Modelos Estocásticos en Finanzas

Prerequisites

Students should have taken an elementary Probability or Probability and Statistics course. Also, it is expected that applicants have achieved strong courses on linear algebra and calculus in several variables.

Learning outcomes

After approving the course the students will be able to

- Have a wide view of the type of derivatives and structured contracts delivered in the financial markets.
- Define a methodology to valuate these class of derivatives for complete financial markets in discrete time, implementing concepts like hedging price and absence of arbitrage opportunity.
- Propose different models to describe the evolution of the price of stocks, in discrete time. These will be based on Markov chains.
- Describe the hedging strategy for derivatives in complete markets, in particular in the binomial model.
- Describe the evolution of the fundamental assets in the risk neutral framework.
- Develop numerical techniques to calculate the arbitrage free price of derivatives using Monte Carlo methods.

Course Content

1. **Fundamental elements of a financial market .**
   Introduction to financial markets. Different contracts based on risky assets. Structured products on indexes, definitions and characteristics, rules of the markets. Interest rates.

2. **Risk neutral valuation and arbitrage considerations.**
   Arbitrage and risk neutral probability measures. Valuation of contingent claims. Single period models. Valuation and hedging in complete and incomplete markets. Investment strategies.
3. **Multiperiod financial markets**

Conditional expectation and martingales in discrete time. Optimal portfolios for the binomial model. Markov models and incomplete markets. Valuation of European options. Cox Ross and Rubinstein model.

4. **American options**
   Stopping time. Snell envelope and decomposition of supermartingales. Valuation of American options. Perpetual and finite horizon cases. Hedging portfolios in complete markets.
5. **Dynamic programming**
   Optimal portfolios and dynamic programming. Martingale methods for solving optimal consumption problem. Optimal portfolios managment with constraints.
6. **Continuous time models**
   Black-Scholes model and generalizations. Contingent claims and market completeness. Hedging problem. Indifference pricing in incomplete markets.

Bibliography

- Baxer Martin and Rennie Andrew. Financial Calculus, An Introduction to derivative pricing. Cambridge University Press, 1996.
- Duffie Darrell. Dynamic Asset Pricing Theory. Princeton University Press, 1996.
- Lamberton Damien and Lapeyre Bernanrd. Introduction to Stochastic Calculus Applied to Finance, Chapman & Hall 1996.
- Pliska, Stanley R. Introduction to Mathematical Finance. Blackwell, 1997.
- Lapeyre Bernard, Sulem Agnes and Taley, Denis. Simulation of Financial Models: Mathematical Foundations and Applications. Cambridge University Press.
- Shreve, Steve. Stochastic Calculus for Finance. Volume I – The Binomial Asset Pricing Model. Volume II – Continuous Time Models, Springer- Verlag, New York, 2004.
- Wilmott, Peter. Derivatives. The Theory and Practice of Financial Engineering.