ASSET PRICING

This course discusses continuous-time asset pricing theory and continuous-time derivative pricing models. Intuitively, we relate some asset returns to other asset returns (derivative assets), appealing to the absence of arbitrage and risk-neutral pricing arguments. To do so, some knowledge of stochastic calculus is needed, so we introduce it. We then look at some applications, specifically, interest rate and credit risk models. Finally, we conclude with an introduction to stochastic optimization in continuous time.

Topics

1. **Introduction** (0.5 week): Some basic and classical ideas in asset pricing. Pricing in the binomial model. Pricing via replication and risk-neutral pricing in discrete time.

2. **Stochastic calculus** (2 weeks): Some probability theory. Relationship between risk-neutral and objective probabilities. Brownian motion. Basic building block for stochastic processes in continuous time. Calculus with processes that contain Brownian motion.

3. **Continuous-time risk-neutral pricing and hedging** (1.5 weeks): Risk-neutral probabilities and pricing in continuous time. Pricing via replication in continuous time. Practical application of dynamic hedging techniques.

4. **Some generalizations of continuous-time risk-neutral pricing** (1 week): Itô processes. The multidimensional market model and the Fundamental Theorems of Asset Pricing (FTAPs). Dividend-paying assets.

5. **Some other common derivatives** (1 week): American derivatives. Optimally chosen expiration time. Forwards and futures. Pricing and hedging for these contracts. Change of numeraire. Foreign exchange.

6. **Interest rates modeling** (2 weeks): Some instruments. Types of interest rates. Instantaneous rates. The market model, short rate, and multi-factor models. The Heath-Jarrow-Morton approach.

7. **Credit risk modeling** (1 week): Some instruments. Spread-based pricing. Hazard rates and defaultable forward rates. Doubly-stochastic models.

8. **Stochastic optimal control** (1 week): Basic optimal control problem. Hamilton-Jacobi-Bellman equations. Solving Hamilton-Jacobi-Bellman equations using finite differences.

Evaluation: 80% exam – 15% homework –5% presentations

Reading

Required:

Lecture notes.

Optional:

Baxter, M. and A. Rennie (1996): *Financial Calculus*, Cambridge University Press.

Duffie, D. (2001): *Dynamic Asset Pricing Theory*, Princeton University Press.

Hull, J. (2003): *Options, Futures and Other Derivatives*, Pearson Education.

Karatzas, I. and S. Shreve (1996): *Brownian Motion and Stochastic Calculus*, Springer Verlag.

Musiela, M. and M. Rutkowski (1997): *Martingale Methods in Financial Modelling*, Springer Verlag.

Huyên Pham (2009): *Continuous-time Stochastic Control and Optimization with Financial Applications*, Springer Verlag.

Protter, P. (1990): *Stochastic Integration and Differential Equations: A New Approach*, Springer Verlag.

Rebonato, R. (1998): *Interest-Rate Option Models*, John Wiley & Sons Ltd.

Schönbucher, P. (2003): *Credit Derivatives Pricing Models*, John Wiley & Sons Ltd.

Shreve, S. (2004): *Stochastic Calculus for Finance II: Continuous-Time Models*, Springer-Verlag.

Some classics:

Black, F. and M. Scholes (1973): "The Pricing of Options and Corporate Liabilities", *Journal of Political Economy* 81, 637–654.

Cox, J., J. Ingersoll, and S. Ross (1985): "An Intertemporal General Equilibrium Model of Asset Prices", *Econometrica* 53, 363–384.

Cox, J., J. Ingersoll, and S. Ross (1985): "A Theory of the Term Structure of Interest Rates", *Econometrica* 53, 385–407.

Harrison, J.M. and D. Kreps (1979): "Martingales and Arbitrage in Multiperiod Securities Markets", *Journal of Economic Theory* 20, 381–408.

Harrison, J.M. and S. Pliska (1981): "Martingales and Stochastic Integrals in the Theory of Continuous Trading", *Stochastic Processes and their Applications* 11, 215–260.

Heath, D., R. Jarrow, and A. Morton (1992): "Bond Pricing and the Term Structure of Interest Rates: A New Methodology", *Econometrica* 60, 77–105.

Merton, R.C. (1973): "Theory of Rational Option Pricing", *Bell Journal of Economics and Management Science* 4, 141–183.