UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Advanced Derivatives

2122-2-F1601M064

Learning objectives

The aim of the course is to provide students with the main mathematical and numerical tools useful for the evalutation of interest rate and equity derivatives.

Contents

Interest Rate Derivatives

- FRA, Futures, and Swaps
- Rate curve bootstrapping in multi-curve regimes
- Black Model and its shifted log-normal variants
- Interest rate volatility: par, forward, no-arbitrage, and SABR model
- Term structure models: equilibrium, no-arbitrage, short rate, and market models
- Caps and Floors, Swaptions, and Bermudan Swaptions
- Credit Default Swaps
- Credit curve bootstrap
- Counterparty risk: clearing, collateralization, and XVA valuation adjustments
- Market risk management: greeks and static replica of structured products

Equity Derivatives

- *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

Interest Rate Derivatives

- Interest Rate Basics
- Rate Curves Calibration
- Black Model
- Volatility
- Caps and Floors
- Swaptions
- Structured Products
- Greeks and Hedging
- Interest Rate Models
- Bermudan Swaption
- Credit Derivatives
- Counterparty Risk, Collateral Protection and Central Clearing
- Credit Default Swaps
- Credit Curve Bootstrapping
- XVAs: Introduction to Valuation Adjustments

- The Reform of Benchmark Interest Rate Indexes and Its Impact on Derivative Pricing

Equity Derivatives

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).

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 in Matlab.

Teaching methods

Classes and practical sessions (Excel, QuantilibXL e Matlab)

Assessment methods

Project work and subsequent oral examination

Textbooks and Reading Materials

Slides provided by the lecturers

For Interest Rates Derivatives

John Hull, Options, Futures and Other Derivatives, 10th edition

Paul Wilmott, on Quantitative Finance

For Equity Derivatives

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