15-MATH-941 Seminar in Financial Mathematics

Optimal Portfolios, Risk Premium, Interest Rates, Quantitative Equity, and Foreign Exchange

– Wednesday nights 6:00-8:40 PM

This course is intended for advanced MS and PhD students as well as the continuing education for the professionals in quantitative finance. It was developed over a number of years of executive training under the auspices of GARP (http://www.garp.com), RISK Training (http://www.incisive-events.com/), and in-house financial industry training/consulting.

Optimal portfolio theory for general multi-factor Markovian Ito-SDE markets

- Multi-factor, multi-tradable, complete and incomplete, Markovian Ito-SDE markets
- Optimal portfolio problems, without or with constraints on the portfolio
- HJB PDE, Monge-Ampere type PDE, mildly non-linear (risk-premium) PDE characterizations of the value function
- An explicit solution example: optimal portfolio under stochastic market appreciation rate
- Major ramifications of the modern optimal portfolio theory:
  1. better portfolio management
  2. better pricing theory: mathematical determination of the pricing risk premium
  3. better hedging, risk management
  4. better FX rate theory

Risk premium, derivative Pricing and Hedging in incomplete markets

- Pricing of multi-contracts in multi-factor, multi-tradable, complete and incomplete, Markovian Ito-SDE markets using HARA and CARA utilities of wealth
- The most general Black-Scholes type pricing PDE (system) with risk premium determination
- General hedging formula (for complete and incomplete markets)
- An Explicit solution example: pricing variance swaps with risk premium determination (how does the general market sentiment affect the price of variance swaps?)

Extensions to American options

- Risk premium for American options – does it differ from the one for European options?
- Fast sparse array Mathematica algorithm for solving the one-space-dimension finite difference free boundary problem for pricing of American contracts

Interest Rates

- Short rate models for stochastic interest rates
- Incomplete market bond pricing using HARA utility of wealth (and the impossibility of CARA pricing under stochastic interest rates)
- Historical US yield curve fitting: could the risk aversion explain/quantify the humped yield curve?

Quantitative Equity

- Classical Miller-Modigliani theory of firm value – Black's dividend puzzle
- When does the dividend policy affect the total investors gain and when it does not?
- Firm value and its volatility via incomplete market pricing theory
  - An explicit valuation formula under stochastic revenue and cost rates
- An explicit valuation formula under dynamic market share

FX rates and FX derivatives

- The optimal-portfolio based, general diffusion theory of FX rates
  - why JPY falls when investors ignore risks – understanding and quantifying
  - The effect of market volatility on FX rates
- FX rates under stochastic interest rates

- FX rates under stochastic volatility
- The general diffusion model for FX derivatives – the general risk premium PDE and the general pricing PDE
- FX derivatives under stochastic interest rates
- FX derivatives under stochastic volatility
    - The most conservative hedging in complete and incomplete FX markets

Implementation, statistics and further empirical verification

- Pricing and hedging of FX futures, FX options, and other derivatives, with correct risk premium
    - Explicit solutions
    - Fourier Transform solutions
- Statistical estimation of model parameters
- Implied volatility skew
- The effect of market risk aversion on the price of FX derivatives
- Hedging implementation and assessment of hedging-efficacy

For more information please contact Prof. Stojanovic at Srdjan@math.uc.edu or 513-556-4064.