

Derivatives

The course consists of two parts. The first part examines fundamental topics and approaches in derivative pricing; it is taught by Dmitry Makarov. The second part focuses on practical aspects of applying derivative pricing techniques; it is taught by Brian Eales.

Abstract

The objective of this elective course is to undertake a rigorous study of derivative financial instruments. The course is quantitatively oriented and requires some background in calculus and statistics. Derivative financial instruments are instruments whose value is “derived” from the value of some underlying asset or assets. Our goal is to learn how to price such instruments using a noarbitrage principle, and how to hedge them.

The course will be particularly relevant to students interested in financial markets, securities trading and structured products development involving derivatives.

Second part will provide a thorough understanding of the applications to which derivative securities can be put in modern financial markets. It will cover the operational characteristics of the instruments and the infra-structure in which they operate. The course will start with a review of the major derivative exchanges and an overview of the instruments offered and a distinction will be drawn between Exchange-based and off-exchange instruments. The course will examine some of the applications to which stock and index equity futures and options can be put and will also examine single and multi-period hedging of interest rates. Towards the end of the course participants will be introduced to asset swaps, total return swaps, credit default swaps and financially engineered equity products.

Prerequisites: Intermediate level calculus and probability theory

Learning Objectives and Outcomes

At the end of the course students will obtain two types skills. First, students will know key properties of standard derivative instruments, such as forwards, futures, swaps, and call and put options. Second, students will be comfortable with analyzing new derivative products using the techniques presented in class.

The student should be able to apply professional knowledge and skills acquired while studying the course in practical areas, including academic research, work in financial institutions, industry, state governance.

Methods of Instruction

The course relies on the following teaching methods:

- Lectures (active participation is encouraged)
- Solving home assignments
- Self-study: reading additional materials assigned during lectures

Grading System and Knowledge Assessment

Part 1:

- Home assignments account for 20%
- Final exam accounts for 80%

Part 2:

Midterm exam 100%

Overall Grade for the Course: The weight of the first part in the overall course grade is 70% and the weight of the second part is 30% (the weights may be adjusted slightly).

Sample materials for knowledge assessment are available in ICEF Information system at <https://icef-info.hse.ru>.

Required Reading

Hull, J. (2011), Options, Futures and Other Derivatives, 8th edition, Pearson International Edition.

Optional Reading

Kolb, R. W. & Overdahl, J. A. (2007), Futures, Options and Swaps 5th edition, Blackwell

Willmott, P., Paul Wilmott on Quantitative Finance, Wiley (the edition does not matter)

Special Equipment and Software Support

Laptop, projector, Internet connection

MS Word, MS Excel

Course plan

Part 1

1) Overview : Historical background and milestones in the development of derivative markets

Key concepts: replication, underlying security, no arbitrage, relative versus absolute pricing

Popular derivative instruments: forwards, futures, options 2) Option pricing: static and discrete-time analysis No arbitrage bounds on option prices.

Types of options: European, American, Bermudan, Asian, etc.

Binomial option pricing models: building binomial trees, pricing on the tree, risk neutral tree probabilities

3) Option pricing in continuous time

Mathematics of option pricing: Brownian motion, Ito's processes, Ito's lemma, partial differential equations, martingale approach

Pricing and replication in continuous time, Black-Scholes formula, option greeks,

Empirical evaluation of Black-Scholes formula, volatility smile

4) Pricing with multiple sources of uncertainty Traded and non-traded risks, stochastic volatility and stochastic interest rate models, market price of risk, pricing convertible bonds

5) Structural and reduced-form models of credit risk Defaultable bonds, bond as an option, credit rating, risky yield curve

Part 2

1. Exchange-based and OTC derivatives Exchange-based derivatives (ETDs): Futures and options – contract specifications, operational characteristics. Over-the-counter (OTC) derivatives: Forwards, Options. Hedging an equity portfolio with futures. Exchange Trade Funds (ETFs), Universal Stock futures (USFs and SSFs), speculation, arbitrage, ‘Chasing alpha’. Portfolio engineering using exchange-traded futures. OTC short term equity swaps (Contracts for Difference (CFD)). Option review.
2. Options and an introduction to Structured Certificates: Market links between options and futures. Structuring certificates using options. The impact of time on officially recognised strategies.
3. Short Term interest Rates and Bonds: Comparing FRAs and STIRs. Using STIR options and Interest Rate Guarantees to hedge single and multiple period exposures. Hedging using bond futures.
4. Swaps: Review of plain vanilla interest rate swaps. Some variations on the basic interest rate swap. Asset swaps. Total return swaps. Credit default swaps.
5. Structured Equity Products: Constructing guaranteed principal products (GPP).