Quantitative Risk Management

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Course aims and intended learning outcomes

In this course, we develop the main theoretical concepts and modelling techniques of QRM. The goal for the students is to acquire practical tools to solve real life problems. We discuss risk management in the context of finance and insurance, but RM applies also to other sectors of the industry.

Main concepts include loss distributions, risk measures, interdependence and concentration of (extreme) risks, techniques derived from probabilistic modelling and statistical analysis, copula and extreme value theory. We also discuss corporate finance concepts like economic valuation of liabilities, capital, capital allocation and structure of capital.

The course is recommended to students who are interested in:
- Actuarial and financial mathematics
- Financial risk management
- Underwriting and market risk
- Corporate finance

Through examples and case studies from the practice, we explain how sophisticated mathematical methods can be integrated in the efficient management of an insurance portfolio of risk. At the end of the course, students should be able to understand how a modern financial institution manages her risks.

Course content

A. The concept of risk, risk measures, and the pricing of risk (4 hours)
   1. Definition of risk in insurance
   2. Risk and risk measures, a coherent measure of risk
   3. A simple example of pricing risk, what is the correct price?
   4. The various components of an insurance price
   5. Capital to cover the risk

B. Aggregation of risk and dependencies (4 hours)
   1. Effects of diversification on the price
   2. The right measure of dependency
   3. A hierarchical dependency structure to avoid over specification
   4. Pricing within a portfolio
   5. Dependence structure and diversification benefits

C. Concept of capital and management of capital (4 hours)
   1. The different perspectives on capital
   2. Risk based capital and economic capital
   3. Capital allocation, what is the right method for what purpose
   4. How much capital does an insurance company need?
   5. Structure of capital

D. Designing and implementing an internal model (4 hours)
   1. History of the development of internal model
   2. Purposes and goals of an internal model
   3. Structure and architecture of an internal model
   4. Model calibration and testing
   5. Conditions for embedding the model in the business process
E. Modelling of economic scenarios, their Impact on capital management (4 hours)
1. The influence of the economy on an insurance company
2. Various ways to build economic scenario generators (ESG)
3. The bootstrapping method to create scenarios
4. Yield curve modeling and stress scenarios
5. Testing of ESG

F. The new Solvency Regulations and the Role of Reinsurance (4 hours)
1. New context for the industry and new solvency regulation
2. Use of internal models and DFA
3. How to optimize a reinsurance cover
4. Case study: multi-lines and covers for catastrophic events

G. Adding time diversification to risk diversification (2 hours)
1. Bank and insurance as risk bearer and the challenges ahead
2. The example of natural catastrophes reserving
3. Measures to mitigate risk and time diversification
4. An investors’ perspective on catastrophe risks

H. Entreprise Risk Management (ERM), towards a holistic approach to risk management (4 hours)
1. The context of risk management: a changing risk landscape
2. Risk management culture
3. Risk and economic capital modeling
4. Emerging risk management
5. Risk controls and processes

Reading list
There is no book or article that covers the full set of chapters. Here are selected books and articles that would treat part of the course. In any case, the students will get a full set of slides for each chapter of the course.

This list is for those who want to deepen their knowledge in this field.

7. Integrating Corporate Risk Management, by Prakash A. Shimpi, David Durbin, David S. Laster, Carolyn P. Helbling and Daniel Helbling, Swiss Re Book, 1999
10. Actuarial Theory for Dependent Risks: Measures, Orders and Models, by Michel Denuit, Jan Dhaene, Marc Goovaerts and Rob Kaas, John Wiley & Sons, Chichester, 2005

Articles

1. An Illustrative Example of Pricing Risk by Michel Dacorogna and Christoph Hummel, TECHNICAL NEWSLETTER SCOR GLOBAL P&C, 2008
2. Capital at Risk Michel Dacorogna and Christoph Hummel, Global Reinsurance, 1st of July 2005
7. The influence of risk measures and tail dependencies on capital allocation, by Davide Canestraro and Michel Dacorogna, SCOR paper 7, January 2010
8. Adapting the solvency regulation to times of crisis, accepting the riskiness of the situation, by Jean-Luc Besson, Michel Dacorogna, Philippe Trainar, SCOR paper 6, January 2010


**Teaching method**

Most of the course will be lectures in front of students, but we will provide some exercises to deepen the understanding and discuss case studies coming from practice. Extensive slides will be distributed to the students and a research project will be used to conclude the course.

**Assessment method and criteria**

The assessment will be done through a research project. By team of two or three, the students will be given a research project to conclude in 8 weeks with a personal report of maximum 15 pages. The research can be done in a team, but the report must be individual.

**Notes and prerequisites**

Place and time of consultation hours

The course will happen over twice 8 days 2 to 3 hours per day (April 15th to April 21st and May 6th to May 12th). There will be consultation hours at the end of each lecture day from 5 to 6pm.