The “ChainLadder” package - Insurance claims reserving in R

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Agenda

- Insurance and claims reserving
- 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

- Insurer sell the promise to pay future unknown claims for an upfront received premium over a given time horizon.
- Unlike other industries insurer don't know the production cost of their product.
- The estimated future claims have to be hold in the reserves, one of the biggest liability item 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
- Most popular methods 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 praxis
- Excel is the standard tool in the industry, but is not an ideal environment for implementing those stochastic methods
- Idea: Use R to implement stochastic reserving methods, and CRAN to distribute them
- Use the RExcel Add-in as a front end for Excel to use the R functions

The ChainLadder package for R

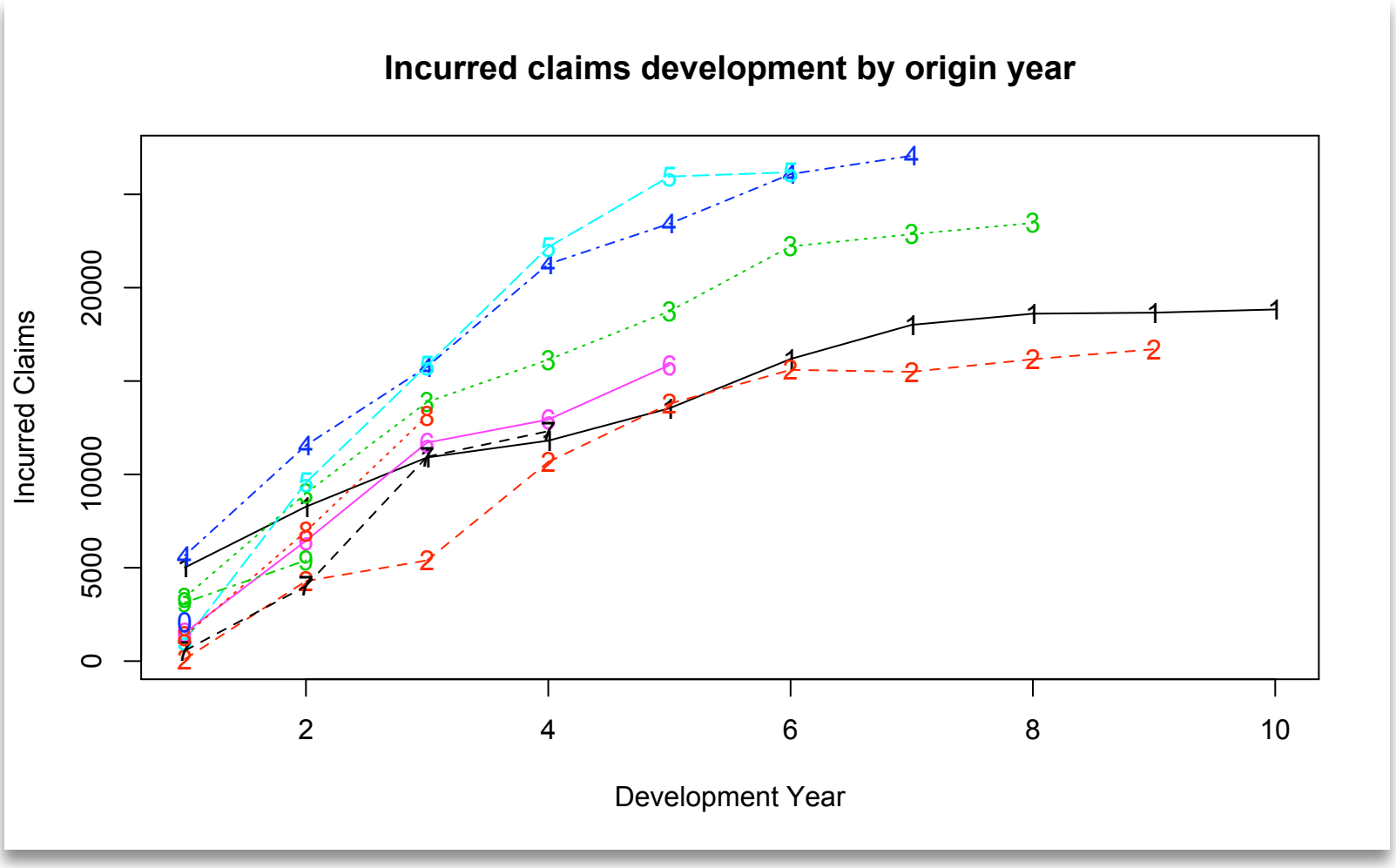
- Started out of presentations given at the Institute of Actuaries on stochastic reserving
- Mack-, Munich-chain ladder implemented, Bootstrap and Log-normal model in experimental stage
- Spreadsheet shows how to use the functions within Excel using the RExcel Add-in
- Available from CRAN
- Home page: http://code.google.com/p/chainladder/
- Contribution most welcome!

