FIXED INCOME ASSET PRICING

Course Objectives and Overview

The universe of fixed income instruments is large and ever more complex. Besides standard fixed-coupon bonds, several other types of securities are available for investment and trade, from inflation indexed securities (TIPS) to floating-rate notes, from mortgage backed securities to debt instruments issued by government agencies, such as Fannie Mae, Freddie Mac, and Ginnie Mae. In addition, a large market of exchange traded and over-the-counter derivative securities is available for trade in order to undertake sophisticated hedging strategies or to adjust the risk/return characteristics of an investment portfolio.

This course covers models and techniques that are used to analyze fixed income securities and their (often embedded) derivatives. By the end of the course, students will learn (i) the basic concepts of fixed income instruments, such as yield curve, forward curve, yield-to-maturity, duration, convexity; (ii) the modern empirical methodologies to describe Treasury bond data, such as “curve fitting” and factor analysis; (iii) effective hedging strategies for fixed income portfolios, such as duration matching, asset-liability management and factor neutrality; (iv) the advanced properties of bonds, such as their risk/return characteristics, and the best predictors of their future returns; (v) modeling techniques used by market participants, such as the models of Vasicek, Cox Ingersoll and Ross, Ho and Lee, Hull and White, Black-Derman-Toy, and Heath-Jarrow-Morton; and, importantly, (vi) how to use these methodologies in practice to value and hedge fixed income products and derivatives, from the traditional securities, such as Bonds, Swaps, Options, Caps and Floors, to the more recent products, such as Inverse Floaters, Range Notes, Mortgage Backed Securities.

The key feature of this course is that it strongly emphasizes the applications of these models to value real world fixed income products, and their derivatives, by focusing both on the practical difficulties of applying models to the data, as well as on the necessity to use computers to compute prices. The course, which is analytical in nature, includes many real world Case Studies and Data Analysis to allow students to apply these models to a wide range of fixed income securities as well as to understand their risk and return characteristics.
Required Material

Book:

Teaching notes:
Available on course web site a few days prior to class

Course web site: http://faculty.chicagobooth.edu/pietro.veronesi/teaching/BUS35130.htm

Recommended Books

A collection of surveys on the most current topics in fixed income, from monetary policy, to mortgage backed securities, from the predictability of bond returns across countries, to the post-crisis derivatives landscape.

Nice book that explains well the details of the fixed income market, including their institutional characteristics, and it develops a good intuition of the various models by using simple tree-like examples.

Nice, simple and comprehensive book on fixed income securities. Highly recommended as an introductory book on the world of fixed income securities and no arbitrage.

Classic book on equity and fixed income derivatives. Lots of models, and pricing methodologies. Always a good reference book to have in your library.

This book is rather technical, but it contains many applications from two practitioners. In particular, they go through fitting exercises, and discuss pros and cons of various models and methodologies. If you can digest the math at the beginning of the book, it is good to read of the practical problems that arise when one tries to use these models in practice.
   This book covers the essentials of fixed income markets in a non technical manner. It is full of numerical, real world examples. Not much about pricing, but that is not the purpose of the book. I enjoyed reading it.

   PhD level book on the econometrics of financial markets. It covers also fixed income securities, but more from an “economic” point of view, rather than from a “no-arbitrage” approach.

**Administrative Notes**

**Office hours:** Open door policy with the following caveats:

1) Try to ask your questions by e-mail first. In many cases the answer can easily be given by e-mail, and you can expect it within a reasonable time.

2) If you expect you need a long meeting, please try to arrange a mutually convenient meeting-time with me first.

**Teaching Assistant:** Oleg Sydyak. Oleg.Sydyak@chicagobooth.edu. He will lead the review sessions, hold office hours and grade the homeworks and the midterm.

**Administrative Assistant:** Susan Compton. Susan.Compton@chicagobooth.edu

**Prerequisites and Requirements**

Strict prerequisite for this course is Business 35000.

Working knowledge of a spreadsheet package such as Microsoft Excel is necessary for the analysis of homework assignments. No specific programming skills are required, but the ability to manipulate Excel spreadsheets (insert new formulas, use Solver, run regressions) will be necessary to solve many of the course assignments.

**Review Sessions**

Weekly review sessions are held throughout the course. In the review sessions, the teaching assistant will give reviews of background material, go through the homework exercises and provide additional clarifications for the material covered in class. Time and location of the review sessions will be announced.
Course Requirements

The course requirements consist of weekly problem sets, a midterm exam and a final take-home exam. The solution of most problem sets will be briefly discussed in class, and students are expected to participate to the class discussion.

