Chain Ladder Plus

A versatile approach for claims reserving

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This presentation is about the work in Pittarello, Hiabu, and Villegas ([2023](#))

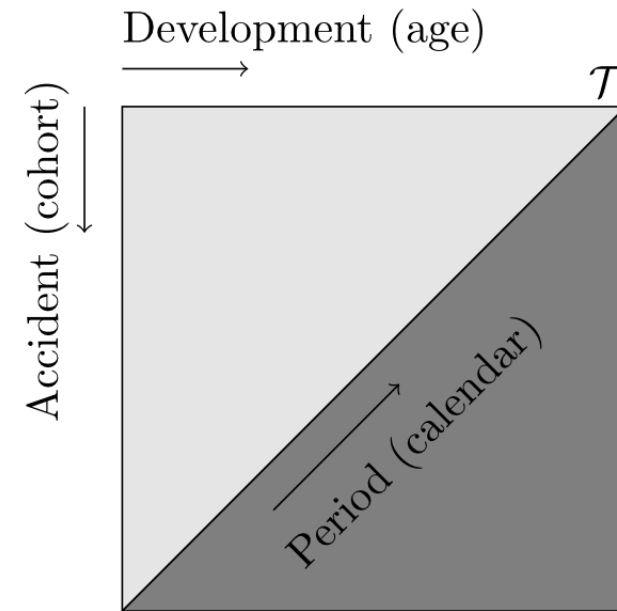Munir Hiabu, Assistant professor. University of Copenhagen.

Andres Villegas Ramirez, Senior Lecturer. UNSW, Sydney.

and the complementary R package `clmplus`, a user friendly implementation of our methods.

Motivation

Lexis diagrams and run-off triangles

Notation	Lexis diagram	Run-off triangle
j	age	development
k	cohort	accident
k+j	period	calendar

We consider the hazard rate models μ_{kj} from the Age-Period-Cohort (APC) family:

$$\log(\mu_{kj}) = a_j + c_{k+j} + g_k,$$

and model the correspondence between development factors and (average) reverse time hazard rates, first appeared in Hiabu (2017):

$$\hat{f}_{kj}^{\mathrm{clmplus}} = \frac{2 + \widehat{\mu}_{kj}}{2 - \widehat{\mu}_{kj}}$$

Our development factors models can be naturally compared with the age-period-cohort models on the amounts $(X_{k,j})$, Harnau and Nielsen (2018).

Model family	Lexis dimensions	Effects
`clmplus`	**age (chain-ladder)**	a_j
`clmplus`	age–cohort	$a_j + g_k$
`clmplus`	age–period	$a_j + c_{k+j}$
`clmplus`	age–period–cohort	$a_j + c_{k+j} + g_k$
Harnau and Nielsen (2018)	**age–cohort (chain-ladder)**	$\log E[X_{kj}] = \eta_k + \gamma_j.$
Harnau and Nielsen (2018)	age–period	$\log E[X_{kj}] = \gamma_j + \zeta_{k+j}.$
Harnau and Nielsen (2018)	age–period– cohort	$\log E[X_{kj}] = \eta_k + \gamma_j + \zeta_{k+j}.$

Results
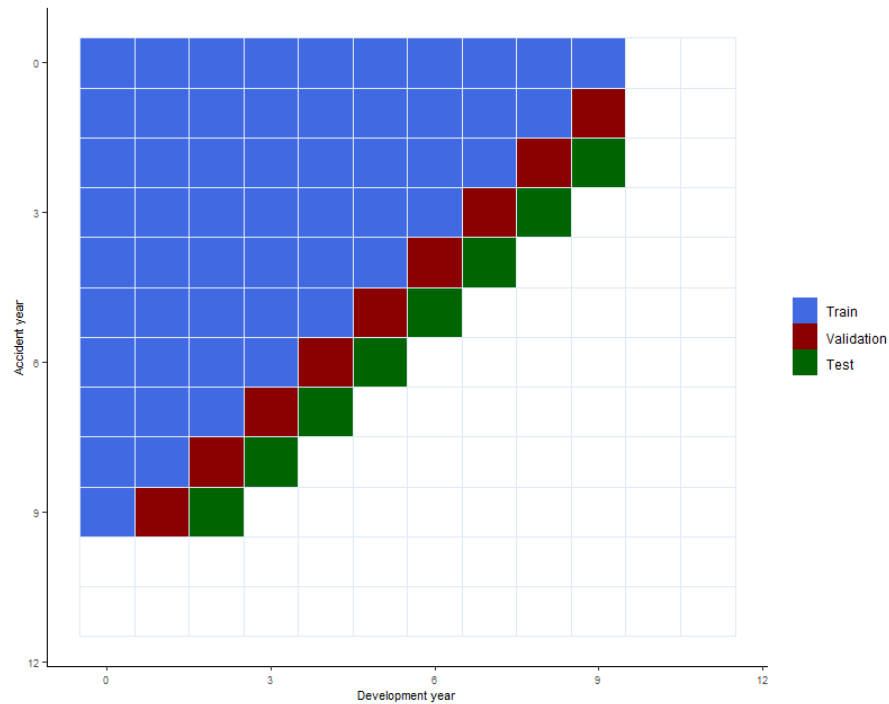
Data split, training (blue), validation (red), and test (green).
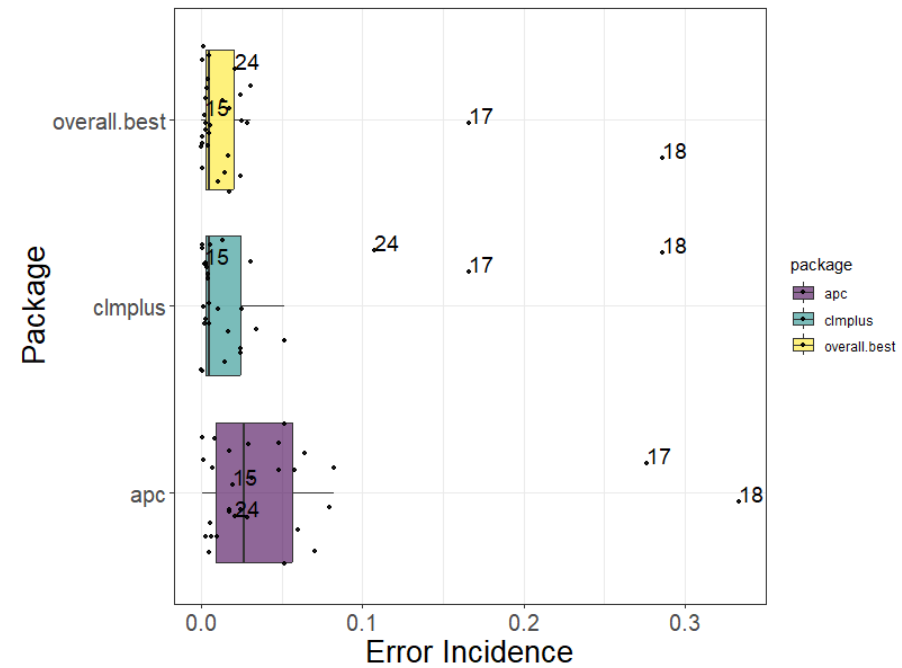
Error incidence comparison on the test set for each model family, `clmplus`, Harnau and Nielsen (2018) and overall best.

