n\right)}$$
$$= C_{i,n-i+1} \sum_{s=n-i+1}^{n-1} \hat{f}_{n-i+1} \cdots \hat{f}_{s-1}\, \hat{\sigma}_s^2\, \hat{f}_{s+1}^2 \cdots \hat{f}_{n-1}^2$$

Conditional estimation error (coming from the fact that f_j are estimated by $\hat{f}_j$)**.**

$$\left(\widehat{C}_{i,n} - \widehat{E\left[C_{i,n}|D_n\right]}\right)^2$$
$$= C_{i,n-i+1}^2 \sum_{s=n-i+1}^{n-1} \frac{\hat{f}_{n-i+1}^2 \cdots \hat{f}_{s-1}^2 \hat{\sigma}_s^2\, \hat{f}_{s+1}^2 \cdots \hat{f}_{n-1}^2}{\sum_{j=2}^{n-s} C_{j,s}}$$

Estimator of conditional variance of $\widehat{C}_{i,n}$ (ultimate claims)

$$\widehat{msep_{C_{i,n}|D_n}\left(\widehat{C}_{i,n}\right)} = \widehat{C}_{i,n} \sum_{s=n-i+1}^{n-1} \frac{\hat{\sigma}_s^2}{\hat{f}_s^2}\left(\frac{1}{\widehat{C}_{i,s}} + \frac{1}{\sum_{j=2}^{n-s} C_{j,s}}\right)$$

Estimator of conditional variance of $\sum_{i=1}^{n} \widehat{C}_{i,n}$ (sum of ultimate claims)

$$\widehat{msep}_{\sum C_{i,n}|D_n}\left(\sum_{i=1}^{n} \widehat{C}_{i,n}\right) = E\left[\left(\sum_{i=1}^{n} \widehat{C}_{i,n} - \sum_{i=1}^{n} C_{i,n}\right)^2 | D_n\right]$$

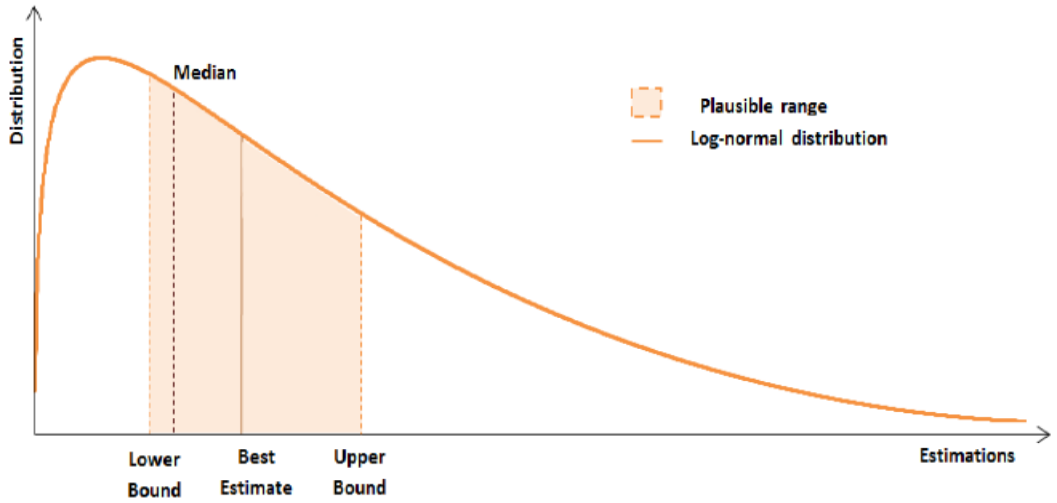
Link between MSEP of $\widehat{C}_{i,n}$ and $\widehat{R}_i$

$$msep_{C_{i,n}|D_n}\left(\widehat{C}_{i,n}\right) = msep_{C_{i,n}|D_n}\left(\widehat{R}_i\right)$$

Mack CHL in claim reserving

Distribution assumption for quantiles estimation

Illustrative example



Chain ladder package in R:

- Quantiles: Cornish-Fisher expansion to approximate the distribution of provision based on mean, standard deviation and skewness.
- Tends to fail when estimating skewness (in case when first periods fully developed).

How to use estimators to calculate higher quantiles (using estimator by moments method):

$$\boldsymbol{R} \sim \boldsymbol{Logn}\,(\mu, \boldsymbol{\sigma}^2)$$

$$\hat{\mu} = \boldsymbol{ln}\left(\widehat{\boldsymbol{R}}\right) - \boldsymbol{ln}\left(\sqrt{\boldsymbol{1} + \widehat{\boldsymbol{msep}}/\left(\widehat{\boldsymbol{R}}\right)^{\boldsymbol{2}}}\right);$$

$$\widehat{\boldsymbol{\sigma}^2} = \boldsymbol{ln}\left(\boldsymbol{1} + \widehat{\boldsymbol{msep}}/\left(\widehat{\boldsymbol{R}}\right)^{\boldsymbol{2}}\right)$$

$$\boldsymbol{R} \sim \boldsymbol{N}\,(\mu, \boldsymbol{\sigma}^2)$$

$$\hat{\mu} = \widehat{\boldsymbol{R}};$$

$$\widehat{\boldsymbol{\sigma}^2} = \widehat{\boldsymbol{msep}}$$

Bootstrap in claim reserving

Prologue

- Simple (distribution free) resampling method
- Even distribution free methods (e.g. chain ladder) only provide a standard deviation of the ultimates/ reserves (or claims development result/runoff result);
- Estimate properties (distribution) of an estimator by sampling empirical distribution.

