

Interest Rates Models

Syllabus. IRFA & MMMEF.

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1 Summary

This 18-hour course provides an in-depth introduction to the modelling of interest rates, in continuous time. Students will develop a solid understanding of term structures, arbitrage-free pricing of fixed-income instruments, and the dynamics of interest rates under risk-neutral measures. Particular focus is placed on short-rate models and their applications in bond and derivative pricing.

2 Prerequisites

Students are expected to have completed the Financial Products course or to be familiar with:

- Discounting and compounding
- Forward and futures pricing
- Basics of stochastic calculus (with a good command of Ito's lemma)

3 Learning Objectives

By the end of this course, students will: At the end of the course, students will be able to:

- Understand the concepts of yield, discount factors, and forward rates
- Use arbitrage arguments to derive fixed income pricing formulas
- Apply short-rate models (Vasicek, CIR, Ho-Lee, Hull-White) to price bonds and derivatives
- Understand Libor Forward Models

4 Course Outline

4.1 Fundamental Concepts

- Notations and products
- Fundamental law of pricing
- Girsanov Theorem
- Conditional expectation and changes of measures and numeraires

4.2 The Lognormal Forward LIBOR Model (LFM)

- The Black formula for caplets
- The Lognormal Forward LIBOR Model

4.3 Short Term rates models

- The Vasicek Model
- n- factors Hull-White models

5 Note to students

Students are encouraged to use R or Python for computational exercises.

This course is quite technical and specific to practice stochastic calculus. It brings together financial objects and advanced mathematical tools. Active engagement, completion of readings, and consistent practice are essential for taking the full benefit from it.

References

- [1] Alan Brace, Dariusz Gatarek, and Marek Musiela. The market model of interest rate dynamics. *Mathematical finance*, 7(2):127–155, 1997.
- [2] Damiano Brigo and Fabio Mercurio. *Interest rate models: theory and practice*, volume 2. Springer, 2001.
- [3] John Hull and Alan White. The general hull–white model and supercalibration. *Financial Analysts Journal*, 57(6):34–43, 2001.
- [4] Rogemar S Mamon. Three ways to solve for bond prices in the vasicek model. *Advances in Decision Sciences*, 8(1):1–14, 2004.