Syllabus: Debt Instruments and Markets
September 1, 1998

Overview

This course is concerned with fixed income securities: bonds and interest rate derivatives. The material is inherently quantitative, but we will try to balance computation with the big picture. This section will have more emphasis than usual on international aspects of fixed income: eurocurrency rates and related derivatives, emerging market debt, and so on.

Materials

We will use the following, listed in declining order of priority:

- Overheads (bullet-point lecture notes).

- Manuscript (my text, work in progress).

- Reading Package (articles and cases).

- Garbade, *Fixed Income Analytics*, MIT Press, 1996.

- Tuckman, *Fixed Income Securities*, Academic Press, 1996.

The first two are available on my home page (see below), the last three in the book store. The overheads are required and will be distributed in class at the appropriate times. The manuscript typically provides more detailed discussion of similar issues. It also contains practice problems, old exams, and answers. The reading package contains cases and articles that I find interesting. I find Garbade very helpful on basic bond analytics. Tuckman is a good reference on pricing derivatives.

Home Page

The overheads and manuscript are on my home page:

<div align="center">http://www.stern.nyu.edu/~dbackus</div>

Most things come in pdf format, which you can view and print with Adobe's Acrobat Reader (available free if you don't have it already). A few older files are postscript, which you can download to your computer and print.

Office Hours

Tuesday, 5:30-7:00pm, and Thursday, 6:00-7:00pm, MEC 11-55, (212) 998-0907. Some Tuesday nights, 8:30-10:00pm, Santorini's (corner of Mercer and Washington Place, check to verify).

Requirements

Grades will be based on assignments and examinations according to the formula:

Assignments	30 percent
Midterm	35 percent
Final	35 percent

Assignments can be done in groups of up to four.

Operating Procedures

- We will start and end class on time.

- The first row is safe, but everyone else can and will be asked questions in class.

- I'm readily available by email (dbackus@stern.nyu.edu). You'll often get a reply within an hour or two, and almost always within a business day.

- I urge you to do all the assignments, but will drop your lowest grade.

- Assigments are due at the start of class. Late assignments will not be accepted without prior arrangement. If necessary, you can fax them to me at (212) 995-4212.

- If I can't answer a question in class, I'll try to figure it out by 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.

- Excuses: Ask yourself, would I try this on my boss? If not, please don't try it on me.

Suggested Grade Distribution

The Finance Department suggests a grade distribution of:

A/A-	20-25%
B's	55-70%
C & below	10-20%

This distribution is a guideline, not a requirement.

Schedule of Classes (approximate)

Class	Date	Content
1	Sep 8	Intro and Bond Arithmetic
2	Sep 10	Bond Arithmetic
3	Sep 15	Bond Arithmetic
4	Sep 17	Bond Arithmetic
5	Sep 22	Macrofoundations
6	Sep 24	Interest Rate Risk, Assignment 1 due
7	Sep 29	Interest Rate Risk
8	Oct 1	Interest Rate Risk
9	Oct 6	Interest Rate Risk
10	Oct 8	Floaters and Swaps, Assignment 2 due
11	Oct 13	Floaters and Swaps
12	Oct 15	Floaters and Swaps
13	Oct 20	Floaters and Swaps, Assignment 3 due
14	Oct 22	Midterm Exam
15	Oct 27	Disasters
16	Oct 29	Disasters
17	Nov 3	Industry Visitor
18	Nov 5	Contingent Claims
19	Nov 10	Contingent Claims
20	Nov 12	Contingent Claims
21	Nov 17	Futures and Options, Assignment 4 due
22	Nov 19	Futures and Options
23	Nov 24	Futures and Options
24	Dec 1	Corporate Debt, Assignment 5 due
25	Dec 3	Emerging Markets
26	Dec 8	Industry Visitor, Assignment 6 due
27	Dec 10	Emerging Markets
28	Dec 17	Final Exam, 7:35pm

Outline and Reading List

1. **Fixed Income Securities**

2. **Bond Arithmetic**

   Garbade, *Fixed Income Analytics*, ch 1.

3. **Macrofoundations of Interest Rates**

4. **Quantifying Interest Rate Risk**

   Garbade, *Fixed Income Analytics*, chs 3, 4, 11.

