

Fixed Income Analysis and Derivatives

Lecturer: Vladimir Sokolov

Course description

The course offers a thorough understanding of the workings and pricing of fixed income securities and derivatives on fixed income securities. The course consists of three parts. In the first part we cover yield curve calculations and topics in bond portfolio management. In particular we cover different measures of bond price sensitivity to changes in yields such as duration and convexity. The second part is devoted to the arbitrage-free and equilibrium term structure models. Students learn contingent securities pricing methods by replication of the portfolio of the synthetic claims and by change of measure. The last part of the course is the application of the no-arbitrage theory to pricing derivative securities in different segments of the market. We cover a broad range of derivative products and contract specifications. Students learn the pricing techniques and the trading strategies for each of the derivative product introduced in this part of the course. The home work material also offers a heuristic introduction to numerical methods and simple numerical recipes.

Grade determination

The final grade is determined as follows:

- 10% — home assignments
- 5% — class participation
- 35% — midterm exam
- 50% — final exam

Main reading

1. Hull J. (2006), Options, Futures and Other Derivatives, Sixth Edition, Pearson International Edition. (H)
2. Jarrow R. (2002), Modeling Fixed Income Securities and Interest Rate Options, Second Edition, Stanford Economics and Finance. (J)
3. Tuckman B. (2002), Fixed Income Securities: Tools for Today's Markets, Second Edition, University Edition, Wiley. (T)

Additional reading

1. Fabozzi F. (2002) The Handbook of Financial Instruments, Wiley Finance. (F)
2. Musiela M. And Rutkowski M. (2005) Martingale Methods in Financial Modeling, Second edition, Springer Finance. (MR)
3. Day A. (2005) Mastering Financial Mathematics in Microsoft Excel, Market edition, Prentice Hall. (D)

Internet resources and databases

1. www.bloomberg.com
2. www.cbonds.ru
3. www.cbot.com
4. www.cme.com
5. www.liffe.com
6. www.rts.ru

Course outline

1. Introduction to the Valuation of Fixed Income Securities

1. Overview of the Bond Sectors and Instruments
Terminology and conventions, Indenture and covenants, U.S. Treasury Bonds, Treasury STRIPS, Corporate debt, Mortgage Backed Securities
Readings: T ch. 1, F ch. 7-11, J ch. 1, MR ch. 9
2. Introduction to Valuation of Fixed Income Securities
Semiannual compounding, Yield-to-Maturity, Full and clean price calculations, The arbitrage free valuation, Deriving the theoretical spot rate, Bootstrapping
Readings: T ch. 2-3, D ch. 4
3. Risks Associated with Investing in Bonds
Interest rate risk, yield curve risk, reinvestment risk, credit risk, liquidity risk, Rating agencies, EMBI+ spreads
Readings:

- (a) Bieri D. and Chincarini L. (2005), “Riding the Yield Curve: A Variety of Strategies”, *Journal of Fixed Income*, September 2005
- (b) Wu T. (2003), “What Makes the Yield Curve Move?” FRBSF Economic Letter 2003-15.
- (c) J.P. Morgan Emerging Market Research (2004), *Emerging Markets Bond Index Plus (EMBI+): Rules and Methodology*
- (d) Moody’s Global Credit Research (2000), *Historical Default Rates of Corporate Bond Issuers 1920-1999*.

