M1 Introduction

General Insurance Modelling : Actuarial Modelling III [1]

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[1]References: Chapter 1 of Wuthrich (2022) | → latest slides

1. The nature of general insurance (MW 1.1)

2. Connections with the course contents

1 The nature of general insurance (MW 1.1)

- General insurance
- Risk components
- Premium components

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

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

$\implies$ we need to add a buffer 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 "gross premium") is always higher than the expected value

1. The nature of general insurance (MW 1.1)
   - General insurance
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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 jobs.

1. The nature of general insurance (MW 1.1)

2. Connections with the course contents

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 risks 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 follow, 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. 2022. "Non-Life Insurance: Mathematics & Statistics." Lecture notes. RiskLab, ETH Zurich; Swiss Finance Institute.