   Zangari, "Market risk methodology," chapter 6 of *RiskMetrics — Technical Document (Fourth Edition)*.

5. **Floating Rate Notes and Interest Rate Swaps**

6. **Risk Management, Accounting, and Control**

   Backus, Klapper, and Telmer, "Derivatives at Banc One," NYU Salomon Center Case C55, 1995.

   Figlewski, "How to lose money in derivatives," *Journal of Derivatives*, Winter 1994, 75-82.

   Kuprianov, "Derivatives debacles," Federal Reserve Bank of Richmond *Quarterly Review*, Fall 1995, 1-39.

7. **State-Contingent Claims**

   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.

   Derman, "Valuing models and modeling value," *Journal of Portfolio Management* (Spring 1996), 106-114.

8. **Forwards and Futures**

   Garbade, "Treasury bond futures: Contract provisions and relation to cash markets," Bankers Trust, May 1985.

   Urich, "Money market interest rate futures contracts," Bankers Trust, August 1994.

9. **Options**

10. **Credit Risk on Corporate Bonds**

11. **Emerging Market Debt**

Smith and Walter, "Goldman Sachs and the Republic of the Philippines," NYU Salomon Center Case C39, 1993.

Smith and Walter, "ICICI," NYU Salomon Center Case C60, 1996.

12. **Mortgages and Mortgage Derivatives**

Assignment 1

Assignments can be done in groups of one to four students. They are due at the start of class and may not be handed in late without prior arrangement.

1. Suppose prices of US treasuries include:

Bond	Maturity (Yrs)	Coupon	Price
A	0.5	2	98.536
B	1.0	4	96.256
C	1.5	6	95.959

   (a) Use these prices to compute the first three discount factors.

   (b) What are the spot rates? Forward rates?

   (c) Compute the par yield for a one-year bond: the coupon rate for which the market price is exactly 100.

   (d) What combination of bonds A and B has the same cash flows as a one-year zero? What is its price?

   (e) What are the yields on the three bonds? Comment on their relation to the spot rates.

2. Disney issued a medium term note maturing June 21, 2000, with annual coupon payments at an annual rate of 8-5/8 percent. Bloomberg quoted a price of 107.667 for settlement September 1, 1998. The issue is denominated in Italian lira. Compute, using the appropriate convention, (a) the number of days since the previous coupon, (b) accrued interest, (c) the invoice price, and (d) the yield.

3. Wal-Mart issued a corporate bond maturing October 15, 2023, with semiannual coupon payments at an annual rate of 6.75 percent. Bloomberg quoted a price of 106.552 for settlement September 1, 1998. The issue is denominated in US dollars and is not callable. Compute, using the appropriate convention, (a) the number of days since the previous coupon, (b) accrued interest, (c) the invoice price, and (d) the yield.

4. The Mexican United States (Mexico) issued a "global" bond maturing May 15, 2026, with semiannual coupon payments at an annual rate of 11.5 percent. After the market tanked on August 31, Bloomberg quoted a price of 88.594 for settlement September 3, 1998. The issue is denominated in US dollars and is not callable. Compute, using the appropriate convention, (a) the number of days since the previous coupon, (b) accrued interest, (c) the invoice price, and (d) the yield.

Assignment 2

Assignments can be done in groups of one to four students. They are due at the start of class and may not be handed in late without prior arrangement.

1. Write a one-page overview of a firm's approach to interest-rate risk management. Your report should be in bullet-point form and include:

   - A one-line summary of the firm's business.
   - A description of the firm's fixed income assets and liabilities.
   - A review of the firm's stated goals with respect to interest-rate risk management
   - A summary of the firm's use (or not) of derivative products to manage interest rate risk.

   You may choose any firm you like (some are more interesting than others), but interesting examples that cross my mind include Bell Atlantic, Coca-Cola, Disney, Pfizer, Time-Warner, and Wal-Mart. An interesting international example is News Corp; note especially the difference in disclosure requirements.

2. Your research department reports spot rates as

Maturity (Years)	Spot Rate (%)
0.5	5.000
1.0	7.000
1.5	6.000
2.0	5.000

   (a) Use these spot rates to compute the price and yield of a two-year 15% bond.

   (b) What is the bond's duration?

   (c) Construct a portfolio of zeros that replicates the two-year bond. Use the durations of the zeros and the formula for the duration of a portfolio to compute the duration of the two-year bond.

