

# 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.

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).

## Part 1: Fundamentals of Derivative Pricing

Lecturer: Dmitry Makarov

### Prerequisites

Intermediate level calculus and probability theory.

### Course Description

The objective of this 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 no-arbitrage 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.

At the end of the course, my hope is that 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 at the lectures.

### 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, Exams, and Homework**

- Home assignments account for 25%
- Final exam accounts for 75%

## **Course Materials**

The lecture notes (to be posted to ICEF web portal) will be self-contained: they will contain all the relevant materials a student needs to successfully master the course. But if I were to recommend textbooks, it would be:

- 1) Hull, J., *Options, Futures, and Other Derivatives*, Prentice-Hall (the edition does not matter)
- 2) Willmott, P., *Paul Willmott on Quantitative Finance*, Wiley (the edition does not matter)

## **Course Outline**

### **Session 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

### **Sessions 2-3. Forwards, futures, swaps**

Forwards, futures, and swaps on different underlying assets: commodity, currency, interest rate. Replication and pricing. Key facts about the use of these securities.

### **Sessions 5-6. Options**

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

## **Section 7-8. Continuous time option pricing techniques**

Black-Scholes setting. Main approaches to pricing derivatives: PDE approach and martingale approach. Black-Scholes formula and option greeks. Empirical tests of the Black-Scholes model

## Part II: Applications of Derivative Securities

**Lecturer:** Brian A. Eales

### Course Objective

This 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.

### Main Readings

Hull, J. (2011), Options, Futures and Other Derivatives, 8<sup>th</sup> edition, Pearson International Edition. (H). (NB early editions of Hull cover the material very well and may be much cheaper to purchase. The 9th ed. costs about £150.).

Eales, B. A. & Choudhry, M. (2003), Derivative Instruments: a Guide to Theory and Practice, Elsevier (E)

### Supplementary Readings

Kat, H. M (2001), Structured Equity Derivatives, Wiley Finance (K)

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

Das, S. (2006), Structured Products Volume 2. Wiley (D).

### Course outline

#### Day 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.

*Workshop 1:* Using the web familiarise yourself with the products offered by the following derivative exchanges:

Eurex [www.eurexchange.com](http://www.eurexchange.com)

NYSE THEICE [www.theice.com](http://www.theice.com)

CME Group [www.cmegroup.com](http://www.cmegroup.com)

*Workshop 2:* Checking available contracts on the web. Hedging an equity portfolio using ETD futures.

*Readings:* (E) Chapter 8, 10, (H) Chapter 2, 3, 14, (K) Chapters 2 – 4 and 7 and 8.

### **Day 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.

*Workshop 3:* Hedging with ETD equity options.

*Readings:* (E) Chapter 10 (H) Chapter 9, 10 and 16 (K) Chapters 10 and 11. See also the major websites for more on option strategies and simulated trading.  
for option strategies.

### **Day 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.

*Workshop 4:* Hedging a bond portfolio.

*Readings:* (E) Chapter 6, (H) Chapters 2, 4 and 6. (NB Pricing methodologies are covered in chapters 28 – 31). (K) Chapters 5, 6

### **Day 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.

*Workshop 5:* Structuring a special interest rate swap.

*Readings:* (E) Chapter 6, (H) Chapter 7, 24 and 32.

### **Day 5: Structured Equity Products:**

Constructing guaranteed principal products (GPP).

*Workshop:* Testing the feasibility of a GPP.

*Readings:* (E) Chapter 12, (K) Chapter 1, 3 & 9. (D) Chapter 4 & 5.