



Backus&Zin/B40.3176.33/Spring 1999

Advanced Fixed Income Analytics for Practitioners

Leonard N. Stern School of Business
November 2, 1998 (draft)

What Is This Course About?

Quantitative models play an increasingly important role in the financial services industry — in valuation, trading, structuring, and risk management. In this course, you will learn how such models are built and used, put them to work yourself using proprietary software, develop insights into their strengths and weaknesses, and hear from experts about industry best practice.

Our approach to modeling introduces state-of-the-art structure with relatively modest technical requirements. Make no mistake: this is a quantitative course. But the level of mathematics rarely rises as high as high school calculus. Our approach includes discrete time and continuous states. In our view, this is both a marked improvement in accuracy over the binomial models typically used in most MBA classes and a substantial gain in simplicity over the stochastic calculus of most high-end financial theory.

Free to students in the course is a set of custom software that can be used to build models, adjust parameter values, and value a variety of fixed income derivatives: caps and floors, swaptions, eurocurrency futures, and so on.

Prerequisite: B40.3333 Debt Instruments and Markets or the equivalent expertise from other sources.

Meeting Times

We meet once a week for 7 weeks, Wednesdays from 5:30 to 8:20pm, March 10 to April 28 (March 17 is spring break).

Class Materials

The essential reading material for the course is (or will be) available on the internet (address below):

- Overheads (bullet-point lecture notes).
- Manuscript (text, work in progress).

In addition, these optional references are available in the bookstore:

- Reading Package.
- Hull, *Options, Futures, and Other Derivative Securities (Third Edition)*, Prentice-Hall, 1997.
- Rebonato, *Interest-Rate Option Models (Second Edition)*, Wiley, 1998.
- Chriss, *Black-Scholes and Beyond*, McGraw Hill, 1997.

The reading package contains cases and articles that we think complement the lectures. Some of them are more advanced than this course, but we think a casual reading has value. Hull is an extremely useful reference for derivatives of all kinds. As a text, however, we find its eclectic approach to modeling a barrier to understanding. Rebonato is the best book we've seen on fixed income derivatives, but its continuous-time emphasis raises the technical demands on its readers. Chriss is a very nice book on exotic options. Serious students of fixed income derivatives might want to buy them all; others can safely spare their wallets.

Home Page

The course home page is

<http://www.stern.nyu.edu/~dbackus/advclass.htm>

Most text files are pdf format, which you can view and print with Adobe's Acrobat Reader (available free if you don't have it already).

Office Hours

David Backus: Wednesday, 4:00-5:30pm, and by appointment, MEC 11-55, (212) 998-0907 and dbackus@stern.nyu.edu.

Stanley Zin: Wednesday, 4:00-5:30pm, and by appointment, MEC 9-58, (212) 998-0722 and szin@stern.nyu.edu.

Requirements

Grades will be based on assignments (80%) and class participation (20%). Assignments are due each week (six altogether) and can be done in groups of up to four. The lowest two assignment grades will be dropped in computing your final grade.

Operating Procedures

- We will start and end class on time and typically take a short intermission.
- Everyone can and will be asked questions in class.
- We are readily available by email (dbackus@stern.nyu.edu and szin@stern.nyu.edu). You'll often get a reply within an hour or two, and almost always within a business day. For best service, choose one of us at a time.
- Assignments are due at the start of class. When appropriate, answers will be distributed at the same time. Late assignments will not be accepted without prior arrangement. If necessary, you can fax them to Backus at (212) 995-4212.
- If we can't answer a question in class, we will do our best to answer it in the next class.
- Material handed out in class will not be available in the next class. You can get copies of old handouts from classmates or the home page.

Schedule of Classes (subject to change)

1. Overview and Review of Binomial Models

- Overview of fixed income derivatives: eurocurrency futures, caps and floors, swaptions, CMT swaps and swaptions
- Fixed income basics: discount factors, spot rates, forward rates
- Properties of bond yields
- Binomial models
 - Short rate trees, recursive valuation
 - Duffie’s formula, calibration
 - Applications to bond options and interest-rate caps
 - Ho and Lee, Black-Derman-Toy
- Assignment: calibration of Black-Derman-Toy model; valuation of interest rate caps
- Reading:
 - Backus, “Introduction to state-contingent claims,” in *Manuscript: Debt Instruments and Markets*; home page and reading package.
 - Black, Derman, and Toy, “A one-factor model of interest rates and its application to treasury bond options,” *Financial Analysts Journal*, January-February 1990, 33-39; reading package.

2. The Vasicek Model

- Assessment of binomial models
- Fundamental theory of arbitrage-free asset pricing
- Vasicek model: solution and calibration
- Hedging: Vasicek v. DV01/duration
- Assessment of Vasicek model
- Assignment: calibration of Vasicek model to DM interest rate data
- Reading:
 - Backus, Foresi, and Telmer, “Discrete-time models of bond pricing,” Sections 2–4; home page and reading package.

3. The Vasicek Model (continued)

- Calibrating to current spot rates
- Options on zeros, coupons bonds, and swaps
- Delta hedging
- Exploiting mistakes in the Black-Derman-Toy model

- Black's approach to fixed income options: swaps, forward starting swaps, and swaptions; caps and floors; the term structure of volatility and the swaption volatility matrix
- Assignment: case tba
- Reading:
 - Backus, Foresi, and Zin, "Arbitrage opportunities in arbitrage-free models of bond pricing," *Journal of Economic and Business Statistics*, January 1998; home page and reading package.
 - Hull, *Options, Futures, and Other Derivative Securities (Third Edition)*, Prentice-Hall, 1997.
 - Hull and White ??

4. Applications

- Case discussion: NatWest ??
- Industry visitor: models and reality
- Assignment: compute implied volatilities for options on eurodollar futures, volatility smiles for nearest contract
- Reading:
 - ...

5. Volatility Smiles and Multiple Factors

- Volatility smiles and their interpretation
- Stochastic volatility
- Other two-factor models
- Implications for options
- Delta-hedging revisited
- Volatility trades
- Assignment:
- Reading:
 - Backus, Foresi, and Telmer, "Discrete-time models of bond pricing," Sections 7 and 8; home page and reading package.
 - Backus, Foresi, Li, and Wu, "Accounting for biases in Black-Scholes," Sections 1-4; home page and reading package.
 - Derman, "Valuing models and modeling value," *Journal of Portfolio Management* (Spring 1996), 106-114; reading package.

6. Futures ??

- Estimating spot rates from eurocurrency contracts

- Forward/futures bias
- Assignment:
- Reading:
 - ...

7. Exotic Options

- ...
- Industry visitor: modeling in the asset design process
- Reading:
 - Chriss, *Black-Scholes and Beyond*, McGraw Hill, 1997.

Things we might do if there's interest:

- Constant Maturity Treasury (CMT) swaps and swaptions
- Mortgages and index-amortizing swaps
- Vol swaps
- Forwards, futures, and options on currencies, equities, and commodities
- Credit spreads: features and models