Idea:

- Random sampling with replacement from the original dataset;
- Theoretical distribution of wanted statistic is complicated or unknown.

In theory:

- resample with replacement from $\boldsymbol{X_{1,1}}, \dots, \boldsymbol{X_{n,1}}$ to obtain $\boldsymbol{X'^{r}_{1,1}}, \dots, \boldsymbol{X'^{r}_{n,1}}$, $\mathrm{r} = 1, \dots, R$.
- Convergence in probability:

$$\widehat{\boldsymbol{R'_i}} - \widehat{\boldsymbol{R_i}} \to \widehat{\boldsymbol{R_i}} - \boldsymbol{R_i} \text{ in probability, } \boldsymbol{n} \to \infty.$$

- How to measure the discrepancy?
- Residuals (proper diagnostics should be used).
- What type of residuals?
- How to scale or standardize residuals?
- It is common to bootstrap the residuals, rather than bootstrap the data themselves.

Bootstrap in claim reserving

Procedure

1) Select actuarial model and predict reserve (get expected values in triangle), e.g. Chain ladder, Over dispersed Poission (ODP) model, etc.

2) Calculate fitted values for observed cumulative triangle
(in case of Chain ladder method used):

$$\widehat{C}_{i,n-i+1} = C_{i,n-i+1}$$

$$\widehat{C}_{i,k-1} = \widehat{C}_{i,k}\,\widehat{f_k}$$

3) Select type of residuals (e.g. Adj. Pearson) $\{r'_{i,j}\}$:

$$r_{i,j}^{P} = \frac{X_{i,j} - \widehat{X}_{i,j}}{\sqrt{\widehat{X}_{i,j}}}$$

$$r_{i,j}^{AdjP} = \sqrt{\frac{n}{\frac{1}{2}n(n+1) - 2n + 1}}\, r_{i,j}^{P}$$

4) Resample obtained residuals R -times -> obtain set of R triangles with bootstrapped residuals (resample with replacement) $\{r_{i,j}^{b}\}, 1 \le b \le R$.

5) Construct back fitted (incremental) triangles with $X_{1,1}'^{b}, \dots, X_{n,1}'^{b}$, in case of use of adjusted Pearson residuals:

$$X_{i,j}'^{b} = r_{i,j}^{bAdjP}\sqrt{\widehat{X}_{i,j}} + \widehat{X}_{i,j}$$

Bootstrap in claim reserving

Procedure (cont.)

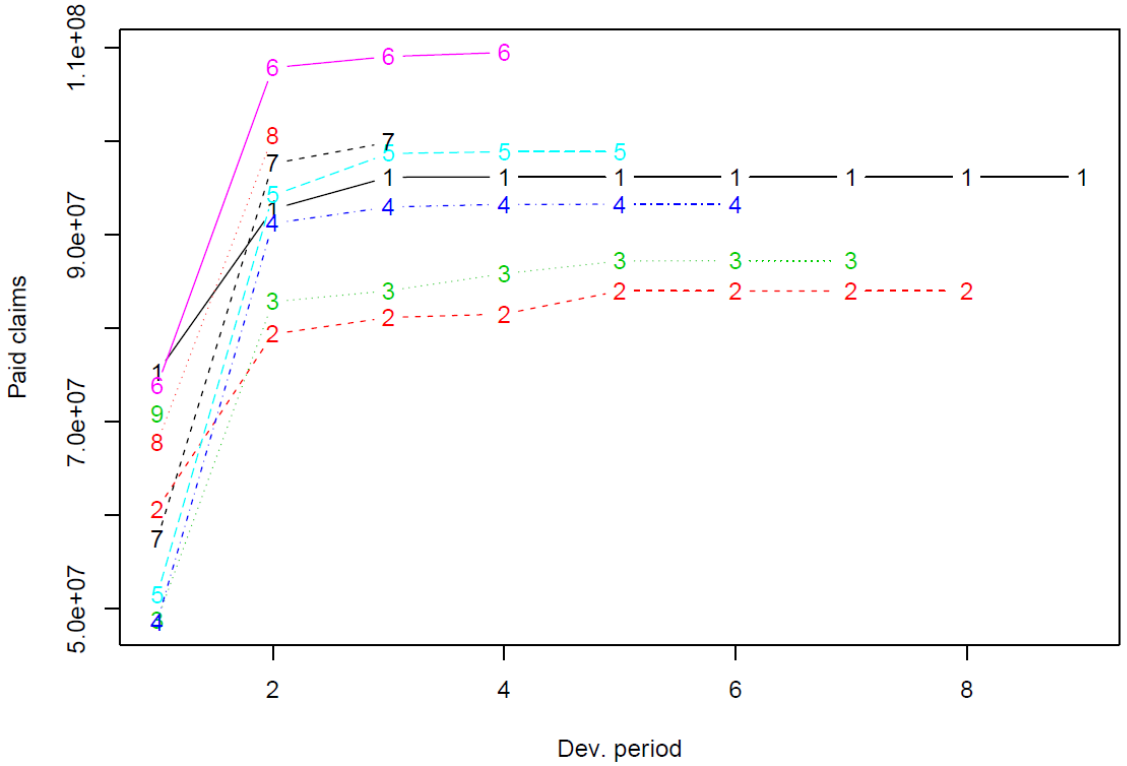
6) Construct pseudo cumulative data of past triangle.
7) Project future periods using selected actuarial method for each bootstrapped triangle and calculate individual reserve (***R*** -times), e.g. Chain Ladder, etc.
8) Estimate empirical distribution of size ***R*** for the reserve (empirical mean, standard error, quantiles, etc.).

