UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Equity Derivatives

2526-2-F1601M064-F1601M074M

Learning objectives

The aim of the course is to provide students with the main mathematical and numerical tools useful for the evalutation of equity derivatives. Furthermore, duting the course the main volatility models are presented.

The main targets are:

1. Knowledge and understanding
   Students will acquire a solid understanding of the theoretical aspects connected with the main topics covered during the course, such as the types of path and non-path dependent derivatives.

2. Applying knowledge and understanding
   Students will be able to effectively apply mathematical methods to solve practical problems consistent with the course topics and to simulate the price dynamics of an equity. Moreover, they should be able to download financial data and to use Bloomberg for pricing non vanilla options.

3. Making judgements
   Students will develop logical and analytical skills useful for tackling and solving complex problems, including those interdisciplinary in nature, and for critically evaluating the obtained results.

4. Communication skills
   Students will learn how to correctly use the mathematical language, so as to accurately and coherently express the acquired theoretical notions, as well as to effectively communicate ideas, methods and results.

5. Learning skills
   Students will develop an independent study method, enabling them to approach subsequent, more advanced studies with awareness and success.

Contents

Black&Scholes and Ito’s lemma for multivariate functions

Change of Numéraire technique.

Exchange and Exotic Options

Numerical Methods in Finance

Stochastic volatility models

Volatility derivatives

Detailed program

Black&Scholes and Ito's Lemma for multivariate functions:
Limits of the Black and Scholes model.
Normal Mixture model for option pricing.
Ito’s lemma for multivariate functions.

Change of Numéraire technique: Introduction to the Change of Numéraire technique.
Derivation of B&S formula using the Change of Numéraire technique

Exchange and Exotic Options: Valuation of Exchange options through change of Numéraire.
Exotic Options: path and non-path dependent.

Numerical Methods in Finance I

Iterative methods: Bisection, Secant and Newton-Raphson Methods and Calibration problem (Matlab functions: fmincon and fminunc)

Monte Carlo Simulation: Theory, Confidence Intervals and Variance Reduction techniques.
Simulation of sample paths and application for option pricing.

Numerical Methods in Finance II
Monte Carlo Simulation for path dependent options.
Binomial and Trinomial tree implementation (an introduction).

Pricing derivatives in Bloomberg

Plain vanilla option prices and implied volatility surface
Simulated scenarios for the underlying and pricing of exotic derivatives in Bloomberg.

Numerical Methods in Finance III
Finite Difference Approximation: first and second derivative.
Application of the finite difference method for the Greeks.

Stochastic volatility models Stochastic Volatility: Derivation of the valuation Equation.
Properties of Stochastic Volatility. Implied Volatility Surface.
Heston Model: simulation, pricing formula and volatility surface.

Volatility derivatives
The log-contract replication formula.
Variance and Volatility Swaps. VIX Index: CBOE Formula.

Prerequisites

Good knowledge of financial math, derivatives and coding.

Teaching methods

Classes with classical teaching methods and practical interactive sessions (Excel, Matlab and use of the data provider Bloomberg).

Some of the lectures will be provided remotely (at most 30% of the hours) in streaming or recorded. The teacher will communicate in advance which lessons will be provided remotely.

Assessment methods

Project work and subsequent oral examination

Final grade=0.4*Grade of the project work+0.6*Grade of the Oral Examination

Project work

-Students will be organized in small groups and each group will receive an assignment related to some of the topics seen during the course. Data used will be downloaded from Bloomberg.

- Each group should produce a report on the assigned project work. Matlab codes used to produce the report should also be included.

Oral examination

-The oral exam and the final grade are individual.

-During the oral examination there be a discussion on the project and on the topics covered in the course.

Textbooks and Reading Materials

Slides and Matlab codes will be provided by the teacher in the elearning page of the course.

J. Hull, 'Options, Futures and other derivatives', 7th edition in English (Prentice Hall).

P. Glasserman, 'Monte Carlo Methods in Financial Engineering' Springer Science, 2003

Semester

First Semester

Teaching language

Italian

Sustainable Development Goals

QUALITY EDUCATION | GENDER EQUALITY