4. Duration and Convexity Measures based on the Parallel Yield curve Shifts

One-factor measures of price sensitivity, Macaulay duration, Convexity, Price-Yield relationship for bonds, The yield value of $1/32$, Convexity adjustments

Readings: T ch. 5-6, J ch. 2, H ch. 4, D ch. 5

5. Bond Portfolio Management

Regression based duration hedging, Key rate durations, Barbell, Ladder, Bullet portfolios

Readings: T ch. 7-8, H ch. 6

2. The Science of Term Structure Interest Rate Models

1. The Term Structure Models of the Short Interest Rates

Zero-coupon bond pricing equation, The dynamic replication principle, market price of risk, fundamental PDE, The Vasicek Model, The CIR model

Readings: T ch. 10-12, H ch. 28, J ch. 17, MR ch. 10

- (a) Chan, K., Karolyi, F., Longstaff, F., and Sanders, A., (1992), “An Empirical Comparison of Alternative Models of the Short-term Interest Rate”, *Journal of Finance*, 47(3), 1209- 1227.
- (b) Cox, J., Ingersoll, J., Ross, S. (1985), “A Theory of the Term structure of Interest Rates,” *Econometrica*, 53(2), 385-407.
- (c) Pearson, N., and Sun, T., (1994), “Exploiting the conditional Density in Estimating the Term Structure: an Application to the Cox, Ingersoll and Ross Model”, *Journal of Finance*, 49(4), 1279-1304.
- (d) Vasicek, O., (1977), “An Equilibrium Characterization of the Term Structure”, *Journal of Financial Economics*, 5(2), 177-188.

2. The No-arbitrage Pricing Models

Ho-Lee model, Hull-White model, BDT model, Model calibration, Continuous time limits, Applications to contingent claims valuations

Readings: T ch. 11, H ch. 28, MR ch. 11

- (a) Black, F., Derman, E., and Toy, W., (1990), “A One-factor Model of Interest Rates and its Application to Treasury Bond Options”, *Financial Analysts Journal* 46, 33-39
- (b) Ho, T., and Lee, S., (1986), “Term Structure Movements and Pricing Interest Rate Contingent Claims”, *Journal of Finance* 41(5), 1011-1029.
- (c) Hull, J. and White, A., (1990), “Pricing Interest Rate Derivative Securities”, *Review of Financial Studies*, 3(4), 573-592.

3. The Heath-Jarrow-Morton Forward Rate Model

One factor binomial tree model, Continuous time model, Trading strategies, Synthetic construction

Readings: J ch. 3-9, H ch. 29, MR ch. 11

- (a) Heath, D., Jarrow, R., Morton A., (1990), “Contingent Claim Valuation with a Random Evolution of Interest Rates”, *Review of Futures Markets*, 9(1), 23-56
- (b) Heath, D., Jarrow, R., Morton A., (1990), “Bond Pricing and the Term Structure of Interest Rate: A Discrete Time Approximation”, *Journal of Financial and Quantitative Analysis*, 25(4), 419-440.
- (c) Heath, D., Jarrow, R., Morton A., (1992), “Bond Pricing and the Term Structure of Interest Rate: A New Methodology of Contingent Claims Valuations”, *Econometrica*, 60(1), 77-105.

3. Valuation of Interest Rate Derivatives

1. Valuing Bonds with Embedded Options

Callable and puttable bonds, Yield-to-worst, Binomial tree approach to pricing, Option adjusted spread (OAS), Effective duration and convexity, Negative convexity for callable bonds

Readings: J ch. 11, T ch. 19

- (a) Hull, J. and White, A., (1993), “Bond Option Pricing Based on a model for the Evolution of bond Prices”, *Advances in Futures and options Research*, 6, 1-13.

- (b) Hull, J. and White, A., (1993), "Using Hull and White Interest Rate Trees", *Journal of Derivatives*, 3(3), 26-36.

2. Futures on the Money Market Instruments

LIBOR, MIBOR, Eurodollar futures, 30-days Fed funds Futures, Russian Interest Rate Futures, Futures hedging, cash-and-carry trade, Predicting the Fed actions with futures

Readings: J ch. 12, T ch. 17, H ch. 2-6, D ch. 10

- (a) Cox J., Ingersoll J., and Ross, S., (1981), "The Relation between Forward Prices and Futures Prices", *Journal of Financial Economics*, 9(4), 321-346.
- (b) Jarrow, R. and Oldfield G., (1981), "Forward contracts and Futures Contracts", *Journal of Financial Economics*, 9(4), 373-382.

