Claims reserving in R with ChainLadder

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Agenda

- What are claims reserves
- How are reserves assessed
- Traditional chain-ladder methods
- Modern stochastic developments
- Opportunities for capital management

The insurance paradox

- Insurers don't sell products but promises
- Promises of unknown cost and delivery date

Liabilities stay on the book

- Premium is received up-front
- Claims are paid later
- Float = Premium - Claims
- Float can be invested

- If Claims < Premiums
- => Free investment

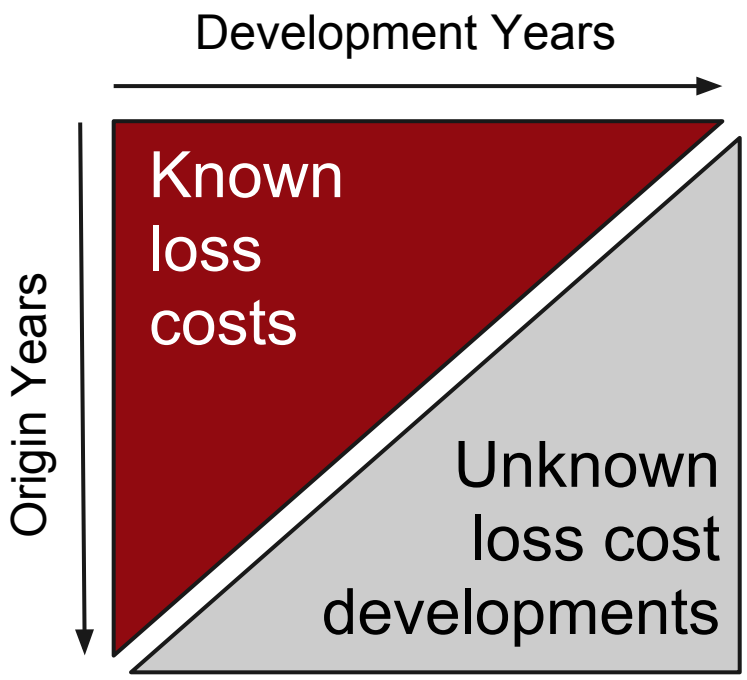
- Outstanding loss costs are held in reserves

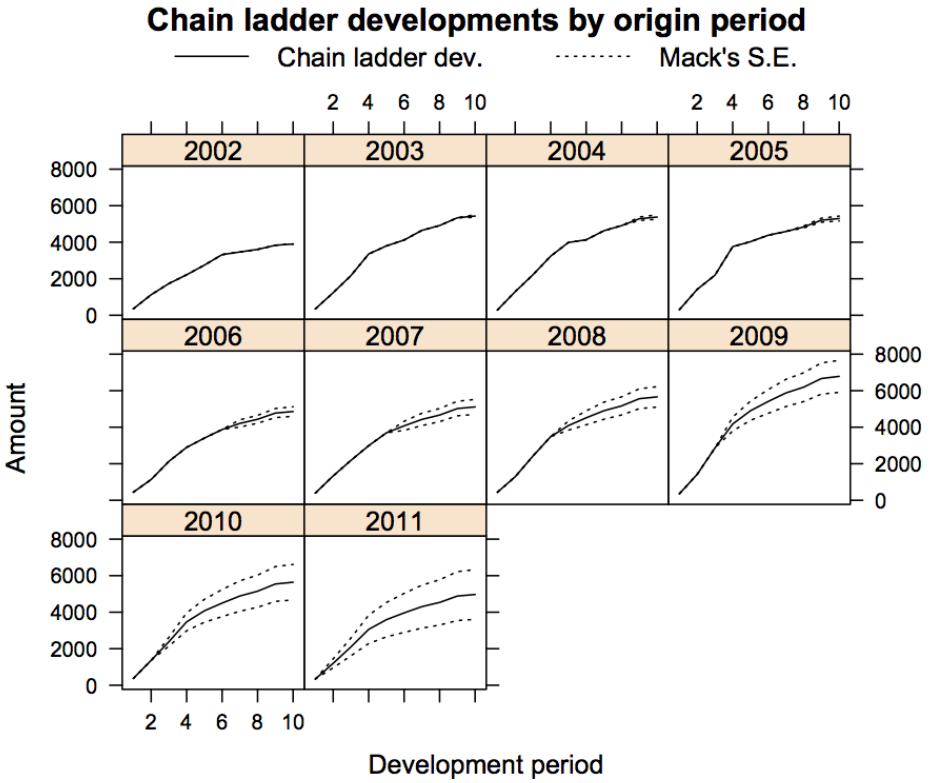
Reserving in insurance

- Capital needs to be held against reserves
- Task: predict ultimate loss cost

- We distinguish between:
  - Paid claims
  - Case reserves: Reported claims but not yet paid
  - Reported claims: Paid + Case reserves
  - IBNR: Incurred But Not Reported claims
  - Reserves = Case reserves + IBNR
  - Ultimate loss cost = Paid claims + Reserves

Insurance data: Triangles





Art & Science

- Changes in businesses and legal environments provide challenges in using historical data
- Often only annual or quarterly data available

- How much can we rely on data?
- How much judgement is required?