   (d) Explain the difference between your two duration calculations.

3. For the Mexican Global of the previous assignment:

   (a) Compute its DV01 and duration.

   (b) If yields of all maturities were to rise 100 basis points, how much would the price fall in dollars and as a percentage?

   (c) Explain briefly why duration, in this case, is different from maturity.

Assignment 3

Assignments can be done in groups of one to four students. They are due at the start of class and may not be handed in late without prior arrangement.

1. You work on Goldman's London swap desk. Six months ago you computed DM spot rates from euro-dm futures contracts on the LIFFE:

Maturity (Years)	Spot Rate
0.5	3.90
1.0	4.06
1.5	4.35
2.0	4.67
2.5	4.90
3.0	5.09

   (a) Use these spot rates to compute swap rates for semiannual DM interest rate swaps with maturities of 2 and 3 years.

   (b) Compute the duration of the fixed-rate leg of the 3-year swap.

   (c) In the last 6 months, spot rates have changed to

Maturity (Years)	Spot Rate
0.5	3.45
1.0	3.50
1.5	3.69
2.0	3.88
2.5	3.95
3.0	4.01

   Describe the change in the spot rate curve.

   (d) What is the current value of the 3-year swap (now with 2.5 years remaining until maturity)? What is your profit or loss if you receive the fixed payments?

   (e) Use your duration calculation to estimate the change in the value of the 3-year swap. How does this answer compare to that in (d)? Explain (briefly) any differences.

2. You are the investment manager of a small bond fund whose expertise is macro-based interest-rate analytics. Over the last year, you note that the yield curve has flattened markedly, with long rates falling substantially relative to short

rates. You believe that weakness and volatility in the US stock market and ongoing problems elsewhere in the world (Japan, Russia, Indonesia, etc) will have either or both of these consequences: downward pressure on short rates and a steeper yield curve. Your task is to construct a bond portfolio that profits from these events, should they occur. You are particularly interested in these US treasury issues:

Issue	Maturity (Yrs)	Price	Yield (%)
5 1/8's of 00	2.0	100.54	4.84
8 3/8's of 08	10.0	114.34	5.54

(a) Compute the DV01 of each of these bonds.

(b) Describe qualitatively how you might invest in these bonds if you thought the yield curve would decline at all maturities, but more at the short end.

(c) Suppose, instead, that you are confident that the yield curve will steepen, but relatively agnostic about the overall level of interest rates. Describe how you might invest to exploit this scenario. Construct, specifically, a combination of the two bonds that profits from an increase in 10-year yields relative to 2-years, but is not affected by equal changes in yields of both maturities. What is the "hedge ratio" (the ratio of 2-year bonds to 10-years)?

(d) Your risk management group estimates that the one-month standard deviations of yields on the two bonds are 0.114 (2-year, annual percent) and 0.066 (10-year). The correlation between them is 0.531. With these numbers, compute the standard deviation, in dollars, of $100 invested in (i) the 2-year bond, (ii) the 10-year bond, and (iii) the yield spread trade constructed in (c). Comment on the differences.

Assignment 4

Assignments can be done in groups of one to four students. They are due at the start of class and may not be handed in late without prior arrangement.

1. Your mission is to use the Ho and Lee model to compute state prices, discount factors, and spot rates.

   (a) If the current short rate is 5%, "volatility" is $\sigma = 1\%$, and "drift parameters" are $\mu_t = 1\%$, what is the short rate tree over two periods (ie, for $n = 0, 1, 2$)?

   (b) Consider a claim to one dollar in state $(i, n) = (2, 2)$. Use the pricing relation and fifty-fifty rule to compute the value of this claim in all states.

   (c) Use Duffie's formula to compute (multiperiod) state prices for the entire tree. Verify that the current price for state $(2, 2)$ is the same one you computed above.

   (d) Use the (multiperiod) state prices to find, for $n = 0, 1, 2$, the current discount factors d_n and spot rates y_n. What feature of the model is responsible for the implied shape of the spot rate curve?

2. Using the same short rate tree, consider the price of a callable zero.

   (a) Compute the price path for a 3-period zero.

