UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Mathematical Finance

2526-3-E3303M024-E3303M031M

Learning objectives

Knowledge and understanding:
Students will acquire a theoretical understanding of fixed income securities, the interest rate term structure, and the main derivative instruments, as well as the models used for their valuation.

Applied knowledge and understanding:
At the end of the module, students will be able to apply mathematical models and quantitative tools to evaluate bonds, build efficient portfolios, and manage risk through derivatives.

Judgment and critical thinking:
Students will be able to critically evaluate assumptions, financial models, and analytical results to interpret complex financial situations and make informed decisions.

Communication skills:
Students will acquire the ability to communicate quantitative results and investment strategies clearly and effectively to both specialist and non-specialist audiences.

Learning skills:
The course lays the foundations for independent study of advanced models and consultation of specialist literature, providing useful skills for learning in the field of quantitative finance.

Contents

The module covers the functioning and valuation of bonds, including different types of bonds, price and yield calculation, analysis of associated risks, and sensitivity measures such as duration and convexity. It then focuses on the principles of portfolio management, concentrating on yield, risk, the efficient frontier, and optimal portfolio construction. Finally, it explores the main types of derivative instruments such as futures, forwards, and options.

The module integrates theoretical lectures with applied components. Materials from the Bloomberg platform will be used to analyze real-world data and demonstrate financial market dynamics. Additionally, the use of Excel will be demonstrated as a tool to apply key quantitative methods for bond valuation, portfolio optimization, and derivative management.

Detailed program

Bond Price and Yield:

1. Basic Features of a Bond
2. Different Types of Bonds
3. Pricing of Zero Coupon Bonds, Fixed-Rate Bonds and Floating-Rate Notes
4. Yield Measures for Fixed-Rate Bonds
5. Analysis of the Risk Factors (Interest Rate Risk, Credit Risk, Market Liquidity Risk)
6. Duration and Convexity

Portfolio Management:

1. Return and Risk
2. Market Characteristics
3. Efficient Risky Portfolios and Efficient Frontier
4. Optimal portfolio

Futures and Forwards:

1. Basic Characteristics
2. Profit and Loss
3. Leverage Effect
4. Pricing and Valuation
5. Hedging

Options:

1. Basic Characteristics
2. Call Option and Put Option
3. Profit and Loss
4. Intrinsic Value and Time Value
5. Binomial Option Pricing Model
6. Black-Scholes Option Pricing Model
7. Put-Call Parity
8. Leverage Effect
9. Option Price Sensitivities.

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Prerequisites

Metodi matematici e statistici 1 is a propaedeutic exam.

Teaching methods

The module includes mainly classroom-based theory lessons and interactive teaching sessions, with discussions, collaborative exercises, and case studies to encourage active student participation. Some of the activities (up to a maximum of 30% of the total) may be delivered remotely, subject to notification by the instructor. Online lessons may be conducted synchronously (streamed) or asynchronously (recorded).

Assessment methods

At the end of the module, there will be a written exam and, at the request of the instructor and/or student and if the written exam is passed, an additional oral exam.

The written exam includes:

- open-ended exercises that allow the instructor to assess the student's ability to apply theory to problem solving.
- theoretical questions, in which the student is asked to provide complete definitions, statements, and proofs of theorems, as well as examples and explanations.

The oral exam consists of theoretical questions and problem solving exercises.

Textbooks and Reading Materials

- E. Mondello. Applied Fundamentals in Finance - Portfolio Management and Investments (2023) Springer Texts in Business and Economics https://doi.org/10.1007/978-3-658-41021-6
- Lecture slides and materials provided by the instructor

Further readings:

- J. C. Hull. Options, Futures, and Other Derivatives, Global Edition 11th Edition (2021) Pearson"

Semester

First semester

Teaching language

English

Sustainable Development Goals

QUALITY EDUCATION