Problem sets and class participation

Problem sets will be handed out on a weekly basis. They focus on the actual fitting of term structure models, and the pricing and hedging of fixed income securities in today’s challenging financial market. Group work is allowed and encouraged, with the strict limit of 4 students per group. Only one copy of the (joint) homework should be turned in. Make sure that your names, ID and section numbers appears on the cover of the homework. Please, try not to change groups during the quarter. If you must change groups, make sure to write a note on the cover of the first problem set after the change.

Most solutions to problem sets will be discussed in class, so students should keep a copy of their solutions handy. Class participation has a weight in the final grade.

Midterm Exam

The midterm will take place in class on week 7 and will last 1 1/2 hours. The midterm will be on both theoretical and practical issues. Of course, the use of a computer won't be necessary to solve the exercises, but bring your calculator. You are allowed to bring to the exam a single, two-sided, 8½x11 sheet with formulas.

Regrade policy: If you think that a serious mistake has been committed in grading your exam, you must submit the exam for a complete regrade along with a detailed written explanation of your objection within 10 business days of receiving the graded exam. There is absolutely no guarantee that the grade will not be lowered with the regrade.

Take-Home Final Exam

The take-home final exam will be similar to the homework assignments, but more structured, with many questions in increasing order of difficulty. Although the final won’t hinge only on programming ability, it will require the use of a computer and the concepts developed in the course. Workgroup is allowed for the final Take-Home Exam. It could well be the pricing of an actual structured derivative product.

Grading

Problem sets and class participation, Midterm and Final are graded between 0-100 and then your score is given by the formula:
Score = \text{max} \left( 0.3 \times \text{Problem Sets} + 0.3 \times \text{Midterm} + 0.4 \times \text{Final}; \right. \\
\left. 0.3 \times \text{Problem Sets} + 0.4 \times \text{Midterm} + 0.3 \times \text{Final} \right)

Class participation is used for borderline cases. If you are a graduating student, you can get a provisional grade (D) if your midterm is above the 25\textsuperscript{th} percentile and you submitted all the homework showing a good work.

\textbf{Honor Code}

Students in my class are required to adhere to the standards of conduct in the Chicago Booth Honor Code and the Chicago Booth Standards of Scholarship. The Chicago Booth Honor Code also requires students to sign the following Chicago Booth Honor Code pledge. "I pledge my honor that I have not violated the Honor Code during this examination," on every examination, as well as on the term project.

\textbf{Disability Accommodation}

If you have a documented disability (or think you may have a disability) and, as a result, need a reasonable accommodation to participate in class, complete course requirements, or benefit from the University's programs or services, please contact Student Disability Services as soon as possible. To receive a reasonable accommodation, you must be appropriately registered with Student Disability Services. Please contact the office at 773-702-6000/TTY 773-795-1186 or disabilities@uchicago.edu, or visit the website at disabilities.uchicago.edu. Student Disability Services is located at 5501 S. Ellis Avenue.

If you have an approved accommodation from Student Disability Services that you plan to use in this course, please contact Academic Services (AcademicServices@lists.chicagobooth.edu) as soon as possible. Academic Services will provide support to you and me and coordinate the details of your accommodations on your behalf.

\textbf{Course Outline}

Please, note the following class schedule is \textit{preliminary} and could be subject to modifications. Reading indicated by "\textit{}" are mandatory.

\textbf{Class 1} \hspace{1em} \textbf{Introduction to Fixed Income Markets}

(a) Zeros and Coupon Bonds, Floating Rate Bonds
(b) Forward Rates, Repos, Strips
(c) Conventions
(d) Zero coupon curve estimation

\textit{} TN #1
\textit{} Veronesi, Ch. 1, 2

Additional Readings:


Sundaresan, Ch. 1-5.
Hull, Ch. 4.

Notes: Homework 1: Interest rate forecasts and forward rates
Due at the beginning of class 2.

Class 2 Interest Rate Risk Management

(a) Duration and Convexity
(b) Duration and Convexity Hedging
(c) Principal Component Analysis: Slope, Level, and Curvature
(d) Factor Neutrality

TN #2
Veronesi, Ch. 3, 4

Additional Readings:

Case Study: The 1994 Bankruptcy of Orange County. Veronesi, Chapter 3.7.


Hull: Ch. 4.
Sundaresan: Ch. 4

Notes: Homework 2: Duration and Convexity of Leverage Inverse Floaters.
Due at the beginning of class 3.

