Interest Rate Derivatives QFGB-8934 (48452) Spring 2025, January 14 ~ May 6

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Text

Lecture notes

Options, Futures, and Other Derivatives, by John Hull, 5th ed., Prentice Hall Financial Mathematics, by Ren-Raw Chen, GSSI

Supplementary Readings

Fixed Income Analysis for the CFA Program, by Frank J. Fabozzi, 2nd ed., FJF Modern Investment Theory, by Robert Haugen, Prentice Hall Credit Derivatives, by Mark Ansen, Frank Fabozzi, Moorad Choudhry, and Ren-Raw Chen, Wiley.

Course Objective

This is a QF-centric fixed income introductory course. We study how to evaluate fixed income securities (a.k.a. interest rate derivatives), compute their prices and risks, and then we can analyze them and hopefully profit from them.

Fixed income securities are commonly known as FICC (fixed-income, commodities, and currencies). Fixed-income includes also credit and mortgages. So broadly speaking, FICC includes everything except for equities and real estate.

Homework (35%)

• mini homework

A series of *mini* homework assignments will be given at the end of a lecture when necessary. These mini homework assignments will be counted 15% toward the final grade.

- *long homework (projects)* There will be three major homework assignments on (1) market (2) credit and (3) liquidity risks. They will count 20% of the final grade.
- bonus considerations
 Every now and then there will be some bonus assignments and certain bonus points will be given. They will only help, but not hurt your final score.

helping each other is fine but EVERYONE needs to hand in his/er homework separately and independently

Exams (65%)

There will be two exams, one in about week 5 (25%) and the other one near the end of the semester (40%).

Course Contents (not in particular sequence) note that there is no class on 2/18 and 3/18 Fixed Income Primer Market conventions daycount, quoting, etc. Yield curve analysis bond pricing model price-yield relationship Treasury market bootstrapping Duration & convexity definition duration and convexity immunization Term Structure of Interest Rates review of Financial Theory: Chs 7,12 Valuation of Interest Rate Derivatives exchange-traded products - Financial Theory: Ch 10 Advanced Interest Rate Derivatives OTC products - of Financial Theory: Ch 10 LIBOR based derivatives IRS Caps and floors (collars) FX market Estimation MLE Mortgage backed Securities prepayment modeling Commodities inventory modeling Credit Derivatives copula (loss function) tranche (or any exotic payouts) There might be a guest speaker TBA

Appendix (long homework from the past, FYI only, actual assignments may be different)

1. Barbell Trading

Collect 1 year of data (from St. Louis Fed) of CMT and assume that they are par bonds. Construct a barbell using one of each following category:

- short end: 3m, 6m, or 1y
- medium end: 2y, 3y, 5y, or 7y
- long end: 10y, 20y, or 30y

You can switch your portfolio anytime you like as frequently as you like (totally subjective and judgment call but <u>at least monthly</u>).

Make sure that the duration (any) is 0 and convexity is positive (as high as possible). Report:

- data (in a graph)
- daily P&L (better in a graph)
- portfolio composition (upon updates)
- duration of all CMT bonds (upon updates)
- convexity of all CMT bonds (upon updates)

2. Capital Structure Arbitrage

This project is to arbitrage between CDS and stocks of the same company. Use a model (e.g. CreditGrades) to compute the hedge ratio:

$$h = \frac{\frac{\partial s}{\partial A}}{\frac{\partial E}{\partial A}}$$

where s is (5y) CDS spread, A is asset (solved for), E is equity (i.e. market cap). s is determined by CreditGrades and E is the equity which is determined by Black-Scholes/Merton/KMV.

- solve for the asset value A and asset volatility σ using the KMV method
- use these values for CreditGrades to compute CDS spreads (assume other parameter values as you wish)
- buy low sell high (compare to market CDS quotes)
- record profits for a year
- report spreads, hedge ratios, and daily and cumulative P&Ls

3. Monte Carlo American Option Valuation

We practice two methods of American option valuation under MC:

- Longstaff-Schwartz
- flat barrier
- (optional) linear barrier