3. Futures on Bonds, Forward Rate Agreements (FRAs)

Cost of carry, basis risk, conversion factors, forwards and futures binomial tree pricing

Readings: J ch. 12, T ch. 20, H ch. 2-6, D ch. 9, F ch. 29

4. Interest Rate Swaps

Terminology and conventions, Pricing of swaps, Swap spreads

Readings: J ch. 13, T ch. 18, H ch. 7, 30 D ch. 8, F ch. 29

- (a) Bicksler, J., and Chen, A., (1986), "An Economic Analysis of Interest Rate Swaps", *Journal of Finance*, 41(3), 645-655.
- (b) Sun, T., Sundaresan, S., and Wang, C., (1993), "Interest Rate Swaps: An Empirical Investigation", *Journal of Financial Economics*, 34(1), 77-99.

5. Valuation of Caps and Floors, Swaptions

Pricing and hedging caps, floors and collars, Caps and floor Greeks, Uses of caps, floors, and swaptions

Readings: J ch. 13, T ch. 19, H ch. 26, F ch. 29

- (a) Longstaff, F., Santa-Clara, P., and Schwartz, E., (2001). "The Relative Valuation of Caps and Swaptions: Theory and Empirical Evidence", *Journal of Finance*, 56(6), 2067-2109.

6. Valuation of Mortgage Backed Securities

Economics of securitization, Cash Flow patterns, Trenches, Classes, Prepayment models, PACS, CPR, Markets quotes and pricing

Readings: T ch. 21, F ch. 14-17

- (a) Anderson, G., Barber, J., and Chang, C., (1993), “Prepayment Risk and the Duration of Default Free Mortgage Backed Securities”, *Journal of Financial Research*, 16(1), 1-9.
- (b) Roll R., and Scott, R., (1989), “Modeling Prepayments on Fixed-rate Mortgage-Backed Securities”, *Journal of Portfolio Management*, 73-82.

7. Valuation of Collateralized Debt Obligations (CDOs)

Structure of CDOs, Synthetic CDOs, CDO Trenching, Role of the rating agencies

Readings: T ch. 21, F ch. 14-17

- (a) Duffie, D., and Garleanu, N., (2001), “Risk and Valuation of Collateralized Debt Obligations”, *Financial Analysts Journal*, 41-59.
- (b) Goodman, L., (2002). “Synthetic CDOs: An Introduction”, *Journal of Derivatives*, 60-72.

Distribution of hours

#	Topic	Total hours	Contact hours		Self study
			Lectures	Seminars	
Introduction to the Valuation of Fixed Income Securities					
1.	Overview of the Bond Sectors and Instruments	6	2		4
2.	Introduction to Valuation of Fixed Income Securities	6	2		4
3.	Risks Associated with Investing in Bonds	12	4		8
4.	Duration and Convexity Measures based on the Parallel Yield curve Shifts	6	2		4
5.	Bond Portfolio Management	12	4		8
The Science of Term Structure Interest Rate Models					
1.	The Term Structure Models of the Short Interest Rates	6	2		4
2.	The No-arbitrage Pricing Models	6	2		4
3.	The Heath-Jarrow-Morton Forward Rate Model	6	2		4

#	Topic	Total hours	Contact hours		Self study
			Lectures	Seminars	
Valuation of Interest Rate Derivatives					
1.	Valuing Bonds with Embedded Options	6	2		4
2.	Futures on the Money Market Instruments	12	4		8
3.	Futures on Bonds, Forward Rate Agreements (FRAs)	6	2		4
4.	Interest Rate Swaps	6	2		4
5.	Valuation of Caps and Floors, Swaptions	12	4		8
6.	Valuation of Mortgage Backed Securities	6	2		4
7.	Valuation of Collateralized Debt Obligations (CDOs)	6	2		4
Total:		108	36	0	72