UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Evaluation of Risk

2526-2-F1601M090-F1601M082M

Learning objectives

1. Knowledge and Understanding
The module provides a sound methodological framewound for the quantification, prediction, and management of risk, particularly in the context of non-life insurance, with potential extensions to financial and emerging risks (cyber, climate...). Core topics include collective risk theory, generalized linear models (GLMs), and the foundations of extreme value theory.

2. Ability to Apply Knowledge and Understanding
Students learn to apply the acquired statistical and computational tools to real-world problems in risk measurement and management. Emphasis is placed on the practical use of software such as SAS (for data coding, graphical representation, and frequency-severity GLMs) and MATLAB (for analyzing the right-tail behavior of insured loss distributions).

3. Independent Judgment
The course develops students' ability to critically assess modeling choices and underlying assumptions in risk analysis. They are encouraged to reflect on the suitability of the applied methods and the reliability of results, with particular attention to decision-making implications in actuarial and financial contexts.

4. Communication Skills
The module enhances the ability to clearly and rigorously communicate analysis results, both in written reports and through effective visual tools. Students gain familiarity with the technical language of the insurance field and are encouraged to present and discuss their analytical decisions in collaborative environments.

5. Learning Skills
The module fosters the development of an autonomous and interdisciplinary learning approach, essential for pursuing advanced studies in actuarial science and quantitative disciplines. The integration of theory and practice supports active and long-lasting learning, also beneficial for future professional engagement.

Contents

The course is organized in two parts, each including theory and applications:

1. Theory: introductory actuarial theory, collective risk modeling, risk pricing and risk reserving for non-life insurance, generalized linear models for insurance princing. Applications: SAS lab on GLMs for frequency-severity modeling.
2. Theory: statistical analysis of extreme events (classic and conditional EVT), reinsurance. Applications: Matlab lab for the estimation of estreme losses (Peaks-over-Threshold) and reinsurance pricing.

Detailed program

Part I: Non-life insurance pricing and reserving

1.1 Introduction to collective risk modeling, claim frequency and loss amount.

1.2 Risk premium, rating factors and key ratios used in non-life insurance pricing.

1.2 Distribution of the total claim cost and loss reserves.

1.3 GLMs: frequency-severity models, practical applications (SAS lab)

Part II: Risk, extreme events and reinsurance

2.1 Basic concepts of statistical Extreme Value Theory (EVT). Classical EVT and applications (estimation of the return period and return level of extreme events). Conditional EVT and applications (upper tail estimation for loss distributions).

2.2 Insurance applications of conditional EVT with the “peaks over threshold” -POT- method: estimation of tail risk measures (VaR, CVaR) and pricing of XL reinsurance contracts.

2.3 Pareto tail distributions and tail index estimation with semi-parametric methods.

2.4 Reinsurance

2.5 Computer lab - programming Matlab functions for:

- exploratory data analysis;
- non-parametric tests of randomness for time series of financial/insurance data;
- parametric estimation (POT) of extreme distributions and related risk measures (VaR, CVaR);
- pricing of an XL reinsurance contract with alternative methods (empirical, POT, semi-parametric).

Prerequisites

Basic knowledge of descriptive statistics, probability distributions, statistical inference.

Being familiar with Matlab is an asset, but is not compulsory. An introduction to Matlab is given in the first laboratory, and can be adjusted to the students' needs.

Teaching methods

The module consists of 5 ects (=35 hours). Lectures are taught in presence in a computer lab and combine actuarial risk theory with coding exercises in SAS and Matlab. Approximately 15 hours will be devoted to interactive activities (insurance data analysis on virtual machines).

In addition, there will be a series of seminars and meetings with professional actuaries and insurance experts.

Assessment methods

Assessment methods aim at verifying that students:

1. have understood the logic behind different statistical methods and are able to associate each method to the appropriate problems/data structures;
2. are trained in statistical methods in view of analyzing a real-world dataset and getting reasonable conclusions;
3. are able to interpret the output of a Matlab analysis and to detect possible data issues.

Assessment methods focus on problem solving and critical interpretation of statistical results, rather than mathematical formulae. Assessment is based on an oral exam, consisting of open questions, exercises and discussion of two case studies (solved by students with Matlab and SAS).

The final grade is the result of a global evaluation of the competences acquired by students in each of the above areas.

Textbooks and Reading Materials

The main source of course material is the e-learning platform, where students can find all the materials they need to prepare for the exam, in particular:

- lecture notes
- exercises with solutions
- a guide to SAS and Matlab (including the statistical library EVIM for extreme value analysis);
- slides of seminars presented by insurance experts.

Students may wish to look into the following additional references:

- Part I: Daboni, L. (1993): Lezioni di tecnica attuariale delle assicurazioni contro i danni, Edizioni LINT Trieste (Chapters 1-4); Boland, P. J. (2007): Statistical and Probabilistic Methods in Actuarial Science, London: Chapman&Hall/CRC (Chapters 1, 2).
- Part II: Mc Neil, A., Frey, P., Embrechts, P. (2015): Quantitative risk management: Concepts, techniques and tools. Princeton University Press (Chapter 5).
- Part II and III: www.qrmtutorial.org : companion website for the book by Mc Neil, Frey, Embrechts (2015), with slides, case studies, datasets, programs.

Semester

Spring.

Teaching language

Italian.

Sustainable Development Goals

QUALITY EDUCATION