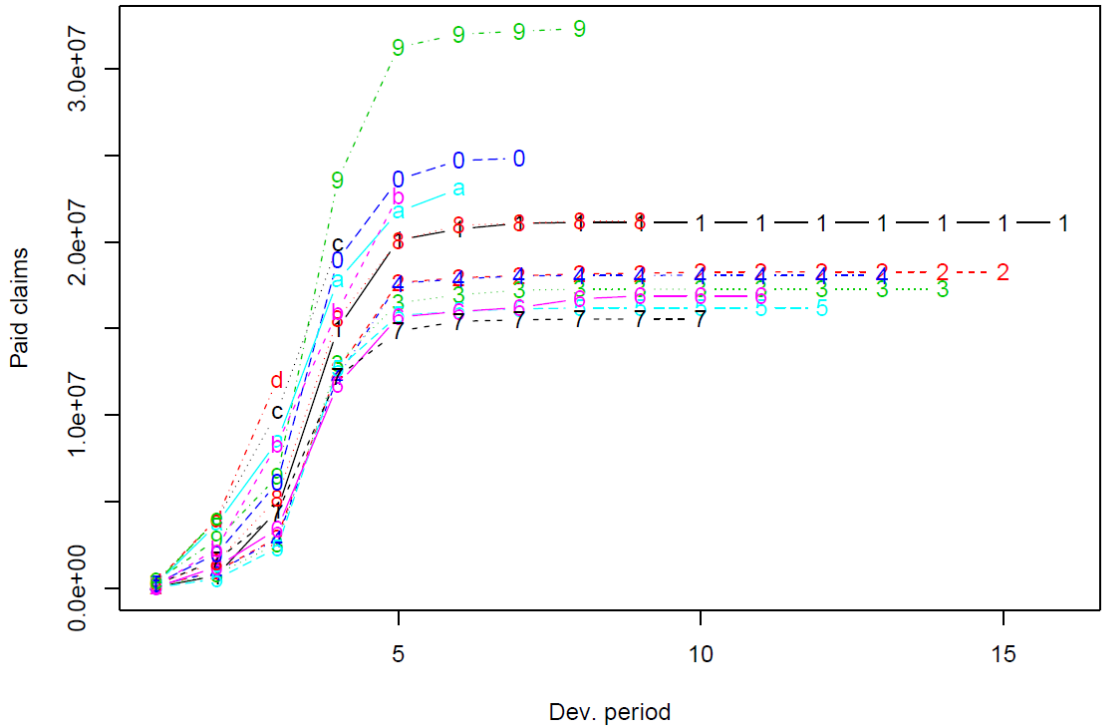
Why to use bootstrap?

- *Unknown or complicated theoretical distribution*
- *Provides not only moment characteristics*
- *No additional assumptions needed*
- *Provides empirical distribution*

Bootstrap vs Mack CHL in claim reserving

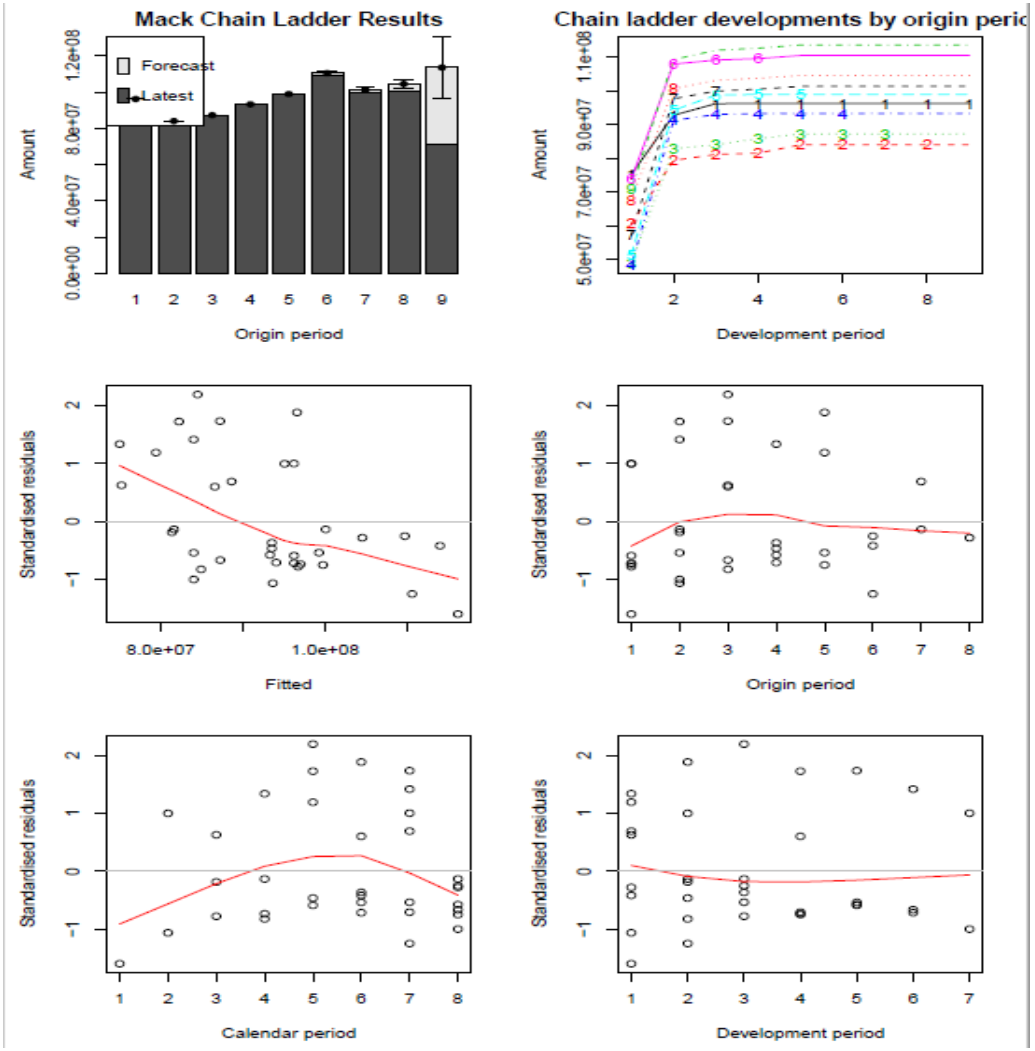
Case study (non-life portfolio claims vs claims in health insurance)



