



UNIVERSITÀ
CATTOLICA
del Sacro Cuore

Quantitative methods for finance

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Course aims and intended learning outcomes

This course provides the students with key quantitative tools for the analysis of financial markets and for the study of optimal decisions made by rational agents. We will examine a set of models that describe the dynamics of asset values under uncertainty. The common thread will be the principles of absence of arbitrage and of market completeness. We will then investigate the technical nature and the economic/financial nuances of the solutions to optimization problems that are associated with rational decision making. We will then carefully study the dynamics of asset values exposed to market risk, as well as to interest rate risk, with a particular focus on risk premia. Theory will be constantly exemplified with classroom applications.

At the end of the course, the student will be familiar with a series of models describing the dynamics of financial asset prices in the presence of different sources of risk. The student will be able to employ these models for asset pricing purposes, as well as for asset allocation decisions.

Course content

One-period financial markets

- construct investment strategies and spot first- and second-type arbitrage opportunities;
- associate the no-arbitrage assumption with the existence of a risk-neutral probability measure;
- relate the concept of market completeness to the one of payoff profiles' replication;
- find no-arbitrage prices for claims that provide given payoff profiles.

Optimization techniques for economics and finance

- properly set up optimization problems related to the unconstrained/constrained objectives of rational agents;
- work out either paper-and-pencil or numerical solutions of such problems;
- appreciate the underpinnings of the solution techniques employed;
- grasp the economic/financial interpretation of the solutions obtained.

Asset values: levels and dynamics

- comprehend the quantitative nature of market risk as well as of interest rate risk;
- understand the equilibrium return on an asset exposed to one of such risks;
- understand the equilibrium price of a non-underlying asset exposed to market risk;
- understand the equilibrium price of a fixed-income asset exposed to interest rate risk.

Reading list

Lecture notes made available on Blackboard.

A. BATTAUZ-F. ORTU, Arbitrage Theory in Discrete and Continuous Time, EGEA, last edition.
J.H. COCHRANE, Asset Pricing, Princeton University Press, 2001.
K. SYDSAETER-P.J. HAMMOND, Mathematics for economic analysis, Prentice-Hall, 1995.

Teaching method

The course is based on frontal teaching with classroom applications of the theory covered.



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Assessment method and criteria

The valuation mark is based on a final written exam, which is made of an open question and a number of multiple-choice questions, aimed at assessing the understanding the theory and the applications of the topics studied, with a maximum score of 32 points. The score, rounded to the closest integer (i.e. ceiled if the decimal part is at least 0.5, floored otherwise), will be the final mark of the course. The “cum laude” mention will be awarded if the rounded score is at least 31. Some simulations of the written exam are published on Blackboard.

Notes and prerequisites

Students should be acquainted with:

- fundamentals of linear algebra;
- basic notions of financial mathematics under certainty (e.g. Compounded interest and annuities);
- random variables and the features of their probability distributions (mean, variance and standard deviation), as well as the features of joint and conditional distributions (covariance and correlation, conditional expectation and variance); Gaussian distributions;
- elements of derivatives pricing (e.g. As they are presented in the Chapters 1-11 of the textbook ‘Options, Futures, and Other Derivatives’, seventh edition, Prentice-Hall, by John Hull).

Office hours

The instructors’ office hours are published on the corresponding personal web pages.