Class 3 (I) The Term Structure of Interest Rates and Bond Returns

(a) The Expectations Hypothesis
(b) Understanding long-term rates
(c) Forecasting bond returns: Fama – Bliss Regressions and the Cochrane – Piazzesi factor

⇒ TN 6
⇒ Veronesi, Ch. 7 (7.3)

Additional Readings:


(II) Inflation, Growth, Risk Premia and the Yield Curve

(a) Inflation, Expected Inflation, and Real Bonds
(b) Treasury Inflation Protected Securities
(c) Monetary Policy and the Term Structure of Interest Rates

⇒ TN6
⇒ Veronesi, Ch 7.

Additional Readings:


Fleckenstein, Longstaff, and Lustig “Why does the Treasury Issue TIPS? The TIPS-Treasury Bond Puzzle” (Journal of Finance)

Notes: **Homework 3: Empirical methods: (a) Principal Component Analysis and Factor Neutrality; (b) The Predictability of long-term bond returns.**
Due at the beginning of class 4.

**Class 4 Interest Rate Derivatives**

(a) Forward Rate Agreements
(b) Interest Rate Swaps
(c) The LIBOR Curve

⇒ TN #3
Veronesi, Ch 5

Additional Readings:

Sundaresan, Ch. 6.
Hull, Ch. 5, 6, 7.


Notes: Homework 4: (a) The Puzzling Negative Swap Spreads and the Swap Spread Trade. (b) Inflation Risk and TIPS.
Due at the beginning of class 5.

Class 5 (I) Interest Rate Derivatives (cntd.)

(a) Black’s Model and the Market Model
   a. Caps and Floors
      i. Flat Volatility vs. Forward Volatility
   b. Swaptions

  ➔ TN #3
  ➔ Veronesi, Ch 20

Additional Readings:

Hull, Ch. 28.

(II) Binomial Trees

(a) Binomial Trees
(b) Using Risk Neutral Trees
(c) Examples
   a. Callable bonds
   b. Caps and Floors
   c. Swaps and Swaptions

  ➔ TN #4
  ➔ Veronesi, Ch. 9 (skim), Ch. 10 (skim), Ch.11.1 – Ch.11.2

Additional Readings:

Hull, Ch. 12, 30.6

Notes: Homework 5. Caps, Swaptions, and Interest Rate Trees. Due at the beginning of class 6.

Class 6 Binomial Trees (cntd)

(a) Fitting (Big) Binomial Trees to the Data
   a. Ho-Lee Model
   b. Simple Black Derman Toy Model
   c. Black Derman Toy Model

⇒ TN #4
⇒ Veronesi, Ch. 9 (skim), Ch. 10 (skim), Ch.11.1 – Ch.11.2

Additional Readings:

Hull, Ch. 12, 30.6

⇒ Stanford Case Study (F-270, Yurday and Duffie): Risk at Freddie Mac.

Notes: Homework 6: Pricing Freddie Mac Callable Securities on Big Trees. Due at the beginning of class 8.

Class 7 I) Midterm

(II) Mortgage Backed Securities

(a) Introduction to MBS
(b) Pricing MBS on Binomial Trees

⇒ TN #5
⇒ Veronesi, Ch 8, 12

Class 8 Mortgage Backed Securities (cntd)
(a) Monte Carlo Simulations on Binomial Trees
(b) Pricing MBS by Monte Carlo Simulations

⇒ TN #5
⇒ Veronesi, Ch. 13

Additional Reading

⇒ HBS Case Study (9-205-122, by Chacko, Hecht, Dessain, Sjoman): Mortgage Backs at Tincoderoga.


Notes: Homework 7: Pricing Mortgage Backed Securities on Trees and Monte Carlo Simulations.
Due at the beginning of class 9.

Class 9 A Rundown on Continuous Time Models

(a) Single Factor Models
   a. Vasicek Model
   b. Cox Ingersoll and Ross Models
(b) Multifactor Affine Models
   a. Multifactor Vasicek Model
   b. Multifactor Hull and White Model
   c. Heath, Jarrow, Morton Model

⇒ TN #7

Additional Readings

Veronesi, Ch. 14, 15


Notes: Homework 8: Relative Value Trades on the Yield Curve.
Due at the beginning of class 10.
Class 10 Derivative Pricing after the Crisis

(a) Collateral requirements and the pricing equation
(b) Double curve pricing of plain vanilla derivatives

⇒ TN #8

Additional Readings

Notes: Final exam handed out.