- Don't forget the reserving cycle!

Standard Method

- Traditionally: Simplistic ratio analysis with manual adjustments (Chain-ladder)

```
> library(ChainLadder)
> round(GenIns/1000) # example data
      dev
origin   1    2    3    4    5    6    7    8    9   10
    1  358 1125 1735 2218 2746 3320 3466 3606 3834 3901
    2  352 1236 2170 3353 3799 4120 4648 4914 5339   NA
    3  291 1292 2219 3235 3986 4133 4629 4909   NA   NA
    4  311 1419 2195 3757 4030 4382 4588   NA   NA   NA
    5  443 1136 2128 2898 3403 3873   NA   NA   NA   NA
    6  396 1333 2181 2986 3692   NA   NA   NA   NA   NA
    7  441 1288 2420 3483   NA   NA   NA   NA   NA   NA
    8  359 1421 2864   NA   NA   NA   NA   NA   NA   NA
    9  377 1363   NA   NA   NA   NA   NA   NA   NA   NA
    10 344   NA   NA   NA   NA   NA   NA   NA   NA   NA

> sapply(chainladder(GenIns)$Models, coef)
3.491 1.747 1.46 1.174 1.104 1.086 1.054 1.077 1.018
```

Stochastic models

- Can statistics help us to judge how much art is required and how much science can be applied?
- Regulatory requirements foster stochastic methods (Solvency II in Europe)
- R provides a fantastic tools to implement new statistical and stochastic models

ChainLadder R package

- The package has implementations of the Mack-, Munich-,Bootstrap, and multi-variate chain-ladder methods
- Loss development factor curve fitting methods of Dave Clark
- Models based on generalised linear models

- Project site:
  - http://code.google.com/p/chainladder/

Idea: Link chain-ladder to linear regression

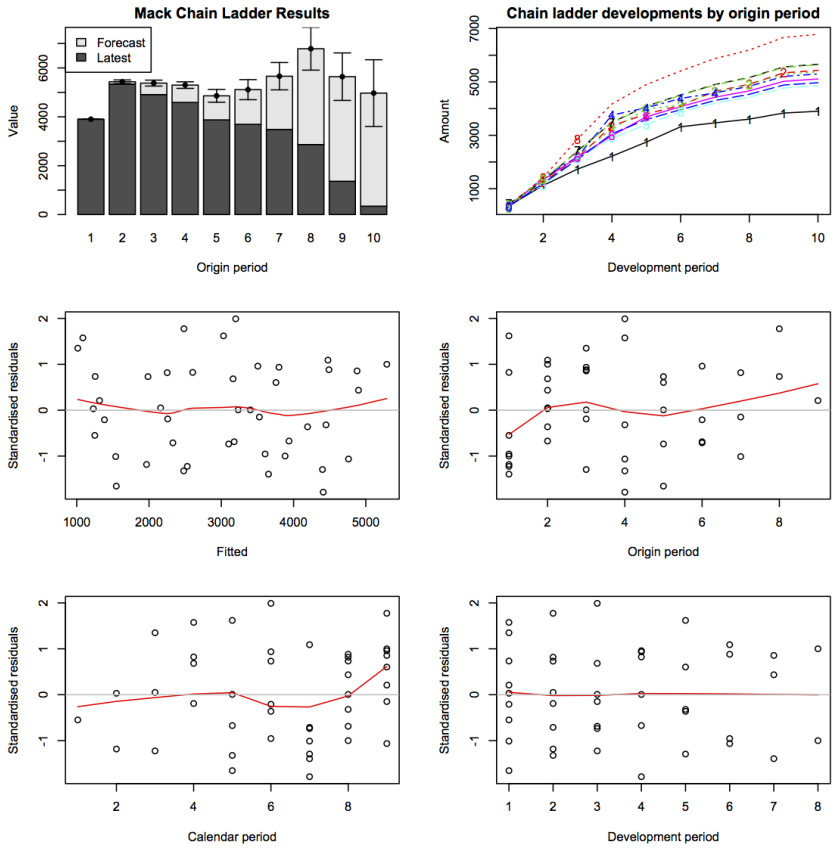
- Chain-ladder can be regarded as weighted linear regression through the origin.
- First age-to-age factor:

```
> x <- GenIns[,1]; y <- GenIns[,2]
> lm(y ~ x + 0, weights=1/x)

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

Coefficients:
    x
3.491
```

Mack-chain-ladder

- Distribution-free approach
- Estimate Std. Err.

