The “ChainLadder” package - Insurance claims reserving in R

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Agenda

- Motivation / Background
- Current status of the "ChainLadder" package
- Example - The Mack chain ladder method
- Next steps
Insurer’s product is a promise of unknown costs

- Insurers sell the promise to pay for future claims occurring over an agreed period for an upfront received premium
- Unlike other industries insurers don’t know the production cost of their product
- The estimated future claims have to be held in the reserves, one of the biggest liability items on an insurer’s balance sheet
Reserving in insurance

- Reserves cover IBNR (Incurred But Not Reported) claims
- Reserves are usually estimated based on historical claims payment/reporting patterns
- The most popular method is called “chain ladder”
- In the past a point estimator for the reserves was sufficient
- New regulatory requirements (→ Solvency II) foster stochastic methods
Current situation

- Over recent years stochastic methods have been developed and published, but have been rarely used in practise
- Excel is still the standard tool in the industry, but is not an ideal environment for implementing those stochastic methods
- The number of R users in the insurance market has grown over recent years
- **Idea**: Use R to implement stochastic reserving methods, and CRAN to distribute them
- Use the RExcel Add-in as a front end for Excel
The ChainLadder package for R

- Started out of presentations given at the Institute of Actuaries on stochastic reserving
- Mack-, Munich-chain ladder implemented, Bootstrap and Log-normal model in experimental stage
- Spreadsheet shows how to use the functions within Excel using the RExcel Add-in
- Available from CRAN
- Contributions most welcome!
Example

- Usually an insurance portfolio is split into 'homogeneous' classes of business, e.g. motor, marine, property, etc.
- Policies are aggregated by class and looked at in a triangle view of cumulative or incremental paid and reported claims
Example of a development triangle

- Start with an aggregate cumulative reported claims development triangle $C_{ik}$

```R
> library(ChainLadder)
> RAA

dev
origin  1   2   3   4   5   6   7   8   9   10
1981  5012  8269 10907 11805 13539 16181 18009 18608 18662 18834
1982  106   4285  5396 10666 13782 15599 15496 16169 16704  NA
1983  3410  8992 13873 16141 18735 22214 22863 23466  NA  NA
1984  5655 11555 15766 21266 23425 26083 27067  NA  NA  NA
1985 10924  9565 15836 22169 25955 26180  NA  NA  NA  NA
1986 15135  6445 11702 12935 15852  NA  NA  NA  NA  NA
1987  5574  4020 10946 12314  NA  NA  NA  NA  NA  NA
1988 13515  6947 13112  NA  NA  NA  NA  NA  NA  NA
1989 31335  5395  NA  NA  NA  NA  NA  NA  NA  NA
1990 20635  NA  NA  NA  NA  NA  NA  NA  NA  NA
```
Example of a development triangle

Cumulative incurred claims development by origin year

Inurred claims

Development year
The chain ladder algorithm

- $C_{ik}$: cumulative loss amount of origin year $1, \ldots, n$
- Losses are know for $k \leq n + 1 - i$
- Forecast $\hat{C}_{ik}$ for $k > n + 1$ with

$$\hat{C}_{i,k+1} = \hat{C}_{ik} \hat{f}_k$$

and

$$\hat{f}_k = \frac{\sum_{j=1}^{n-k} C_{j,k+1}}{\sum_{j=1}^{n-k} C_{jk}}$$

Chain ladder ratios – volume weighted average
The Mack chain ladder method

- The Mack chain ladder method [1,2] allows under certain assumptions to estimate the ultimate loss and the standard error around it.
- It is straightforward in R to implement it, as the chain ladder method can be regarded as a linear regression through the origin [3].

```r
# Chain ladder ratio for development step 1
x <- Triangle[1:(n-1),1]; y <- Triangle[1:(n-1),2]
chainladder.model <- lm(y~x+0, weights=1/x)
coef(chainladder.model )
2.999359
```
MackChainLadder - Example

> library(ChainLadder)
> MCL <- MackChainLadder(RAA)
> plot(MCL)

> MCL

<table>
<thead>
<tr>
<th></th>
<th>Latest</th>
<th>Dev.To.Date</th>
<th>Ultimate</th>
<th>IBNR</th>
<th>Mack S.E</th>
<th>CoV</th>
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</thead>
<tbody>
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<td>1981</td>
<td>18,834</td>
<td>1.000</td>
<td>18,834</td>
<td>0</td>
<td>0</td>
<td>NaN</td>
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<tr>
<td>1982</td>
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<td>16,858</td>
<td>154</td>
<td>143</td>
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<tr>
<td>1983</td>
<td>23,466</td>
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<td>24,083</td>
<td>617</td>
<td>592</td>
<td>0.959</td>
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<tr>
<td>1984</td>
<td>27,067</td>
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<td>28,703</td>
<td>1,636</td>
<td>713</td>
<td>0.436</td>
</tr>
<tr>
<td>1985</td>
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<td>28,927</td>
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<td>0.529</td>
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<tr>
<td>1986</td>
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<td>19,501</td>
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<tr>
<td>1987</td>
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<td>17,749</td>
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<td>0.405</td>
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<td>1988</td>
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<td>1989</td>
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<td>16,045</td>
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<td>6,332</td>
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<tr>
<td>1990</td>
<td>2,063</td>
<td>0.112</td>
<td>18,402</td>
<td>16,339</td>
<td>24,566</td>
<td>1.503</td>
</tr>
</tbody>
</table>

Totals:
Sum of Latest: 160,987
Sum of Ultimate: 213,122
Sum of IBNR: 52,135
Total Mack S.E.: 26,881
Total CoV: 52
Next steps

- Implement further stochastic reserving methods, see for example [4]
  - The bootstrap and log-normal methods are in an experimental stage
- Provide more diagnostic tools to verify the model assumptions
- Advertise R as the ideal language for knowledge transfer for stochastic reserving methods


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