MATH-470

Martingales in financial mathematics

Schmutz Michael

Cursus	Sem.	Type
Ing.-math	MA2, MA4	Opt.
Mathématicien	MA2	Opt.
Minor in statistics	E	Opt.
Statistics	MA2, MA4	Opt.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Oral
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

The aim of the course is to apply the theory of martingales in the context of mathematical finance. The course provides a detailed study of the mathematical ideas that are used in modern financial mathematics. Moreover, the concepts of complete and incomplete markets are discussed.

Content

- Discrete time models and the Fundamental Theorem of Asset Pricing
  - Fundamental results
  - Binomial- and trinomial model
  - The Snell envelope, optimal stopping, and American options

- Geometric Brownian motion and the Black-Scholes model
  - Option pricing and hedging
  - Greeks, volatility surface, model calibration
  - Exotic options

- On the theory of (no-)arbitrage in continuous time

- Selected topics on
  - Local- and stochastic volatility models
  - Stochastic interest rates
  - Lévy driven models
  - New trends in financial mathematics
  - Deep hedging

Keywords

martingales, semimartingales, financial mathematics, theory of (no-)arbitrage

Learning Prerequisites

Recommended courses

Stochastic calculation

Important concepts to start the course

Stochastic calculation

Learning Outcomes

By the end of the course, the student must be able to:

- Explore in detail the use of martingales in financial mathematics.
- Prove a criteria for absence of arbitrage in a framework based on a finite probability space and state an analogous general result.
- Prove a criteria for completeness of a viable market model framework based on a finite probability space and state an analogous general result.
- Explain the difference and the resulting consequences between claims and American options.
- Derive prices for some financial derivatives based on several different models.
- Derive different hedging strategies for some financial derivatives based on several different models.
- Analyze the choice of asset price models according to different criteria.
- Optimize the calibration of chosen asset price models.

Assessment methods

Exam oral
Dans le cas de l'art. 3 al. 5 du Règlement de section, l'enseignant décide de la forme de l'examen qu'il communique aux étudiants concernés.

Supervision

Office hours	Yes
Assistants	No
Forum	No
Others	Office hours by prior arrangement

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

- Lamberton, D. and Lapeyre, B. (2008), Introduction to Stochastic Calculus Applied to Finance, Second Edition, Chapman and Hall, London.
- Shiryaev, A.N. (1999), Essentials of Stochastic Finance: Facts, Models, Theory, World Scientific Publishing, Singapore.
- Barndorff-Nielsen, O.E. and Shiryaev, A.N. (2015), Change of Time and Change of Measure, Second Edition, World Scientific Publishing, Singapore.
- Eberlein, E. and Kallsen, J. (2019), Mathematical Finance, Springer Finance, Cham.
- Jarrow, R.A. (2021), Continuous-Time Asset Pricing Theory, Second Edition, Springer Finance, Cham.

Ressources en bibliothèque

- Introduction to Stochastic Calculus Applied to Finance / Lamberton
- Essentials of Stochastic Finance / Shiryaev
- Continuous-Time Asset Pricing Theory / Jarrow
- Mathematical Finance / Eberlein & Kallsen
- Change of Time and Change of Measure / Barndorff-Nielsen

Moodle Link

- https://go.epfl.ch/MATH-470