- Check model assumptions via residual plots

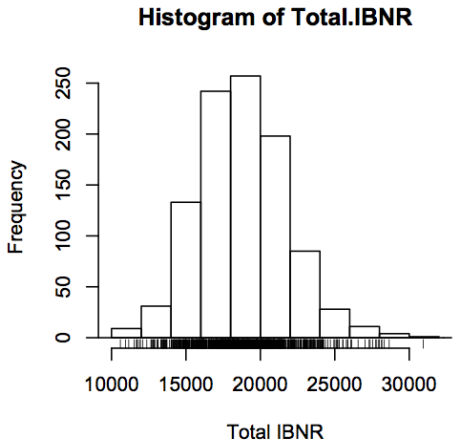


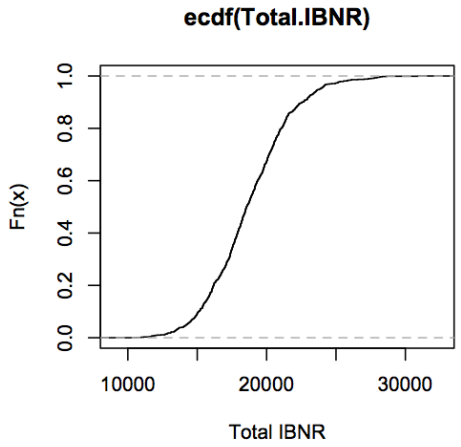

```
> GNI <- MackChainLadder(GenIns/1000, est.sigma="Mack")
> plot(GNI)
```

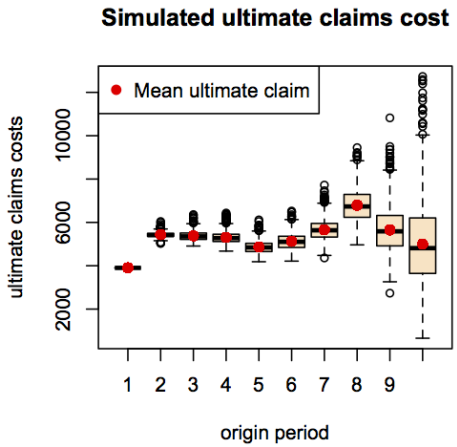
Bootstrap method

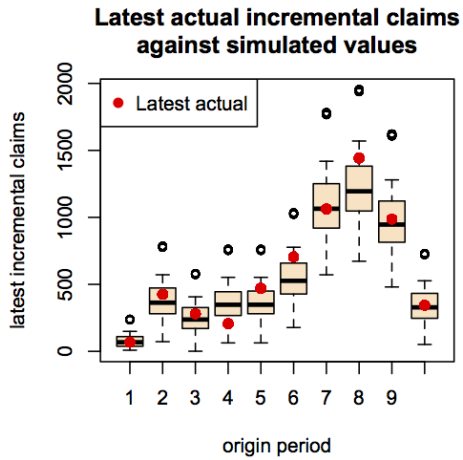
- Estimate full distribution of outcomes

```
> B <- BootChainLadder
(GenIns/1000)
> plot(B)
```







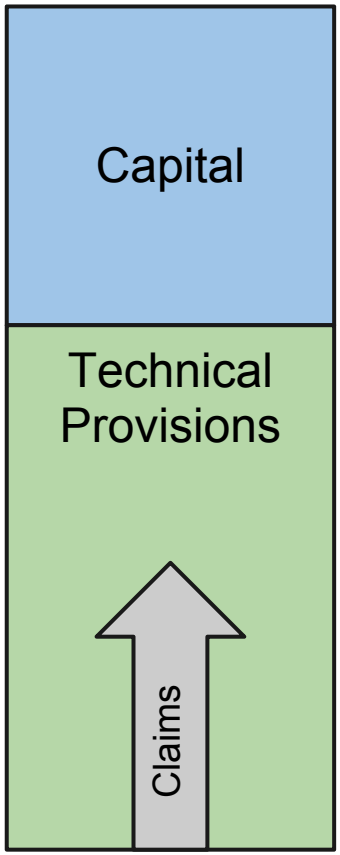


Other methods provided by ChainLadder

- Munich chain-ladder
- Multivariate chain-ladder
- Generalised linear models
- Bayesian methods
- Loss development factor fitting curves

If reserving capital is well understood ...

- Insurer with proven reserving track record have to carry 'excess capital'
- Stochastic models allow
  - To split capital in layers of riskiness
- Potential investment opportunity for capital markets



Conclusion and Outlook

- Stochastic methods provide a better understanding of the reserving risk
  - Opportunities for more efficient capital management

- Next steps for the package
  - Write package vignette
  - Find more volunteers
  - Establish consistent user interface

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- my co-authors:
  - Dan Murphy
    - http://trinostics.com/
  - Wayne Zhang
    - http://www.actuaryzhang.com/

- all who contributed to the package with bug reports, feedback and suggestions

Links and contact

ChainLadder:

- http://code.google.com/p/chainladder/

My blog:

- http://lamages.blogspot.com/

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References

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