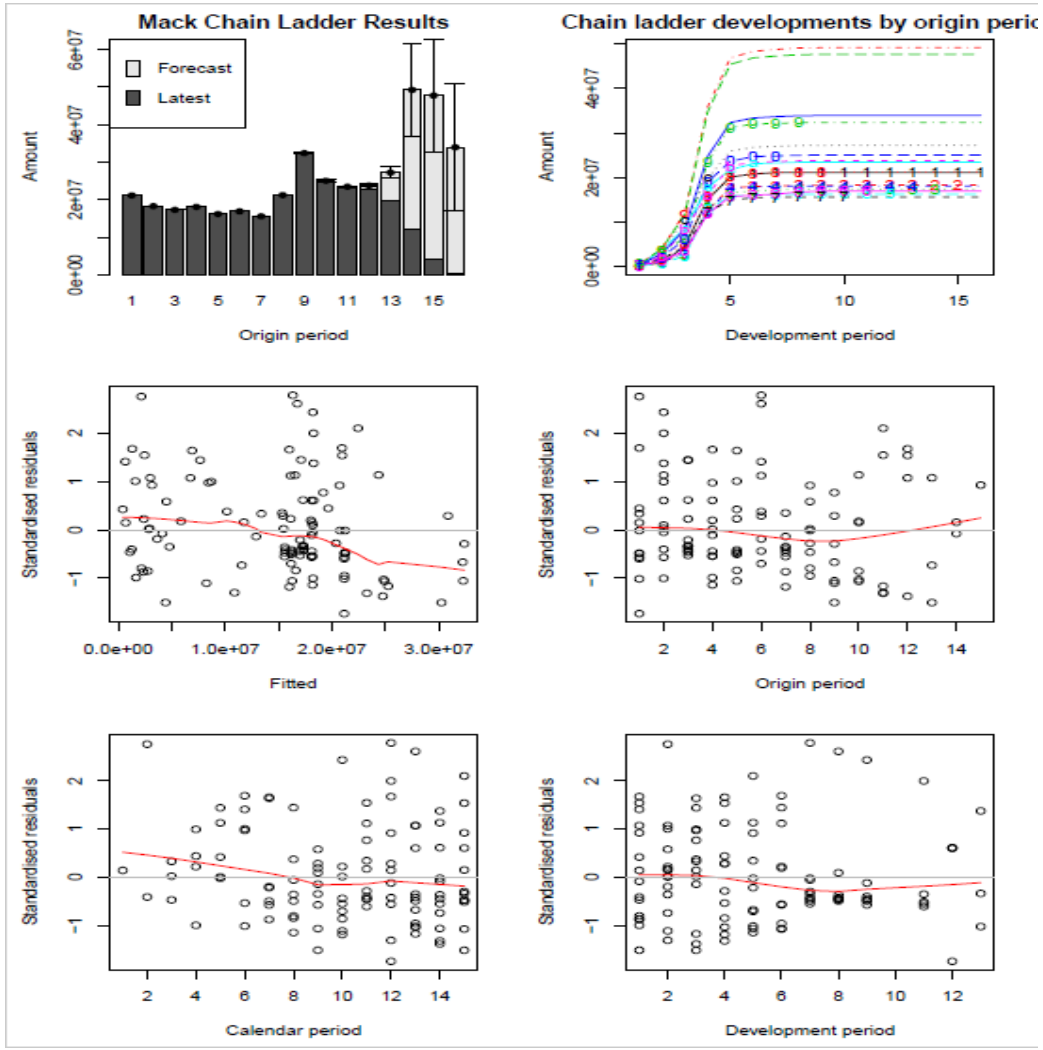


Mack CHL: case study

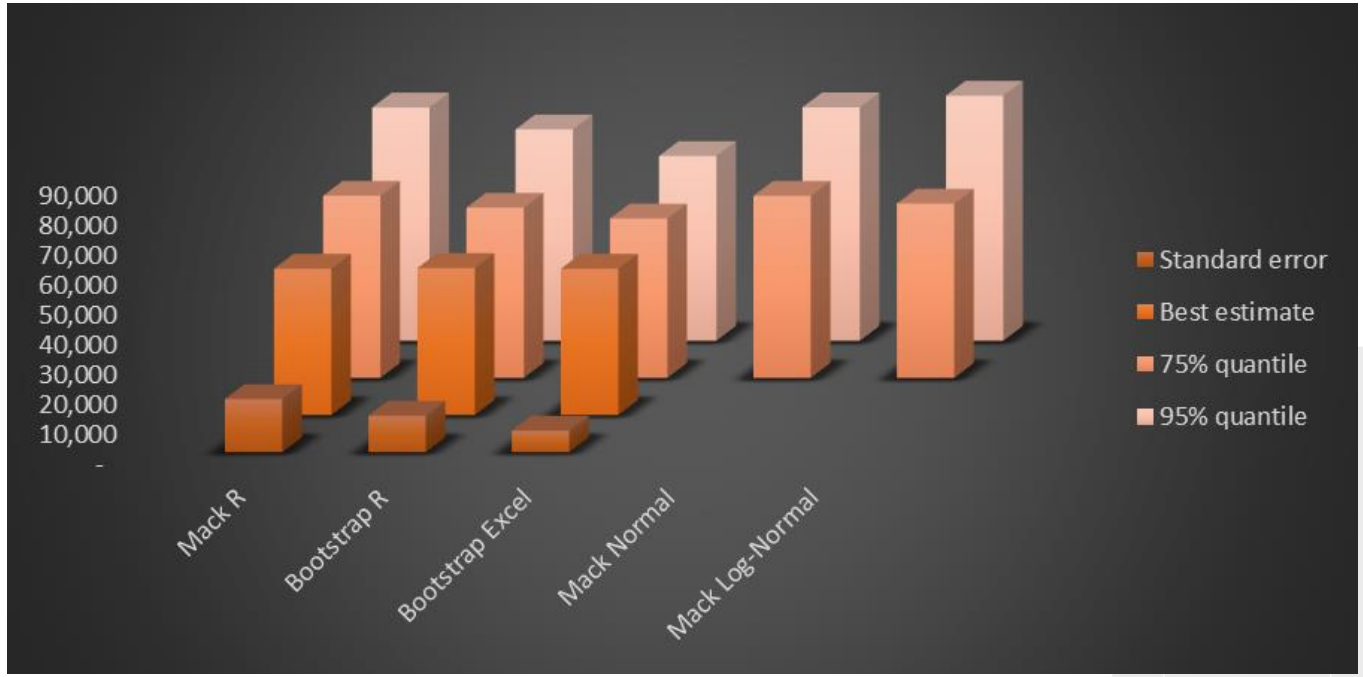
Non-life portfolio

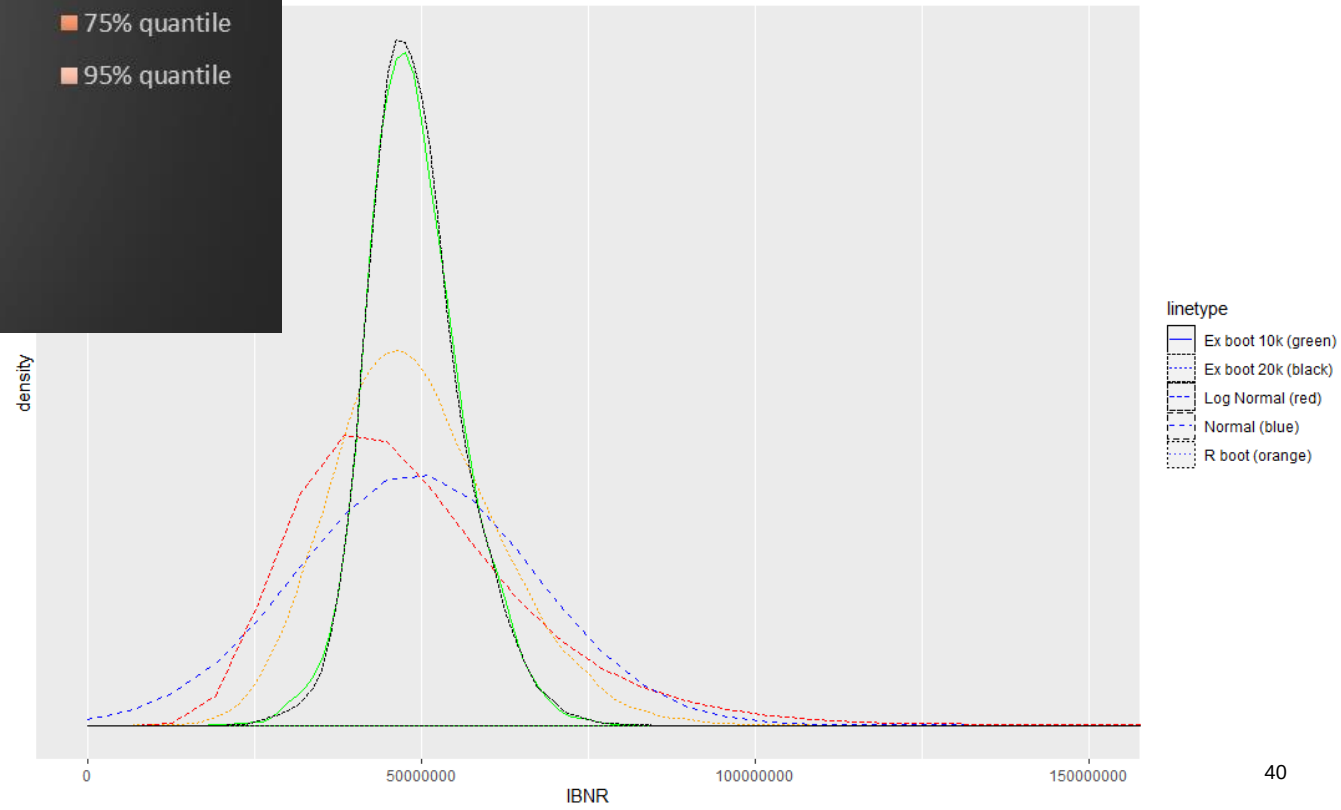


Health portfolio

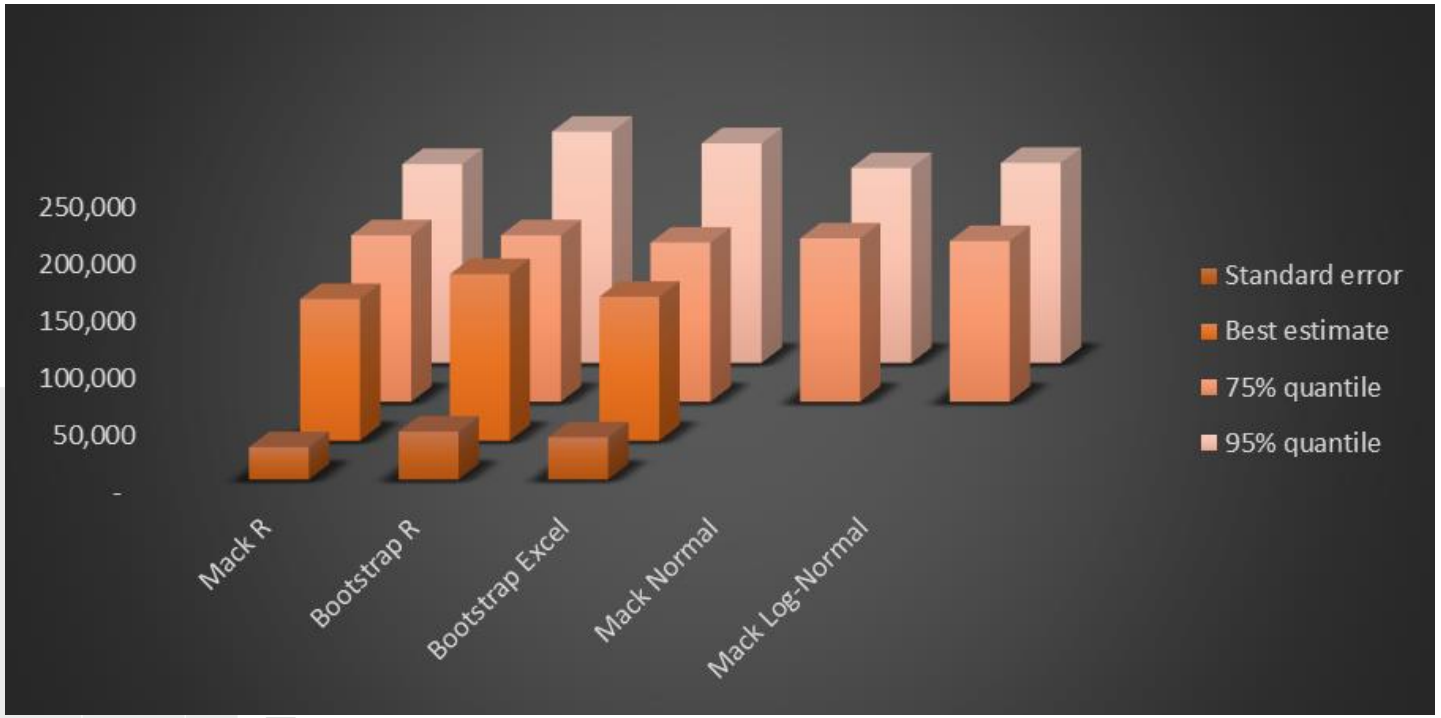


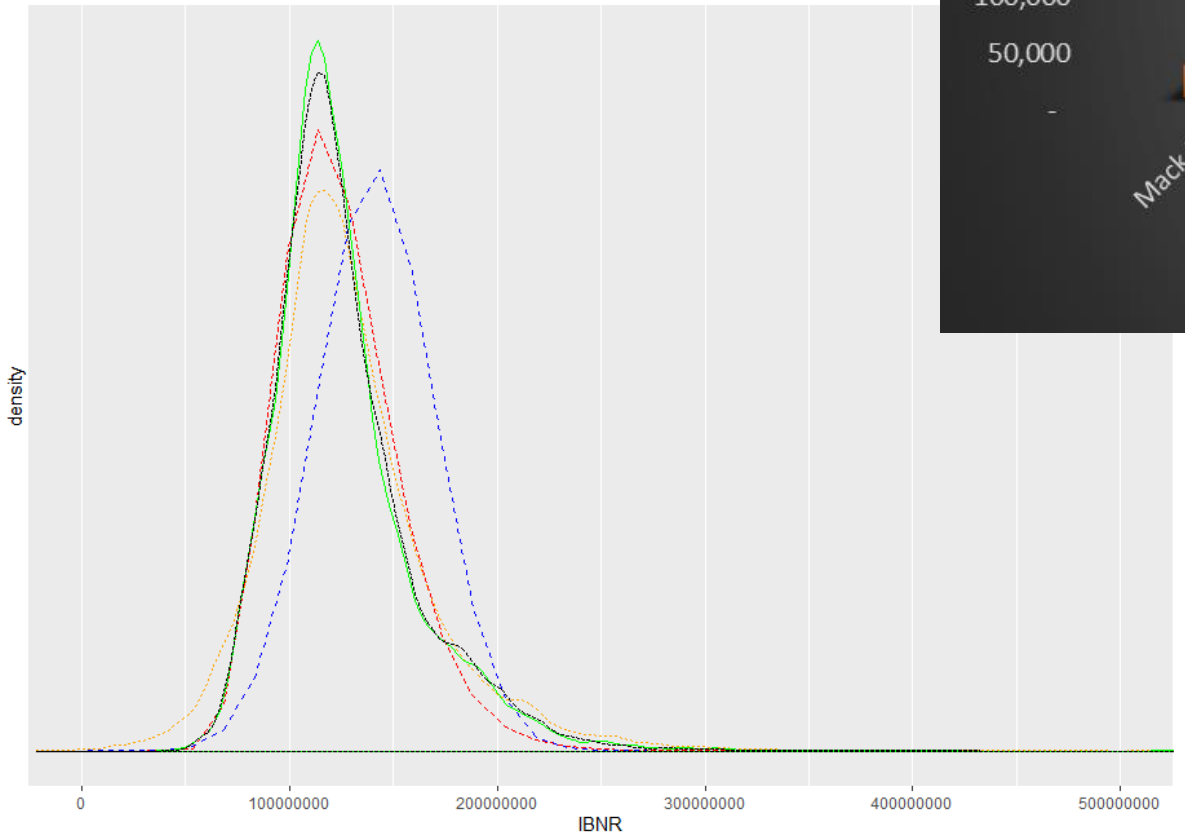
Reserve estimates: Non-life portfolio





Reserve estimates: Health portfolio





Bootstrap vs Mack CHL in claim reserving

Conclusion

Strengths

Bootstrap

- Empirical distribution vs unknown distribution of reserves
- Robust simulation technique
- Easy to interpret results

Mack

- Does not require distributional assumptions (BE)
- Seems to be less prudent than bootstrap (depends on data)
- Easy to interpret results

→ still mostly used in practice

Weaknesses

Bootstrap