The chain ladder method

- Start with an aggregate cumulative claims (C_{ik}) development triangle for portfolio of insurance policies

```
> 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 1092  9565 15836 22169 25955 26180    NA    NA    NA    NA
  1986 1513  6445 11702 12935 15852    NA    NA    NA    NA    NA
  1987  557  4020 10946 12314    NA    NA    NA    NA    NA    NA
  1988 1351  6947 13112    NA    NA    NA    NA    NA    NA    NA
  1989 3133  5395    NA    NA    NA    NA    NA    NA    NA    NA
  1990 2063    NA    NA    NA    NA    NA    NA    NA    NA    NA
```

The chain ladder method



The chain ladder algorithm

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

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

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

Chain ladder ratios – volume weighted average

Chain ladder forecast

```
n <- ncol(Triangle)
Latest <- Triangle[row(Triangle) == (n+1 - col(Triangle))]
y <- colSums(Triangle, na.rm=TRUE)
x <- y-Latest
f <- c(y[-1]/x[-n], 1) # chain ladder ratios
f
2.999359 1.623523 1.270888 1.171675 1.113385 1.041935 1.033264
1.016936 1.009217 1.000000

fult <- cumprod(rev(f))
Ultimate <- rev(Latest) * fult
Ultimate
18834.00 16857.95 24083.37 28703.14 28926.74 19501.10 17749.30
24019.19 16044.98 18402.44
```

Chain ladder forecast

```
path<-searchpaths()[grep("ChainLadder", searchpaths())]
source(paste(path,"/Experimental/BootstrapReserve.R", sep=""))

B<-BootReserve(RAA)
B
```

	IBNR.mean	IBNR.sd	25%	50%	75%	90%	99.5%
1	0.0000	0.0000	0.0000000	0.000000	0.0000	0.0000	0.000
2	130.8245	733.5834	-0.1535163	1.405083	192.5669	743.3353	3103.457
3	651.0346	1263.3610	3.0722512	357.417205	1188.1725	2258.5680	5273.677
4	1670.3624	1997.3429	329.4232481	1246.756459	2732.4428	4393.3242	8575.825
5	2814.3203	2520.3980	1146.9726732	2364.739072	4084.0970	5922.8344	12595.872
6	3717.2472	2564.9740	1937.3839200	3156.089102	4960.8341	7165.0118	12431.719
7	5578.8586	3359.5433	3156.8398184	4969.462293	7375.0892	10283.0475	17088.939
8	11108.8197	5054.4514	7454.3661089	10431.584208	14284.3592	17426.9004	28117.888
9	10808.2757	6003.8756	6533.5270375	9962.487017	14463.4308	18799.1909	29798.696
10	17155.1122	13763.1495	6904.7018476	15167.352991	26019.3023	35622.5777	59244.223

Chain ladder ratio as linear regression

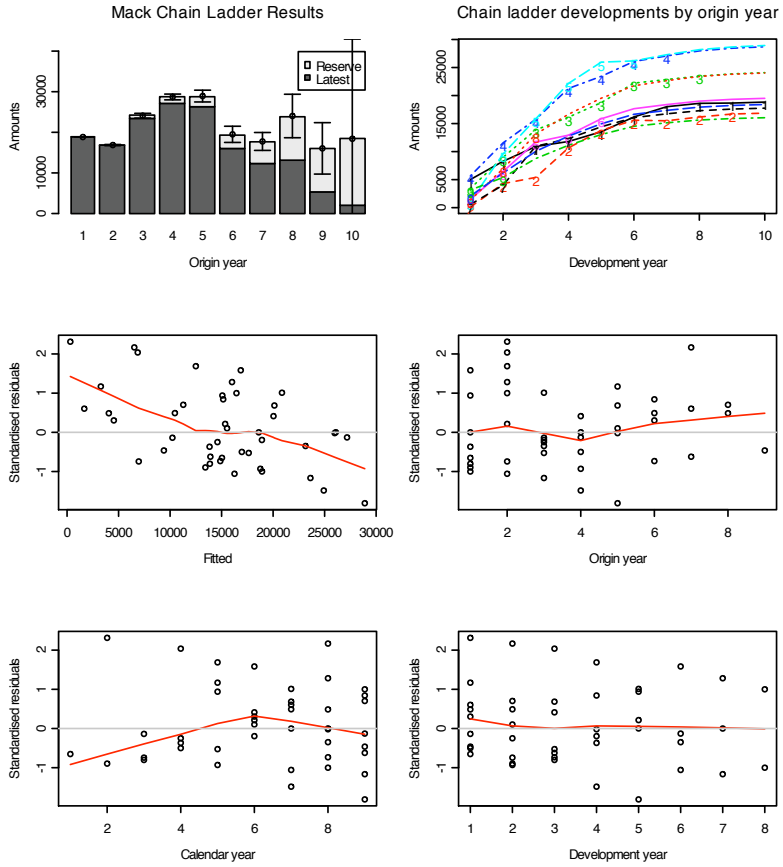
```
# Chain-ladder-link ratio is a weighted linear regression
# through the origin
x <- Triangle[,1]; y <- Triangle[,2]
chainladder.model <- lm(y~x+0, weights=1/x)
chainladder.model

Call:
lm(formula = y ~ x + 0, weights = 1/x)
Coefficients:
    x
2.999
```

The Mack method

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

	Latest	Dev.To.Date	Ultimate	Reserve	Mack.S.E	Mack.S.E.Ratio
1981	18,834	1.000	18,834	0	0	NaN
1982	16,704	0.991	16,858	154	143	0.928
1983	23,466	0.974	24,083	617	592	0.959
1984	27,067	0.943	28,703	1,636	713	0.436
1985	26,180	0.905	28,927	2,747	1,452	0.529
1986	15,852	0.813	19,501	3,649	1,995	0.547
1987	12,314	0.694	17,749	5,435	2,204	0.405
1988	13,112	0.546	24,019	10,907	5,354	0.491
1989	5,395	0.336	16,045	10,650	6,332	0.595
1990	2,063	0.112	18,402	16,339	24,566	1.503

	Totals:
Sum of Latest:	160,987
Sum of CL-Ultimate:	213,122
Sum of CL-Reserve:	52,135
Total Mack S.E.:	10,085
Total S.E.% of Reserve:	19



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Libero was created to offer

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- Insurers and investors opportunities to invest in diversifying insurance instruments.

Libero can tailor propositions for insurers at different lifecycle stages.

- Start-ups.
- Steady state.
- Accelerated growth.
- M&A strategies (both offensive and defensive).

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