

Princeton University: Department of Economics  
**ECO 466/FIN 521: Fixed Income – Models and Applications (fall 2010)**  
(August 22<sup>nd</sup> 2010, preliminary)

Instructor: Ana Babus, ababus@princeton.edu  
Office hours: W 11:00-12:00pm  
Preceptor: Yi Li

BCF 103  
M,W 8:30-9:50am

Fixed income markets have experienced dramatic growth and innovation in recent years, and have come to play a central role in the day-to-day operation of the financial system (and the recent crisis). This course examines a broad range of securities traded in fixed income markets – from simple U.S. Treasuries and corporate bonds, through futures and options, to state-of-the-art credit derivatives – and develops the tools necessary to price and hedge them. The course will cover (a) the basic concepts of fixed income instruments, such as yield, duration, and convexity; (b) modern empirical methods used to describe bond yields, such as “curve fitting,” factor analysis and default probabilities; (c) modeling techniques for valuing fixed income securities and their derivatives (Vasicek, Cox-Ingersoll-Ross, Ho-Lee, Hull-White, Black-Derman-Toy, Heath-Jarrow-Morton, market models); (e) and how to apply these methods in practice to traditional derivative instruments (swaps, options), as well as, recently popular credit derivatives and structured products (mortgage backed securities, collateralized debt obligations).

### **1. Pre-requisites**

This course is intended for students in the Master in Finance program (FIN 521) and junior and senior undergraduates (ECO 466) with a significant mathematical background and an appetite for quantitative analysis. The prerequisites are:

- knowledge of calculus, including partial differentiation and integration;
- knowledge of probability and statistics;
- an introductory asset pricing class (ECO 362 or FIN 501);
- and a derivatives pricing class (ECO 465).

### **2. Grading**

FIN 521 and ECO 466 students are graded on a different curve. Course grades are based on:

- FIN 521: problem sets (20%), midterm exam (20%), final exam (40%) and a final project (20%)
- ECO 466: problem sets (20%), midterm exam (30%), and the final exam (50%)

Problem sets: There will be six problem sets assigned during the semester. Although students are permitted to work together on the assignments, each student must submit

their problem set individually. Some assignments will be purely analytical while others will be numerical, requiring the use of a programming language (e.g. MatLab) or Excel to process financial data. Late problem sets will not be accepted.

Midterm and final exam: The midterm will be in class on TBA. The final exam will be given during the exam period on a date to be announced by the Registrar. The midterm and final will be based on class lectures and on material covered in the problem sets.

Final project (for FIN 521 only): The final project will be due on January 11<sup>th</sup>, 2011. Requirements for the project will be announced at a future date.

### **3. Textbook**

The textbook for this course is Fixed Income Securities: Valuation, Risk and Management (John Wiley and Sons, 2010) by Pietro Veronesi; the book is available for purchase through Labyrinth Books.

Two optional textbooks are:

- Damiano Brigo and Fabio Mercurio, Interest Rate Models: Theory and Practice, 2nd ed., Springer Finance, 2006
- Jessica James and Nick Webber, Interest Rate Modelling, John Wiley and Sons, 2007.

Both of these books are quite dense and should be considered references rather than texts. If you decide to purchase one of them, the Brigo/Mercurio book is likely to be the best long-term investment. It is the most up-to-date in terms of the models and methods it covers and has a strong focus on practical implementation, which will be valuable should you decide to pursue a career in fixed income.

### **4. Additional References**

Additional references covering the mathematics of financial derivatives, general asset pricing knowledge and specialized topics in fixed income are listed below. References to the books will appear throughout the syllabus.

#### **Derivatives:**

John Hull, Options, Futures and Other Derivatives, 6th ed., Prentice Hall, 2005

This is the gold standard for a technical reference text on derivatives pricing and financial engineering. Fixed Income builds on many of the techniques developed in a typical derivatives course.

David MacDonald, Derivatives Markets, 1st ed., Pearson Education, 2003

An accessible introduction to options, futures and derivatives; the standard textbook used in ECO 465.

**Fixed Income:**

Suresh Sundaresan, *Fixed Income Markets and Their Derivatives*, 2nd ed., South-Western College Publishing, 2006

This book does a good job of explaining the details of fixed income markets and develops a good intuition for various models by using trees. This is a useful book to have if you are looking for simple illustrations of the arbitrage restrictions that have to hold across securities.

Bruce Tuckman, *Fixed Income Securities*, John Wiley and Sons, 2002

A simple and comprehensive introduction to the world of fixed income securities. Highly recommended as an introductory book.

**Credit:**

Darrell Duffie and Kenneth Singleton, *Credit Risk*, Princeton University Press, 2003

This is a specialized reference covering the pricing of credit-sensitive securities, such as defaultable bonds, credit default swaps and structured securities (e.g. collateralized debt obligations).

David Lando, *Credit Risk Modeling: Theory and Applications*, Princeton University Press, 2004

Another classic Ph.D.-level reference on credit risk.

## Course Outline

1. Introduction to Fixed Income Markets
2. Yields, Forward Rates and Arbitrage
  - a. Fixed income products and basic analysis
  - b. The term structure of zero-coupon (discount) rates
  - c. Duration and convexity
  - d. Theories of the term structure
3. Risk-neutral and Risk-forward Pricing
  - a. Change of measure
  - b. Risk-neutral probabilities and the stochastic discount factor
  - c. Ito's Lemma and stochastic calculus
  - d. The PDE approach to pricing
4. Affine Term Structure Models
  - a. Introduction to continuous-time modeling (Vasicek and Cox-Ingersoll-Ross)
  - b. Risk-neutral pricing: Monte Carlo simulation and trees
5. No-arbitrage Models
  - a. Ho-Lee and Hull-White models
  - b. Black-Derman-Toy model
6. Interest Rate Derivatives
  - a. Black's model
  - b. Bond options, caps, floors and collars
7. Multi-factor Models
  - a. Factor decomposition
  - b. Multi-factor affine models
  - c. Heath-Jarrow-Morton and market models
8. Credit and Credit Derivatives
  - a. Credit rating agencies
  - b. Modeling default:
    - i. Structural models
    - ii. Reduced-form models
  - c. Credit default swaps (CDSs)
9. Securitization and Structured Finance
  - a. Modeling default dependence
  - b. Pooling and tranching
    - i. Mortgages and related securities
    - ii. Collateralized debt obligations (CDOs)