Why the hell do we still stick to Chain-Ladder and Bornhuetter-Ferguson?

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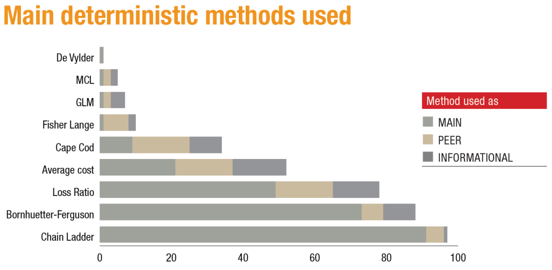
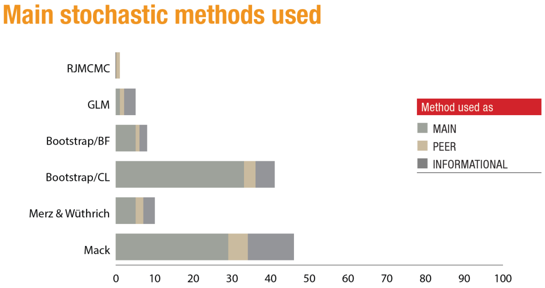
What you can expect to see:

- Not another glowingly talk about machine learning and big data techniques in P&C reserving.
- Almost no math, at least no complicated one.
- A lot of real world examples.
- Some „not very well known“ insides into well known reserving methods.
- Some controversial statements and hopefully discussion about it (try to roast me, please).

ASTIN Working Party „Non-Life Reserving Pactices“, [4]





About 90% Chain-Ladder and 75% Bornhuetter-Ferguson!
Do you really believe that almost all portfolios follow Chain-Ladder and/or Bornhuetter-Ferguson?

Missing impotant method:

Actuarial judgement!

Reasons for the fixation on Chain-Ladder and Bornhuetter-Ferguson

- Most **software** available does not support other methods adequately or at all.
- **Auditors and regulators** make problems if other methods are used (or if Chain-Ladder and Bornhuetter-Ferguson are not considered).
- **Education** of actuaries hardly mentions other methods.
- Actuaries do not have the **time** to investigate their portfolio and other methods deeply.

other information

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data

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Problems:

- high-dimensional data
- vague other information
- models do not really fit
- randomness
- ...

actuary

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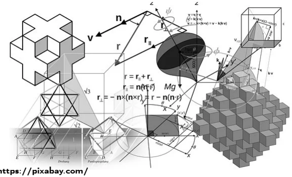
models



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Consequences:
Models and their results have to be explainable and not too complex, in order to adapt them for not modelled information and changes (the so called actuarial judgement).

How it works:

- Group similar claims and payments into pots.
- Aggregate claims data to get the law of large numbers working.
- Find an exposure that you (believe to) know and that reflects the change of the aggregated claims data over time, for instance in a linear way:

$$\text{claims data } S_{t+1} \approx f_t \cdot \text{exposure } E_t.$$

- Use the observed past development of older similar pots to estimte f_t and to project the future development of the claims data.
- Claims data are for instance payments, incurred losses, number of reported claims, number of open claims . . .

Incremental vs. cumulative

We will look at changes S_t of claims data over time, incremental data, the corresponding cumulative data are denoted by $C_t := \sum_{j=0}^{t} S_j$.
The ultimate and the reserves are denoted by $U = \sum_t S_t$ and $R = \sum_{t>now} S_t$, respectively.

Chain-Ladder

General idea:

$$S_{t+1} \approx f_t C_t,$$

here C_t works as exposure that reflects the volume.
But, why should we pay even more if we already have paid a lot?
Known issues

- very unstable if f_t is very large of if $C_t \approx 0$.
- Chain-Ladder on paid losses $\neq$ Chain-Ladder on incurred losses.
- poorly allocation of the total reserves to origin periods, for instance if all claims are already settled.
- heavily dependence on the last observed value C_{now}.

Constant exposure P

General idea:

$$S_{t+1} \approx f_t P$$

Examples for the exposure P are (risk) premium (**loss ratio method**), sum insured, number of reported claims (**average costs**), a priory ultimate (**Bornhuetter-Ferguson**) ...
Since the exposure is constant, one often does not consider the development and only looks

- at the ultimate, i. e. $U \approx \sum_t f_t P$, or
- at the reserves, i. e. $R \approx \sum_{t>now} f_t P$.

Cape-Cod

- Issue with Chain-Ladder: The ultimate

$$U \approx \prod_{t>now} (1 + f_t) C_{now}$$

depends heavenly on the last observed cumulative value C_{now}, which is a realisation of a random variable.
- Idea: Smoothening of the „last diagonal" with respect to some given constant exposure P (risk premium) and then apply Chain-Ladder to calculate the reserves.

$\Longrightarrow$ The reserves are approximately proportional to an adapted constant exposure $\widetilde{P}$, i. e. $R \approx g_t \widetilde{P}$.

Case reserves as exposure

General idea:
Payments during the year S^P_{t+1} are approximately proportional to the case reserves CR_t at the begin of the year and the same for changes in incurred losses S^I_{t+1}, i. e.