- Robust as selected underlying estimation method
- Diagnostics of residuals and square residuals needed → no patterns should be visible (zero mean, symmetrically distributed with mutual variance).
- Higher quantiles → higher number of simulations

Mack

- Does not give full distribution (like quantiles, VaR, etc.)
- Additional assumptions are needed (normally or lognormally distributed reserves).
- Strong assumptions may not be fulfilled.

Takeaway points

What other choices does one have?

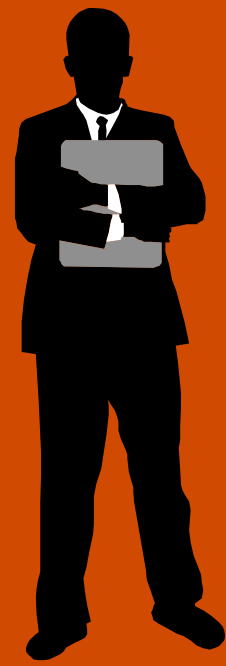
- Micromodels
- GLM
- Bayesian methods
- Markov Chain Monte Carlo methods
- Re-reserving
- Combine methods
- Expert judgment

Other considerations

- Interpretation
- Traceability
- Assumptions
- Capital adequacy
- Better run-off?
- Different stakeholders involved
  - Policyholders
  - Regulator
  - Employees
  - Directors
  - Shareholders and other investors

4

Proposed tax legislation – change in tax base for technical provisions



Proposed tax legislation

Possible accounting approaches and impact on insurance companies

Effective date 1.1.2020

Difference between current tax base @ 31.12.2019 and tax base @ 1.1.2020 to be taxed on the top of ordinary tax in two instalments

Tax base @ 31.12.2019 under current statutory accounts (SA)

Tax base @ 1.1.2020 under Solvency II MVBS (SII)

What if returned to parliament?

Accounting principles

Tax to be paid
19%*(SA – SII)

Type of difference in tax bases:

a) *Temporary* difference (DTA is eligible)

b) *Permanent* difference (DTA not available)

Accounting for *Deferred tax asset (DTA)* and *Reserve on tax*
(current PwC opinion)

Test *recovery* of DTA

Accounting principles (IAS8)

Impact through OCI only:

- *Change in accounting policy*;
- *Correction of error*.

Thoughts on retroactive effect of legislation (*applying substance over form*) → impacts OCI

Correct accounting treatment of DTA and tax reserve → impacts P&L
(current PwC opinion)

Potential issues

Test recovery of DTA: to show future tax bases are sufficient in order to use DTA in future.

When to account for?

Liquidity needed – impact on target ratios (liquidity ratio, solvency ratio, etc.)?

Impact on *price of financial instruments* in case of more sellers on the market at the same time?

