MAFS5030 - Quantitative Modeling of Derivative Securities

Course objective

This course is directed to those students who would like to acquire an introduction to the pricing theory of financial derivatives. The course starts with the exposition of basic derivative instruments. We then discuss the fundamental concepts of financial economics, like the fundamental theorem of asset pricing, risk neutral valuation principle. The renowned Black-Scholes pricing theory and martingale pricing theory are introduced. Extended option pricing models, like exchange options, quanto options, risky debt models, transaction costs models are considered. We also discuss the notion of implied volatility and volatility smile, variance swap and VIX.

Prerequisite and exclusion

A course on stochastic calculus (MAFS5010) should be taken concurrently or earlier. No prior knowledge in finance is required.

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Textbook

"Mathematical Models of Financial Derivatives" second edition, by Yue Kuen KWOK, Springer Verlag (2008), 530 pages.

Course content

- 1. Introduction to derivative instruments
 - 1.1 Basic instruments: bonds, forward contracts and futures
 - 1.2 Exotic swap products
 - 1.3 Options: Rational boundaries of option values
 - 1.4 American options: Optimal early exercise policies
- 2. Discrete securities model
 - 2.1 Single-period models: Dominant trading strategies and linear pricing measure
 - 2.2 No-arbitrage theory and risk neutral probability measure: Fundamental Theorem of asset Pricing
 - 2.3 Valuation of contingent claims and complete markets
 - 2.4 Information structures and filtrations in multi-period models
 - 2.5 Notion of martingales: Discounted gain process and self-financing strategy
 - 2.6 No-arbitrage principle and martingale measure
 - 2.7 Binomial option pricing models
- 3. Black-Scholes-Merton framework and Martingale Pricing Theory
 - 3.1 Review of stochastic processes and Ito calculus
 - 3.2 Change of measure Girsanov's Theorem
 - 3.3 Riskless hedging principle and dynamic replication strategy
 - 3.4 Martingale pricing approach
 - 3.5 European option pricing formulas and their greeks

4. Extended option models

4.1 Continuous dividend yield models: Time dependent parameters

- 4.2 Exchange options: Change of numeraire
- 4.3 Quanto options equity options with exchange rate risk exposure
- 4.4 Implied volatility and volatility smiles
- 4.5 VIX, variance swaps and timer options
- 4.6 Merton's models of risky debts
- 4.7 Transaction costs models

Grading policies

120-minute mid-term examination: Oct. 25; Topics 1 and 2	50%
120-minute final examination: Dec 8; Topics 3 and 4	50%