Derivatives

MAE, Module 2, 2020-2021

Vyacheslav Gorovoy, PhD
NES
vgorovoy[at]nes.ru

Course information

Course Website: https://my.nes.ru

Instructor's Office Hours: by assignment

TAs: TBD

Course description

The course is an introduction to the theory and practice of derivative instruments. It will cover the non–arbitrage pricing of forward and futures contracts, binomial and Black–Scholes–Merton model for option pricing, hedging and replication of derivatives and other important topics. The material will be particularly relevant to students interested in financial markets, securities trading and structured products development involving derivatives.

Since of the quantitative nature of the course, the Python is used for lecture notes and HWs.

Course requirements, grading, and attendance policies

Prerequisites:

1. Calculus
2. Probability, statistics
3. An introductory finance course

Grading:

3 homework problem sets	**30% (each 10%)**
Game	**10%**
Exam	**60%**

Course contents

- **Introduction to Derivative instruments**
- **Forward and Futures contracts**: Arbitrage arguments. Pricing by arbitrage. Investing, trading, hedging, and arbitrage applications. Foreign exchange, equity, and commodity markets.
- **Interest Rate Review**: Interest rate curve. Compounding period. Forward interest rate. FRA. Swaps.
- **Introduction to Options**: Option basics. Model–free properties of option prices. Arbitrage relationship. The binomial model of asset price dynamics. Risk neutral valuation.
- **The Black–Scholes Model**: Modeling stock price behavior. Geometric Brownian motion. Lognormal distribution. Risk–neutral valuation. The Black–Scholes–Merton option pricing formula.
- **Hedging**: Option hedging. Greeks . Synthetic replication and hedging of options. Option hedging. Delta hedging. Greeks. Portfolio Insurance.
- **Volatility**: Implied volatility. Implied distribution. FX and equity smiles. The volatility surface and term structure. Historical versus implied volatility.
- **Credit Value Adjustment:** Valuation of credit risk related to derivatives transactions. Wrong/Right way risk.
- **Structured Products**: Capital protected and Yield enhancement products.

Description of course methodology

- Lectures
- Homeworks
- In-class simulation: derivative game

Sample tasks for course evaluation

Exotic call:
This option has the standard call payoff pays max(S_T – K ,0) at expiration T. However, the holder of the option does not pay any premium upfront when the contract is set up, but must pay a fixed cash amount Q to the option writer at expiration only if S_T>K . Derive a closed-form formula for this cash amount Q to be paid at expiration if the option expires in-the-money, and use the formula to compute Q when S=K=100, T=1Y, vol=25%, r=2%, q=1%

Course materials

Textbooks and materials

- Lecture notes
- John Hull, “Options, Futures, and Other Derivatives”
- Paul Wilmott on Quantitative Finance

Academic integrity policy

Cheating, plagiarism, and any other violations of academic ethics at NES are not tolerated.