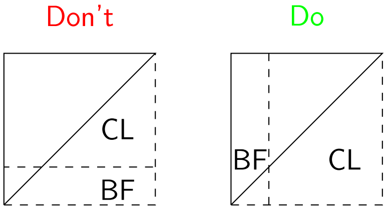
$$S^P_{t+1} \approx f^P_t CR_t \qquad \text{and} \qquad S^I_{t+1} \approx f^I_t CR_t.$$

Projection of payments and incurred losses leads to the same ultimate and the allocation of the total reserves to origin years reflects the current exposure in terms of case reserves.
The issue of no or too low case reserves, because of late reported claims or reopenings, can be dealt with by additional „virtual case reserves“:

- number of late claims times mean ultimate and
- number of reopened claims times mean future payments, respectively.

Combination of Chain-Ladder and Bornhuetter-Ferguson (or other methods)

- Most actuaries (and software) select one method **by origin period** (pot).
- This is **inconsistent**: Why the development of a pot should change its behaviour form one year of estimation (Bornhuetter-Ferguson) to the next (Chain-Ladder).
  Moreover, it often leads to profit or losses because of „model change“.
- The consistent approach is to change the exposure with **development time**, i. e. constant exposure (Bornhuetter-Ferguson) for earlier development years and cumulative data (Chain-Ladder) for later development years.



Average costs

- General idea is

$$S_{t+1} \approx f_t N,$$

where N is the ultimate number of reported claims (and f_t represents the mean payment).

- Why should closed claims have an affect on future payments?
- How about taking the at the begin of the year active (open) claims?
  We can get them by the difference of the number of reported claims (Chain-Ladder?) and the number of inactive (closed) claims (number of active (open) claims as exposure).

Excess part of large claims

- In general it is a good idea to take care of large (strange) claims explicitly.
- One possibility is to separate the part exceeding a given threshold.
- Here case reserves in excess of the threshold (plus some virtual once for late large claims) are a natural exposure.

Subrogation

- General idea: We can get back only what we have paid before and we cannot get back something twice.

$\Rightarrow$ Take the payments net of subrogations as exposure for the projection of subrogations.

- Project the payments gross of subrogation and calculate the net figures by subtracting the subrogations!

Integrity compensation (Swiss mandatory accident insurance)

- These are lump sums that are proportional to the insured salary, where the proportionality factor depends on the severity of the injury (integrity grad).
- First project the number of claims with integrity compensation by taking the number of reported claims as exposure.
- Then project the integrity compensation with exposure equal to the number of claims with such compensation times the insured salary, i. e. the development factors f_t will represent a mean integrity grad.

Inflation

Assume without inflation we have

$$S_{t+1} \approx f_t E_t.$$

We can only observe the inflated values

$$\widetilde{S}_{t+1} := I_{t+1} S_{t+1} \approx f_t I_{t+1} E_t = f_t I_{t+1} g_t^{-1}(\widetilde{E}_t),$$

where g_t represents the (hopefully invertible) impact of inflation on the exposure E_t.
That means, the inflated (observable) values satisfy

$$\widetilde{S}_{t+1} :\approx f_t \bar{E}_t,$$

with exposure $\bar{E}_t := I_{t+1} g_t^{-1}(\widetilde{E}_t)$.
Therefore, all we have to do is to get a good estimate of the inflation. ;-)

Stochastic model (Linear Stochastic Reserving Methods)

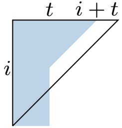
Analogues to Mack's Chain-Ladder model [3] we can assume that

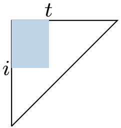
$$E\left[S_{i,t+1}^{m} \middle| \mathcal{D}_t^{i+t}\right] = f_t^m E_{i,t}^m,$$

$$Cov\left[S_{i,t+1}^{m_1}, S_{i,t+1}^{m_1} \middle| \mathcal{D}_t^{i+t}\right] = \sigma_t^{m_1,m_1} E_{i,t}^{m_1,m_2},$$

where:

- m, m_1 and m_2 indicate the pot (triangle).
- $\mathcal{D}_t^{t+i}$ represents the „past with respect to calender period $i+t$ and development period t“.
- the exposures E_t^m depend linearly on the „past with respect to the origin period i and development period t“.
- the exposures $E_t^{m_1,m_2}$ depend on the „past with respect to the origin period i and development period t“.





Estimates

Analogues to A. Röhr [5] one can estimate (some formulas get a bit nastier):

- Expected ultimates and reserves.
- Uncertainties with respect to time horizons from $t = 1$ (Merz-Wüthrich like) to $t = \infty$ (Mack like).

Two free to use implementations (R package and an ActiveX component) are available on sourceforge [1].

Recomendations

- Get to know your portfolio.
- Choose the estimation method based on the specifics of the pot.
- Educate less experienced actuaries as well as auditors and regulators.
- Demand more functionality in the reserving software you use.

Have a drink and something to eat in order to digest what you have just seen.

[1] René Dahms.
Implementation of LSRMs [2] under GPL 3. (http://sourceforge.net/projects/lsrmtools/).

[2] René Dahms.
Linear stochastic reserving methods.
Astin Bull., 42(1):1–34, 2012.

[3] Thomas Mack.
Distribution-free calculation of the standard error of chain ladder reserving estimates.
Astin Bull., 23:213–115, 1991.

[4] Caroline Thobie Pierre Miehe, Judith Lutz and Fabrice Taillieu.
Non-Life Reserving Pactices. (https://ar.casact.org/astin-working-party-releases-report-on-reserving-practices-for-general-insurance-worldwide/).

[5] Ancus Röhr.
Chain Ladder and Error Propagation.
Astin Bull., 46(2):293–330, 2016.