M1 Introduction[1]

General Insurance Modelling : Actuarial Modelling III

Professor Benjamin Avanzi

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[1] References: Chapter 1 of Wuthrich (2020) | → latest slides

1. The nature of general insurance (MW 1.1)

2. Connections with the course contents

General insurance

- also called **non-life**, or **property and casualty**
  - Includes: car, liability, property, workers compensation, marine, credit, legal, travel, health, ...
- for more background:
  - see `general insurance practice` for further details about the general insurance area
  - see `Pooling and Insurance` for further details about the law of large numbers mechanism

1. The nature of general insurance (MW 1.1)
   - General insurance
   - Risk components
   - Premium components

Risk components

Risk / randomness comes from different sources:

- Pure randomness (also called "process risk" or "aleatoric risk")
  - Nature of the risk
  - Can be "controlled" by volume (law of large numbers)

$$\lim_{n\to\infty} \Pr\left[\left|\frac{1}{n}\sum_{i=1}^{n} Y_i - E[Y_i]\right| \geq \epsilon\right] = 0$$

- Model risk ("epistemic risk")
  - *All models are wrong, some are useful*
  - model world $\neq$ real world
  - even if model was right, wrong parameters
  - non-stationarity

$\Longrightarrow$ we need to add a buffer/margin to the cost of the risk transfer.

Insurance organises a risk transfer:

- costing of this transfer is an actuarial problem
- makes sense only because people are risk averse, unless insurance is forced: this is because the cost of insurance (the premium) is always higher than the expected value

1. The nature of general insurance (MW 1.1)
   - General insurance
   - Risk components
   - Premium components

Premium components

$$
\begin{aligned}
\text{gross premium} \quad = \quad & \text{pure risk premium} \\
& + \text{risk margin} \\
& + \text{profit margin} \\
& - \text{financial gains on investments} \\
& + \text{underwriting expenses} \\
& + \text{loss adjustment expenses (LAE)} \\
& (+ \text{taxes})
\end{aligned}
$$

This is not necessarily the premium that is charged to customers, but calculating the right hand side is one of the actuary's roles.

2 Connections with the course contents

- Modules
- R packages used in this course

Modules

- We typically insure multiple risks:
  - We need to know how to aggregate them (Module 2)
  - We need distributions for counts and sums, including random sums (Modules 2, 3, and 4)
  - Those risk may not be independent (Module 5)
- We need a distribution for the losses
  - The "pure risk premium" is the expectation of the risk (Module 3)
  - The "risk margin" is typically function of the distribution of the insured loss–a quantile, or a function of variance (Modules 3 and 4)
  - Sometimes those risks can be extreme (Module 6)
- Losses arise over time, and there may be time dependencies (relationships across time) that are relevant to the modelling (Modules 7-10)

2 Connections with the course contents

- Modules
- R packages used in this course

R packages used in this course

The following packages are useful and should be installed and loaded on your machines:

- `stats` is a generalist package providing statistical functions
- `MASS` ("Modern Applied Statistics with S") is a powerful package for data analysis
- `tidyverse` is a package for wrangling and preparing data for analysis
- `actuar` is a package with functions that are specific to actuarial studies see Dutang, Goulet, and Pigeon (2008)
- `fitdistrplus` builds on the abovementioned packages for advanced fitting features see Delignette-Muller and Dutang (2015)
- `VineCopula` package will be used extensively in Module 5 (Copulas)
- `evir` and `extRemes` will be used extensively in Module 6 (Extreme Value Theory) see Gilleland and Katz (2016)
- `xts` and `astsa` will be used extensively in Module 7–10 (Time Series and Analysis)

In the lectures that follows, I will indicate which package a function comes from the first time it appears by writing `package::function`, and then will drop the `package::` part as it is not needed once you load that library. [Note this allows you to call a specific function from a package without loading it (useful when there are package clashes).]

References

Delignette-Muller, Marie Laure, and Christophe Dutang. 2015. "Fitdistrplus: An r Package for Fitting Distributions." *Journal of Statistical Software* 64 (4).

Dutang, Christophe, Vincent Goulet, and Mathieu Pigeon. 2008. "Actuar: An r Package for Actuarial Science." *Journal of Statistical Software* 25 (7).

Gilleland, Eric, and Richard W. Katz. 2016. "extRemes 2.0: An Extreme Value Analysis Package in R." *Journal of Statistical Software* 72 (8).

Wuthrich, Mario V. 2020. "Non-Life Insurance: Mathematics & Statistics." Lecture notes. RiskLab, ETH Zurich; Swiss Finance Institute.