Timeline & Prospective impact of proposed tax legislation

31.12.2019

Tax base for technical provisions as under current Czech accounting standards

Potentially effective from 31.12.2020/1.1.2021

1.1.2020

Tax base for technical provisions under Solvency II (“Act on insurance”)

Tax base difference (temporary → eligibility for DTA / permanent → no DTA)

Reserve for current income tax from tax base difference (accounted against OCI or P&L)

If DTA, test of realizability/recoverability (accounted against OCI or P&L – as treatment of tax reserve)

Tax to be paid in 2 settlements

June 2020

Corporate income tax return for FY 2019

Tax advance based on FY 2019 (not affected by tax base difference)

May be requested additional tax advance by ministry of finance (exceptionally)

Jan 2021

Tax base for technical provisions under Solvency II

If DTA, test of realizability/recoverability each year

Potential external audit of Solvency II market value balance sheet

Impact on audit of external financial statements

June 2021

First instalment from tax base difference to be paid together with corporate income tax return for FY 2020

Potential impact on next year tax advance

June 2022

First instalment from tax base difference to be paid with tax together with corporate income tax return for FY 2020

Vyhláška č. 502/2002 Sb.
ČÁST ČTVRTÁ - ÚČETNÍ METODY A JEJICH POUŽITÍ

”

§ 16

Ostatní technické rezervy

(6) Položka „C.6. Ostatní technické rezervy“ zahrnuje zejména rezervu na hrozící ztráty z pojištění, která je částkou doplněnou navíc k rezervě na nezasloužené pojistné z hlediska rizik přebíraných pojišťovnou, aby bylo možné pokrýt veškeré nároky a výdaje spojené s platnými pojistnými smlouvami překračující výši rezerv na nezasloužené pojistné a splatné pojistné vyplývající z těchto smluv. Položka C.6. obsahuje rovněž „*Rezervu na závazky Kanceláře*“, „Rezervu na splnění závazků z použité technické úrokové míry a ostatních početních parametrů“ nebo ostatní technické rezervy, pokud jsou účetní jednotkou vytvářeny.

§ 16a

Rezerva na závazky Kanceláře*

(1) „Rezerva na závazky Kanceláře“ je rezervou na splnění závazků z ručení za závazky Kanceláře podle zákona upravujícího pojištění odpovědnosti z provozu vozidla. Rezerva je určena ke krytí uvedených závazků, k jejichž plnění Kancelář *nemá odpovídající aktiva*. Tuto rezervu tvoří pojišťovna v rozsahu, v jakém se podílí na celkových závazcích Kanceláře, její výše se stanoví matematicko-statistickými metodami.

*Česká kancelář pojistitelů

Česká kancelář pojistitelů

- Different accounting treatment of provision on CKP liabilities.
- Statutory accounts: defined by Bill 502/2002 Sb. as part of “other technical provisions”.
- Solvency II market value balance sheet: technical provision as a liability to policyholders.
- How to classify and valuate market value of such liability into MVBS?
- Is there an option to classify as financial liability?
- Is there an option to buy out company’s market share on not covered liability?
- What about future revaluations?
- Future liquidity needed?
- What with 1.3 billion CZK of bonds available on the market?

ROZVAHA

k 30.6.2019

(v tis. Kč)

IČ: 70099618

Česká kancelář pojistitelů

Milevská 2095/5, Praha 4

Legenda	Číslo řádku	Hrubá výše	Úprava	Čistá výše	Minulé období
a	b	2	3	4	1
AKTIVA	1				
B. Dlouhodobý nehmotný majetek	2	3 276	3 081	195	208
C. Investice	3	3 012 526	172	3 012 354	3 199 591
I. Pozemky a stavby (nemovitosti), z toho:	4	2 275	172	2 103	2 213
a) provozní nemovitosti	5	2 275	172	2 103	2 213
II. Investice v podnikatelských seskupeních	6	200		200	200
3. Podíly s podstatným vlivem	7	200		200	200
III. Jiné investice	8	3 010 051		3 010 051	3 197 178
1.Akcie a ost.cenné papíry s proměnlivým výnosem, ostatní podíly	9	181 283		181 283	175 190
2. Dluhové cenné papíry, v tom:	10	2 457 668		2 457 668	2 388 661
a) oceňované reálnou hodnotou	11	2 457 668		2 457 668	2 388 661
6. Depozita u finančních institutcí	13	6 100		6 100	1 600
7. Ostatní investice	14	365 000		365 000	631 727
E. Dlužníci	15	1 409 920		1 409 920	1 584 258
I. Pohledávky z operací přímého pojištění	16	2 183		2 183	918
1. Pojistníci	17	2 183		2 183	918
II. Pohledávky z operací zajištění	19	6 830		6 830	6 487
III.Ostatní pohledávky	20	1 400 907		1 400 907	1 576 853
1. Pohledávky z příspěvků pojistitelů	21	6 277		6 277	30 827
2. Ostatní pohledávky	22	68 900		68 900	25 312
b) pohledávky za osobami, ve kterých má účetní jednotka podstatný vliv	23	64 022		64 022	25 075
3. Daně	24	7 730		7 730	7 714
4. Pohledávka za pojistiteli	25	1 318 000		1 318 000	1 513 000
F. Ostatní aktiva	26	251 459	2 028	249 431	333 446

5

Conclusion

Sources

[1] E. L. Kaplan, P. Meier, Nonparametric estimation from incomplete observation, 1958

[2] Mack, T., Distribution-free calculation of the standard error of chain ladder reserve estimates, 1993

[3] Wüthrich, M. V., Merz M., Stochastic Claims Reserving Methods in Non-Life Insurance, 2006

[4] Nelson, C. R., Siegel A.F., Parsimonious modeling of yield curves, 1987

[5] Svensson, L. E. O., Estimating and interpreting forward interest rates, 1994

Thank you

Contain of the presentation should not represent any professional advice!

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