RMBI4210 – Quantitative Methods for Risk Management

Spring, 2021-22

Instructor

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Office Hour: Tuesday, 2:00pm - 3:00pm or by appointment

Meeting Time and Venue

Lectures
Tuesday and Thursday, 10:30am – 11:50am; Online Zoom meeting

Course Objective and Description

This course illustrates the use of various quantitative techniques (statistical analysis, optimization and simulation methods) and financial engineering principles (hedging and arbitrage), in the quantification and management of financial risks. The topics include characterization of financial risks, hedging of market risks, immunization of bond risks, credit portfolio and loss distribution, Value-at-Risk and expected shortfall, coherent measures of risk and economic capital, credit yield curve modeling, credit default swaps and structured credit products, CreditMetrics and copula models of default correlation.

Course Content

1. 1. Nature of financial risks
   1.1 Wall Street fails Main street
   - Systemic risk
   - Black Monday: market failure arising from program trading
   - Long Term Capital Management: failure of convergence arbitrage
   - Barings Bank failure: loss of risk control
   - Model risk: Constant Proportional Debts Obligations
   - Legal risk: Lehman Brothers' mini-bonds

   1.2 Hedging of equity risks
   - Volatility risks and their measurements
   - Dynamic hedging of options
   - Minimum variance hedge ratio

   1.3 Hedging of interest rate risks
   - Duration measure
   - Horizon rate of return
   - Bond immunization
   - Bankruptcy of Orange County, California

2. Loss distribution and risk measures
   2.1 Portfolio loss distribution
   - Credit risk: Loan portfolio losses
   - Fitting of loss distribution

2.2 VaR (Value-at-Risk) and Expected Shortfall
- VaR calculations
- Expected shortfall
- Coherent risk measures
- Risk control for expected utility-maximizing investors
- Economic capital
- Extreme Value Theory

3. Default intensities and exponential model of joint defaults
   3.1 Implied probability of defaults and default intensities
   - Credit yield curves
   - Credit spread and default intensities

   3.2 Exponential models of joint defaults
   - Joint survival of two obligors
   - Multi-obligor extension
   - Simulation algorithm

4. Credit derivatives
   4.1 Structured credit derivative products
   - Credit default swaps
   - Synthetic Collateralized Debts Obligations

   4.2 Hazard rates and credit derivatives pricing
   - Implied hazard rates and calibration
   - Building blocks of credit derivatives pricing

5. CreditMetrics and Gaussian copula
   5.1 CreditMetrics
   - Credit migration of firm credit indexes
   - Monte Carlo simulation

   5.2 Copula models of default correlation
   - Definition of copula
   - CreditMetrics interpreted as Gaussian copula
   - Generalized Gaussian copula framework
   - Vasicek model

Assessment Scheme

The assessment is based on one mid-term test and one final examination

Grading policies

80-minute mid-term test (OPEN book) on March 24 (Thursday)	40%
120-minute final examination (OPEN book)	60%

Student Learning Resources

References

1. Hull, J., *Risk Management and Financial Institution*, 4th edition (2015), Prentice Hall. (downloadable from HKUST Library)
2. Bluhm, C., Overbeck, L., Wagner, C., *Introduction to Credit Risk Modeling*, second edition (2010), Chapman & Hall/CRC.
3. Roncalli, T. *Handbook of Financial Risk Management* (2020) Chapman & Hall/CRC.

Teaching Approach

Lectures:

- Focus on the use of quantitative techniques in the modeling of market and credit risks.
- Emphasize on the quantitative understanding of risk measures, like Value-at-risk and expected shortfall, and their limitations.
- Understand the mechanism of default correlation via the mixture models
- Review of industrial practices in risk management and lessons learned from real life credit cases.

Intended Learning Outcomes

Upon successful completion of this course, students should be able to understand:

1. Nature of various forms of financial risks: market risk, credit risk, basis risk and liquidity risk.
2. Hedging of equity risk in financial options
3. Bond immunization and horizon rate of return
4. Quantitative measures of portfolio risk using VaR and expected shortfall, and their limitations.
5. Estimation of VaR and expected shortfall using the extreme value theory.
6. Default intensities and calibration of default probabilities from defaultable bond prices
7. Credit default swaps and its valuation
8. Collateralized Debt Obligations
9. Understand the popular industrial code, CreditMetrics, for modeling credit portfolio risk.
10. Understand the role of copula functions to model default correlation.