

## ASSET PRICING II

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 absence of arbitrage and risk-neutral pricing arguments. To do so, some knowledge of stochastic calculus is needed, so we introduce it. Finally, we look at some applications, specifically, interest rate and credit risk models.

### Topics

1. **Introduction** (0.5 weeks): 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 generalisations of continuous time risk-neutral pricing** (1 week): Itô processes. Models with time-varying interest rates. The multidimensional market model and the Fundamental Theorems of Asset Pricing (FTAP). 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 modelling** (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 modelling** (2 weeks): Some instruments. Spread-based pricing. Hazard rates and defaultable forward rates. Doubly-stochastic models. Structural models.

**Evaluation:** 60% exam – 40% problem sets

### Reading

*Required:*

Lecture notes.

*Optional:*

- Baxter, M. and A. Rennie (1996): *Financial Calculus*, Cambridge University Press.
- Björk, T. (1998): *Arbitrage Theory in Continuous Time*, Oxford University Press.
- Duffie, D. (2001): *Dynamic Asset Pricing Theory*, Princeton University Press, 3<sup>rd</sup> ed.
- Hull, J. (2003): *Options, Futures and Other Derivatives*. Pearson Education, Upper Saddle River NJ USA, 5<sup>th</sup> ed.
- Karatzas, I. and S. Shreve (1996): *Brownian Motion and Stochastic Calculus*, Springer Verlag.
- Musiela, M. and M. Rutkowski (1997): *Martingale Methods in Financial Modelling*, Berlin, 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., Chichester, England, 2<sup>nd</sup> ed.
- Schönbucher, P. (2003): *Credit Derivatives Pricing Models*, John Wiley & Sons Ltd., Chichester, England.
- 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.