6 ECTS

15F020

Pricing Financial Derivatives

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Introduction

This course gives an introduction to one of the branches of finance that requires advanced quantitative techniques which is derivatives pricing. Taking observed market prices as input we will introduce and use the mathematical tool of Itô calculus to obtain the corresponding value of derivatives of the stock. The main model is Black-Scholes model, but stochastic volatility and variance gamma will also be examined. We will also see how this theory extends to stochastic interest rates.

Objectives

The main purpose of this course is to introduce the machinery of Itô calculus and show how it can be applied to solve the problem of pricing and hedging financial derivatives on continuous and discrete time models, such as options, futures and forwards contracts. By the end of the course, students will have good knowledge of how these products work, how are they used, how are they priced and how financial institutions hedge their risks when they trade the products.

Required Background Knowledge

The students are expected to have taken during their studies a basic Probability and Statistics course. Therefore, we expect them to be familiar with the basic concepts of Probability such as probability space, random variables, distribution of a random variable and common discrete and continuous distributions such as Normal, Poisson etc., and expectations. However, all these concepts will be revised during the course.

Learning Outcomes

By the end of the course, the students will be able to use the machinery of Itô calculus, and be capable to evaluate the price of current financial derivatives and construct the hedging portfolio. Practitioners from banks will be invited to give seminars to students.

Methodology

Slides containing all the material will be exposed in class and completed with explanations in the white board. There will be list of exercises for each chapter that will be solved during the TA sessions.

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Evaluation

Homework assignments (30%) and final exam (70%). There will be some homework assignments, that will contain numerical exercises to be done using Matlab, and some theoretical exercises. The homework assignments are done in groups of 2 students. The final exam will contain theoretical exercises similar to those handled during the TA classes.

Course contents

Chapters 1, 2, 3, 4, 5, 7, 10, 12, 13 and 15 of the book: Joshi, M.J. The Concepts and Practice of Mathematical Finance Second Edition Cambridge University Press, 2008.

Specify a description, materials and cases that will be worked in class:

Session	Title, materials and cases
1	Introduction (Chapter 1)
2	Pricing methodology and arbitrage (Chapter 2)
3-5	Option pricing with trees (Chapter 3)
6	Practicalities (Chapter 4)
7-10	Itô calculus (Chapter 5)
11	Practical pricing (Chapter 7)
12	Exotic options (Chapters 8,9)
13	Static replication (Chapter 10)
14	American options (Chapter 12)
15-17	Pricing interest rate derivatives (Chapters 13,14)
18	Stochastic volatility (Chapter 16)
19	Variance Gamma models (Chapter 17)
20	Smile dynamics (Chapter 18)

Bibliography

Joshi, M.J. The Concepts and Practice of Mathematical Finance Second Edition Cambridge University Press, 2008.

Professor's Biography

Eulalia Nualart has a Tenured Associate Professor position at the Department of Economics of the University Pompeu Fabra since 2012. Before she had a permanent research and teaching position at the Department of Mathematics of the University of Paris 13, after doing a PostDoc at the University of Paris 6, with a research

fellowship from the National Swiss Foundation. She earned her PhD in Probability from the École Polytechnique Fédérale de Lausanne in 2002. She broadly works in the field of stochastic analysis and its applications to stochastic differential equations and stochastic partial differential equations.