We compare our approach with Harnau and Nielsen (2018) on 30 public data sets. For each tool-box and for each data set, we train the models (blue), we select the best performing within the tool-box and the absolute best (red). We score their performance again on the test set (green). The performance measure is the error incidence $\mathrm{EI} = \left| \dfrac{\sum_{k+j=m} \hat{X}_{kj} - X_{kj}}{\sum_{k+j \leq m} X_{kj}} \right|$.
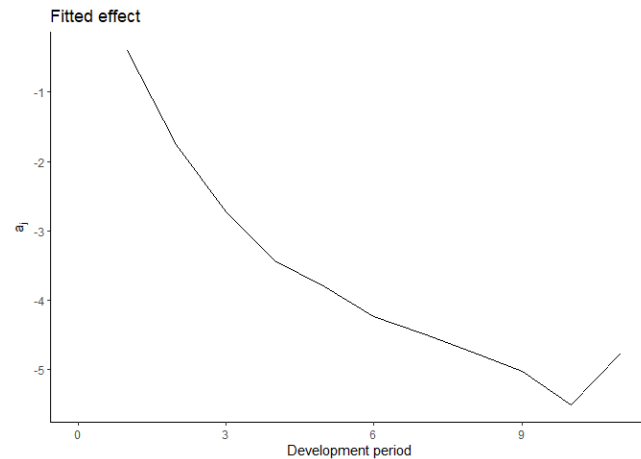
Implementation

The `clmplus` tool-box (age model)

```
1  library(clmplus)
2  data(sifa.mtpl)
3
4  sifa.mtpl.rtt <- RtTriangle(cumulative.payments.triangle=sifa.mtpl)
5
6  hz.chl=clmplus(RtTriangle=sifa.mtpl.rtt,
7               hazard.model='a')
```
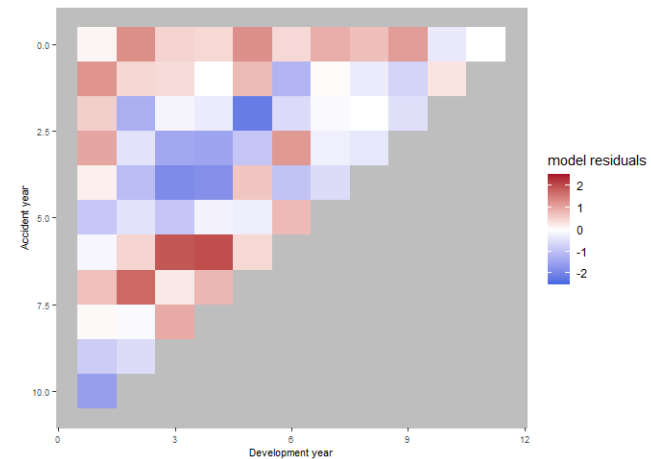
Plot the fitted effects

```
1  plot(hz.chl)
```


Inspect the residuals

```
1  plotresiduals(hz.chl)
```

Bibliography

Bibliography

Harnau, Jonas, and Bent Nielsen. 2018. "Over-Dispersed Age-Period-Cohort Models." *Journal of the American Statistical Association* 113 (524): 1722–32.

Hiabu, Munir. 2017. "On the Relationship Between Classical Chain Ladder and Granular Reserving." *Scandinavian Actuarial Journal* 2017: 708–29.

Pittarello, Gabriele, Munir Hiabu, and Andrés M Villegas. 2023. "Chain Ladder Plus: A Versatile Approach for Claims Reserving." *arXiv Preprint arXiv:2301.03858*.