   (b) Suppose the zero is callable by the issuer at 93 in one period (six months). What are the cash flows associated with calling the bond? Use these cash flows to compute the price path of the call option and (from this) the price path of the callable bond.

   (c) Describe how you might replicate the cash flows of the callable bond with the underlying zero and a six-month zero. What combination of these two instruments do you need to reproduce the value of the callable bond in the initial up and down states? Comment on your answer.
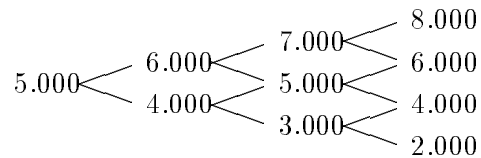
Assignment 5

Assignments can be done in groups of one to four students. They are due at the start of class and may not be handed in late without prior arrangement.

1. Corporate issuers often trade off protection and cost. For example, an issuer of floating rate debt might want protection against a large increase in interest rates, but such protection typically comes with a cost. Consider a 2-year structured note making payments based on

$$\text{Rate} = \begin{cases} \text{LIBOR} & \text{if LIBOR} < 7.00 \\ 7.00 & \text{if LIBOR} \geq 7.00, \end{cases}$$

which places a 7% "cap" on interest payments. As usual, semiannual payments are half the rate. At maturity, the note returns its principal of 100 as well as its final interest payment.

   (a) Calibrate a short rate tree for the Ho and Lee model to spot rates of $(y_1, y_2, y_3, y_4) = (5.00, 5.50, 5.75, 5.85)$ using $\sigma = 1.2$ (all of these numbers are annual percentages).

   (b) Using this tree, compute the cash flows generated by the note for each state and report them in a tree. Note that you will have to discount them one period to fit them in the tree.

   (c) Use the cash flows to compute the price path for this asset, indicating its value at each node in the tree.

   (d) Describe the effect of the cap on the price in different parts of the tree.

   (e) What is the cost to the issuer of the cap? How might the issuer reduce the cost?

2. One of the most widely traded classes of fixed income options is swaptions: options on swaps. We examine one such instrument here using our benchmark short rate tree,

   (a) Compute the discount factors and spot rates associated with this tree. What is the 2-year swap rate?

(b) Compute the cash flows for a 2-year receive fixed swap based on the rate calculated above. Discount them accordingly and list them in a tree.

(c) Use the cash flows and short rates to compute the price path for the swap.

(d) Consider a 6-month European option to buy the swap at par (namely, zero). Compute its cash flows and price.

(e) Explain how such a swaption might be used to lock in a rate in six months.

Assignment 6

Assignments can be done in groups of one to four students. They are due at the start of class and may not be handed in late without prior arrangement.

1. On September 1, these spot rates on US treasury and industrial corporates were reported by Bloomberg (type CURV [GO]):

Maturity	Treasuries	Aaa Corporates	Baa Corporates
0.5	4.98	5.49	5.90
1.0	5.00	5.44	5.84
1.5	4.93	5.42	5.82
2.0	4.87	5.40	5.79

   (a) Compute the implied ("matrix") prices of 2-year 6.5% treasury, Aaa, and Baa bonds.

   (b) Describe the spreads between treasuries and corporates. What factors account for them?

2. Merrill Lynch reports (*Fixed Income Weekly*, September 1, 1998): "The gapping [large increase] in yield spreads across all sectors of the market has now taken corporate yield spreads back to levels last seen in late 1989 and early 1990. It is alarming that nearly 8 years of narrowing spreads can be reversed so viciously on a few months. ... We believe that current spreads have discounted the risk of deteriorating fundamentals [and that spreads could tighten quickly in some sectors]. ... Niagara Mohawk, with its substantial spread and improving credit story, is probably the most compelling [example]."

   (a) Speculate briefly on why spreads have widened and why they might tighten in the near future.

   (b) If you were to invest in Niagara Mohawk, what kinds of information would you want to see?

3. Use Bloomberg to find an interesting emerging market bond. Examples include:

   - Argentina FRB 8's of 3/05 (type ARGENT CORP GO)
   - Mexico Global 11.5's of 2026 (type MEX CORP GO)
   - ICICI 8's of 01 (type ICICI CORP GO)

   Your job is to

(a) Describe its essential features to a prospective American investor.

(b) Explain its risks clearly enough to avoid future legal action.

One page maximum for both parts.