Fixed Income Derivatives: Risk Management and Financial Institutions

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Practical Information

My Information:

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I will be available by email and try to respond as quickly as possible.

However, asking questions in the break between lectures is often best.

Lectures

Mondays 15.00-17.00 at Gothersgade Aud. 1

Fridays 8.00-10.00 at Gothersgade Aud. 1

In lecture, I will combine the use of slides and the blackboard.

Lectures are intended to be self-contained, but you will benefit far more from lectures if you have read the material in advance.

The lecture notes will *not* contain all the material you will need and simply reading the slides will not be enough.

If you have not looked at the material yet, do still come to lecture.

SLIDES AND LECTURES!

Textbook:

Arbitrage Theory in Continuous Time (4th edition), Thomas Bjork
Oxford University Press, December 5. 2019, Chapters 4-5, 15 and 19-23

Papers and lecture notes:

Fixed Income Derivatives Lecture Notes, Martin Linderstrøm,
University of Copenhagen, February 3. 2013

Interpolation Methods for Curve Construction, Patrick S. Hagan and Graeme West,
Applied Mathematical Finance, June 2006, Vol 13, No 2., pages 89-129

Managing Smile Risk, Patrick S. Hagan, Deep Kumar, Andrew S. Lesniewski, Diana E. Woodward,
Wilmott Magazine, January 2002, Vol 1, pages 84-108

Pricing Derivatives on Financial Securities Subject to Credit Risk, Robert Jarrow and Stuart M. Turnbull,
Journal of Finance, March 1995

Valuation of Credit Default Swaps, Dominic O'Kane and Stuart Turnbull,
Fixed Income Quantitative Research, Lehman Brothers, April 2003

Supplementary readings:

Arbitrage Theory in Continuous Time (4th edition), Thomas Bjork
Oxford University Press, December 5. 2019, Chapters 1-3 and 6-8

Stochastic Calculus for Finance II: Continuous-Time Models, Steven Shreve
Springer Finance, June 28. 2005, Chapters 1-6

Problem sets

Weekly problem sets will be posted on Canvas.

I expect that you will work on *all* the problems posted in preparation for the exam.

The problem sets will be drawn from core course topics and are intended to resemble the questions asked on the final exam.

Students are strongly encouraged to work in groups to solve the problems.

Problem sets will consist of a combination of a problems requiring pen-and paper computations and problems involving the use of an appropriately chosen piece of software (Python).

Some solutions to the problem sets will be posted, but don't expect them to be very elaborate and do make sure you know how to solve the problems.

Software

Many of the problems sets and the exam will require some software.

In principle, you can use a wide range of different programs and programming languages *but* you are strongly encouraged to use Python.

Some of the problems will be simple enough that they can be solved in a spreadsheet but the majority of problems will require you to code yourself.

Throughout the course, we will develop a library in Python containing a wide range of tools also used in the financial industry.

How you use Python is up to you (Jupyter, Spyder or script) but solutions will be posted in the form of a simple script.

Check out Corey Schafer or others on Youtube for an introduction to Python.

Final exam

12 hour written, take-home exam on January 18. 2025

The exam is individual and NO collaboration is allowed.

The final exam will, to some extent, be individualized.

Exam questions will combine pen- and paper computations, programming and interpretations of the results.

You will be required to submit your code with the final exam in a form so that I will be able to run your code.

I will be more specific about the exam and what I expect of you when we get closer to the big day.

Why study fixed income markets?

- Fixed income markets are gigantic and huge sums of money change hands every day.
- Bonds are used by a wide range of institutions (governments, corporations, mortgages, etc.).
- Fixed income markets reflect the state of the economy and the actions of mayor players such as central banks.
- Fixed income markets also reflect the actions of individuals and both their willingness and ability to take risk.
- Many of the crises we have seen in the recent past have come from fixed income in some form.
- In this course, we will both the develop tools to analyze fixed income markets and also apply them in practice.

Course outline

Static discrete time models

Review of no-arbitrage pricing in a static discrete time market, first and second fundamental theorem of asset pricing, zero coupon bonds, the term structure of interest rates, forward rate agreements, fixed rate bonds, floating rate bonds and interest rate swaps.

Introduction to more exotic bonds and derivatives

BLAH BLAH BLAH

Brownian motion and Ito calculus

Brownian motion and its characteristics, quadratic variation, ordinary and stochastic differential equations, ito processes and Ito's lemma.

Course outline

Dynamic short rate models

Short rate dynamics, $\mathbb{P}$- and $\mathbb{Q}$ dynamics, no-arbitrage conditions, market completeness, the Vasicek, Ho-Lee, CIR and Hull-White models, forward rate models (HJM), forward measures, LIBOR market models, the Black model, swaptions and swap market models.

Interest rate derivatives

Bond options, greeks, caps and floors, swaptions, volatility smiles, SABR model, FX forwards, FX swaps, asset swaps and credit default swaps.

Market implementation

Model fitting, inversion of the yield curve, interpolation methods, hedging, risk management, yield-to-maturity, duration and convexity.