UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Financial Risk Theory

2425-2-F1601M061

Learning area

Learning objectives

The course aims to give the main tools for the risk measurement and management and to deepen the knowledge of the statistical tools learned during the basic courses of statistical inference and probability in order to improve the student's ability in analyzing financial time series. To this end, interval estimation and hypothesis testing techniques will be extended to the time series context and they will be applied in order to study the features of financial returns.

Copulas will be used to deepen the knowledge of the CreditMetrics and CreditRisk+ model by considering the possible dependence among the elements of the credit portfolio.

Some numerical applications will be provided and, if possible in the second semester, some lessons will be held in the computer lab so that the theoretical insights can actually lead to an increase of the student's practical ability.

Contents

Value at Risk, Conditional Value at Risk, risk measures and optimization.

Statistical inference for time series and inference for risk and performance measures of financial assets. Introduction to Copulas and their use in CreditMetrics and CreditRisk+.

Detailed program

Preliminaries. Review on probability theory, quantiles, first and second order stochastic dominance and portfolio theory, and statistical inference.

Risk measures and portfolios of derivatives. Definition of a risk measure. Definition of Value at Risk (VaR) and outline of the Basel Committee rules. Examples of computation of VaR for discrete and continuous distributions. Properties of VaR. Computation of VaR for portfolios of stocks under the assumption of normality of the yields of the stocks. Delta and Delta-Gamma approximations of the computation of the VaR of derivatives portfolios (under the assumption of normality of the yield of the underlyings). Outline of the estimation of the Variance-Covariance matrix. Historical simulations and Monte Carlo Method for the computation of VaR. Backtesting. Drawbacks and applications of VaR.

CVaR and optimization. Axiomatic definition of a coherent risk measure. Conditional Value at Risk (CVaR): definition, examples and coherence. Application of CVaR to portfolio optimization. Acceptance set of a risk measure and representation of risk measures via acceptance sets.
Coherent (and convex) risk measures and thier relation with utility theory.

Overview of dynamic risk measures, capital allocation problems and systemic risk measures.

Numerical examples and complements.

The delta method and its applications
Normality tests and goodness of fit tests
Kernel Density Estimation

Definition of stochastic process in discrete time

Laws of large numbers and central limit theorems for dependent data and their applications in finance
Descriptive and Inferential analysis of the returns of financial assets: inference on the expected return, standard deviation, VaR, and Sharpe Ratio.
Copulas and their applications in the CreditMetrics and CreditRisk+model.

Prerequisites

Basic notions of mathematical analysis, probability theory, statistical inference, and informatics.

Teaching methods

The lessons will be held mainly in presence with traditional lectures and exercises. A small percentage (anyway, smaller than 30%) could be taken online (in streaming) in case of necessity.

In all the lectures a "mixed" approach will be used: moments of erogative teaching and of interactive teaching will alternate in variables proportiosn (also depending on the subject and of the activity). Typically, the interactive component will be greater during exercises and lab and, roughly, around 30% of the total.

Assessment methods

Risk measures:

The exam is composed by a written part (composed by open questions and exercises) and an optional oral part. The final score takes into account the parts above.

The exam can be replaced - if agreed by the student - by the development and discussion of an assignment to be done and discussed necessarily by January 2025.

Statistica dei mercati finanziari:

The exam is divided in two parts:

1. theoretical examination: the student is required to answer in writing to some open-ended questions.
2. practical examination: the student is required to apply the theoretical tools studied during the course in a practical test on a pc (using the R software).

The final evaluation will be given by the average of the evaluations in the theoretical and practical tests.

The final score of Financial Risk Theory is obtained by weighted average of the marks of Risk measures and of Statistica dei mercati finanziari.

Textbooks and Reading Materials

Artzner, Delbaen, Eber and Heath (1999): “Coherent measures of risk”, Mathematical Finance.

Danielsson, J. (2011). Financial risk forecasting: the theory and practice of forecasting market risk with implementation in R and Matlab. John Wiley & Sons.

Duffie, Pan (1997): “An Overview of Value at Risk”.

Follmer, Schied (2004): Stochastic Finance. An introduction in Discrete Time. De Gruyter. http://search.ebscohost.com.proxy.unimib.it/login.aspx?direct=true&db=nlebk&AN=388088&site=ehost-live&scope=site

Hull (2000):“Options, futures and other derivatives”; Prentice Hall.

Jorion (2000): “Value at Risk”, Mc Graw Hill.

Meucci (2005): “Risk and asset allocation”, Springer Finance.

Rosazza Gianin, Sgarra (2013): Mathematical Finance: Theory Review and Exercises. Springer

Wilmott (2003):“Introduzione alla Finanza Quantitativa”, Egea.

Nelsen, R. B., An Introduction to Copulas, Springer, 2006.

Karlin S. and Taylor, H.M., A First Course in Stochastic Processes. Academic Press, 1975.

Classroom materials provided during the lessons

Sustainable Development Goals

DECENT WORK AND ECONOMIC GROWTH | INDUSTRY, INNOVATION AND INFRASTRUCTURE