

Statistical Methods with Application to Finance

a.y. 2025/2026

Summary

The goal of this course is to provide students with an understanding of various statistical tools commonly used in the framework of economics and finance, with a focus on financial risk.

Specifically, students will learn the main features of financial data and recognize the stylized facts of asset returns; the course will teach students the basics of time series models and forecasting techniques; finally, more complex models for dealing with non-constant volatility will be discussed.

Example of applications to real-data will be presented during the course. Students will learn how to apply fundamental techniques from exploratory data analysis, simple models for stationary processes and model selection. Practical sessions (about 10 hours) will be devoted to the use of the statistical software R (<https://www.r-project.org/>) for the analysis of financial data and estimation of statistical models for time series.

The *Statistics* course is a prerequisite for this course.

Short content of the course

Review of basic concepts on financial markets, prices and risk.

Returns; log returns; multi-period returns; issues for portfolios. Index numbers and stock market indices. Distributional properties of returns; review of statistical distributions and their moments; visualization of financial data.

Simple models for financial time series.

Characteristics of time series data; stationarity; correlation and autocorrelation function; white noise and linear models; autoregressive models; simple moving average models; ARMA Models; residual analysis, diagnostics and model choice; unit-root nonstationarity; integrated ARMA (or ARIMA) models; introduction to seasonal models.

Forecasting

Point forecasts and prediction intervals, exponential smoothing, forecasting using ARMA models.

GARCH and conditional volatility

Testing for ARCH effects; the ARCH model; GARCH models; fitting ARMA+GARCH Models to financial returns.

Risk measures (Optional).

How to measure financial risk? Value at risk and expected shortfall. Risk aggregation.

Textbooks and other material

The material for the course will be available at the Moodle page for the course and includes slides, exercises, sample tests, report and scripts for the R labs, ecc.

Reference books:

- J. Danielsson, “Financial Risk Forecasting”, 2011, Wiley & Sons
- R.S. Tsay, “An Introduction to the Analysis of Financial Data with R”, 2013, Wiley & Sons
- D. Ruppert, D.S. Matteson, “Statistics and Data Analysis for Financial Engineering with R examples”, 2015, second edition, Springer

Structure of the course

The course will consist of frontal lectures and practical exercises (45 h). For active participation in R sessions, students are encouraged to bring a laptop with R and RStudio installed. Self-assessment quizzes and homework assignments will be scheduled during the course.

The course will be held in presence and students are encouraged to attend all lessons. Lecture recordings will be available to the course team via MS Teams. Any changes that occur in the timetable will be communicated via Moodle.

Lecturer

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Visit the personal units page for office hours.

Final Exam

The final exam consists of a 2-hour written test with theoretical questions and exercises, aimed at ascertaining the student’s knowledge of the topics covered in class. The exam also includes questions to verify the student’s ability to interpret and discuss the results of statistical analyses performed with the R software on real data sets.

The final grade is on a scale of 30 and a minimum score of 18/30 is needed to pass the exam. Note that it is compulsory to register in Esse3 within the reported deadline.