3 ECTS

18F034
Advanced Option Pricing and Modeling

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Introduction

This is a course on stochastic volatility models with a special focus on real practice applications. Our starting point will be the need of consistently pricing different types of derivatives. Towards this end, we will cover some common concepts and techniques as local volatilities, forward start options or variance swaps. We will discuss the main properties of stochastic volatility models and their corresponding implied volatility surface. In particular, we will analyze in detail the Heston model and the SABR model. Finally, we will discuss the state-of-the art of volatility modeling. This course will be based on the book [1], by L. Bergomi (*Risk*'s 2009 Quant of the Year).

Objectives

The main purpose of this course is to introduce the main modeling problems in option pricing and hedging. By the end of this course students will become familiar with the main models and their applications in real market practice. Moreover, students will understand the limitations of these tools, and they will know about the state-of-the-art of the research in this area.

Learning outcomes

At the end of the course, the students will be able to work with the main tools in stochastic volatility modeling. In particular, they will be able to compute implied and local volatilities, to use volatility models to price different types of derivatives, and to calibrate these models from the implied volatility surface.

Required background knowledge

The students are expected to have taken the previous course 15F020- Pricing Financial Derivatives I.

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Methodology

Slides containing all the material will be exposed in class and completed with explanations and examples in Python.

Evaluation

The evaluation will be based on a project covering some the contents of the course. This project will include some exercises in Python.

Course contents

The course contents will be based on chapters 1, 2, 3, 4, 5, 6 and 8 of the book [1], that we will complement with the bok [2]. The outline of the course will be as follows:

Session	
1	• Introduction 1: Usable risk-management models. How (in)effective is delta hedging? The Black-Scholes case and the real case. On the way to stochastic volatility
2	• Local volatility 1: Local volatility as a market model. SDE of the local volatility model. From prices to local volatilities. The Dupire formula. No-arbitrage conditions.
3	• Local volatility 2: From implied volatilities to local volatilities. From local volatilities to implied volatilities.
4	• Local volatility 3: The dynamics of local volatility. Future skews and volatilities of volatilities
5	• Local volatility 4: Delta and carry P&L. The Vega hedge. Risk-managing with local volatilities.
6	• Forward-start options1: Pricing and hedging, The forward smile risk.
7	• Forward-start options2 : Forward-start options in the local volatility model.
8	• Variance swaps and delta-hedged log contracts
9	• Stochastic volatility models. An example of one-factor dynamics: The Heston model 1: Forward variances. Term-structure and smile. The limits of the model in practice
10	• Stochastic volatility models: The SABR model. Term-structure and smile. Rough volatilities

3 ECTS

18F034
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Bibliography

[1] Bergomi, L. Stochastic volatility modeling. Chapman and Hall/CRC, 2016.
[2] Gatheral, J. The volatility surface: a practicioner's guide. John Wiley & Sons, 2006.

Professors Biography

Prof. Alòs is Associate Professor at Universitat Pompeu Fabra. She earned her PhD in Mathematics from the University of Barcelona in 1998. Her research relies on the applications of stochastic analysis in mathematical finance. In particular, it is focused on the application of Malliavin calculus techniques and the use of fractional noises in market modeling. She has been one of the pioneers in modeling volatility by means of short memory processes (nowadays called 'rough volatilities'). She currently serves as an Associate Editor at *SIAM Journal of Financial Mathematics*. Her current collaborators include professionals both from the academia and from the industry.

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