

Fixed Income Analysis

Course Syllabus

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1. Course Objective and Format

Fixed income analysis is an optional course for the master level students at ICEF. The course runs in the first semester and offers a thorough understanding of the workings and pricing of the fixed income securities and derivative instruments 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 different measures of bond price sensitivity are introduced such as duration and convexity. This part of the course is particularly useful for students that are planning to take the CFA exams. The second part of the course introduces the arbitrage-free and equilibrium term structure models. Students will learn the contingent securities pricing methods by replication of the portfolio of the synthetic claims. This part of the course is particularly useful for students that are planning to work in the field of the quantitative finance. The last part of the course introduces applications of the no-arbitrage theory to pricing derivative securities in different segments of the bond market. We cover a broad range of fixed-income 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 various numerical recipes.

1.1 Prerequisites

For part 1 a good knowledge of the basic concepts of the modern finance and investment analysis is recommended. For parts 2 and 3 a good knowledge of the binomial tree methods in quantitative finance is recommended.

1.2 Methods of Learning

The following methods and forms of study are used in the course:

- Interactive lectures
- Self-study

1.3 Learning Outcomes

- Able to learn, acquire new knowledge, skills, including fields other than professional.
- Able to identify the scientific nature of the problems in the professional field.
- Able to solve problems in professional sphere based on analysis and synthesis.
- Able to work with information: to find, evaluate and use information from various sources, necessary to solve scientific and professional problems (including those on the basis of a systematic approach).
- Able to collect and analyze the source data necessary for the calculation of economic and socio-economic indicators characterizing the activities of economic entities;
- Able to prepare an informational review and / or analytical report using domestic and foreign sources of information.

1.4 Grade determination

5 % Class participation

10 % Home assignments

25 % Mid-term test

60 % Final Exam

$$G = 0.05 * G_{\text{class}} + 0.1 * G_{\text{ha}} + 0.25 * G_{\text{midterm}} + 0.6 * G_{\text{fe}}$$

Examination is in writing.

Sample materials for knowledge assessment are available in ICEF Information system at <https://icef-info.hse.ru>. The final grades are transferred to 10- and 5-points grades in accordance with the ICEF Grading Regulations (par.3) available at https://icef-info.hse.ru/goto_icef_file_29837_download.html

1.5 ICEF's Regulations on retake exams

Within ICEF Master's programme, the retake period for the first semester must end no later than March 01; for the second semester – no later than October 15.

A retake schedule includes one date of the retake for every course, and Master's students at ICEF can have only one retake with the Commission, in accordance with the rules of the final retake. For Master's courses that involve external assessment, retake examination papers cannot be released to students after grading, and results of such retakes cannot be subject to appeal.

Retakes are organized in accordance with the [HSE Interim and Ongoing Assessment Regulations](#) (incl. Annex 8 for ICEF). Grade determination after retakes is done in accordance with ICEF Grading Regulations (par. 5) available at https://icef-info.hse.ru/goto_icef_file_29837_download.html

2. Literature

2.1 Main Readings

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)

2.2 Supplementary Readings

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)

2.3 Internet resources

www.bloomberg.com
www.cbonds.ru
<http://www.cmegroup.com/>
www.moex.ru

4. Course Outline

Part I. Introduction to the Valuation of Fixed Income Securities

- **Week 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

- **Week 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

- **Week 3. Risks Associated with Investing in Bonds**

Interest rate risk, yield curve risk, reinvestment risk, credit risk, liquidity risk, Rating agencies, EMBI+ spreads

Journal Readings:

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

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

One-factor measures of price sensitivity, Maculalay 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

- **Week 5. Bond Portfolio Management**

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

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

Part II. The Science of Term Structure Interest Rate Models

- **Week 6. 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

Journal Readings:

1. 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.
2. Cox, J., Ingersoll, J., Ross, S. (1985), "A Theory of the Term structure of Interest Rates," *Econometrica*, 53(2), 385-407.
3. 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.
4. Vasicek, O., (1977), "An Equilibrium Characterization of the Term Structure", *Journal of Financial Economics*, 5(2), 177-188.

• **Week 7. 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

Journal Readings:

1. 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
2. Ho, T., and Lee, S., (1986), "Term Structure Movements and Pricing Interest Rate Contingent Claims", *Journal of Finance* 41(5), 1011-1029.
3. Hull, J. and White, A., (1990), "Pricing Interest Rate Derivative Securities", *Review of Financial Studies*, 3(4), 573-592.

• **Week 8. 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

Journal Readings:

1. 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
2. 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.

3. 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.

Part III. Valuation of Interest Rate Derivatives

- **Week 9. 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

Journal Readings:

1. Hull, J. and White, A., (1993), "Bond Option Pricing Based on a model from the Evolution of bond Prices", *Advances in Futures and options Research*, 6, 1-13.
2. Hull, J. and White, A., (1993), "Using Hull and White Interest Rate Trees", *Journal of Derivatives*, 3(3), 26-36.

- **Week 10. 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

Journal Readings:

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

- **Week 11. 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

- **Week 12. 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

Journal Readings:

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

- **Week 13. 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

Journal Readings:

1. 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.

- **Week 14. 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

Journal Readings:

1. 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.
2. Roll R., and Scott, R., (1989), "Modeling Prepayments on Fixed-rate Mortgage-Backed Securities", *Journal of Portfolio Management*, 73-82.

- **Week 15. 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

Journal Readings:

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

3. Distribution of hours

Topic	Total hours	Lectures	Self-study
1. Overview of the Bond Sectors and Instruments	9	4	5
2. Introduction to Valuation of Fixed Income Securities	7	2	5
4. Risks Associated with Investing in Bonds	7	2	5
5. Duration and Convexity Measures based on the Parallel Yield curve Shifts	7	2	5
6. Bond Portfolio Management	7	2	5
7. The Term Structure Models of the Short Interest Rates	7	2	5
8. The No-arbitrage Pricing Models	7	2	5
9. The Heath-Jarrow-Morton Forward Rate Model	7	2	5
10. Valuing Bonds with Embedded Options	7	2	5
11. Futures on the Money Market Instruments	7	2	5
12. Futures on Bonds, Forward Rate Agreements (FRAs)	7	2	5
13. Interest Rate Swaps	7	2	5
14. Valuation of Caps and Floors, Swaptions	7	2	5
15. Valuation of Mortgage Backed Securities	7	2	5
16. Valuation of Collateralized Debt Obligations (CDOs)	7	2	5
Total:	114	34	80

