ICEF, Higher School of Economics, Moscow
Msc Programme
Autumn 2017

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%.

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 in class.

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 20%
- Final exam accounts for 80%

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., O*ptions, Futures, and Other Derivatives*, Prentice-Hall (the edition does not matter)
2) Willmott, P., *Paul Wilmott on Quantitative Finance,* Wiley (the edition does not matter)

Course Outline and Topics

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 II: Applications of Derivative Securities

Derivative Securities

Lecturer: Brian A. Eales, Associate London School of Economics

Course Objective

This course 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 infrastructure in which they operate. The course will start with a review of the major derivative exchanges and an overview of the instruments offered. A distinction will be drawn between Exchange-based and off-exchange instruments. The course will examine some of the applications to which stock, equity index and interest rate futures and options can be put. It 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.

Practical computer-based workshops will help to consolidate students' understanding of the instruments discussed during lectures.

Assessment Method

Mid-term test (100% for this part of the course; 30% of the final grade for the course)

Main Readings

Flavell, R., Swaps and other Derivatives, Wiley (2009). (F)

Hull, J. (2011), Options, Futures and Other Derivatives, 8th 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 £180.).

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

Supplementary Readings

Choudhry, M., Fixed Income Securities and Derivatives Handbook, Bloomberg (2005). (C)

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

Knop, R., Structured Products, Wiley (2002). (Kn)

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

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

Reference Sources

Wilmott, P. (2007), Paul Wilmott introduces Quantitative Finance, 2nd edition. Wiley. (A good all round source of financial market and instrument information.)
Veronisi, P. (2010), Fixed Income Securities, Wiley. (N.B. The first 4 chapters are a good source of background information. Later chapters examine modelling the yield curve and various approaches to pricing.)

Valdez, S. and Molyneux, P. (2016), An introduction to Global Financial Markets, Palgrave. (Part 6 of this text introduces Derivative Products; the earlier chapters provide an insight into the rationale of the markets themselves.).

Some specialized sources are presented on the PowerPoint slides.

Course outline

Day 1. Exchange-based and OTC derivatives

Exchange-based derivatives (ETDs): Futures on equity and bonds – contract specifications, operational characteristics.
Over-the-counter (OTC) derivatives: Forwards and Contracts for Differences (Short term equity swaps).
Hedging an equity portfolio with futures.
Using futures: speculation, arbitrage, 'Chasing alpha'. Portfolio engineering using exchange-traded futures. Bond Futures: Contract specifications and physical delivery. Basis. The conversion factor. The Cheapest-to-Deliver (CTD (Bond).

Workshop 1: Using the web familiarise yourself with the products offered by the following derivative exchanges:
Eurex www.eurexchange.com
THEICE www.theice.com
CME Group 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: Comparing the valuation of an exchanged based future with a synthetic future created using exchange based 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
using options.

Day 3: Interest rate derivatives and 'Plain' Vanilla Swaps.
The yield curve. Short-term interest rates. Comparing FRAs and STIRs.
Valuing a plain vanilla interest rate swap initially and following the passage of time.
Some variations on the basic interest rate swap.

Workshop 4: Analysing and valuing an interest rate swap.

Readings: (F) Chapters 1, 2, and 3, (E) Chapters 4, 6, (H) Chapters 5, 6 and 7.

Day 4: More Complex Swaps:
Asset swaps. Total return swaps. Equity Swaps, Credit default swaps.

Workshop 5: Analysing and valuing second-generation interest rate swaps.

Readings: (F) Chapters 4 and 5, (E) Chapter 6, (H) Chapter 7, 24 and 32.

Day 5: Structured Equity Products:
Constructing and analysing guaranteed principal products (GPP).

Workshop 6: Structuring and examining a guaranteed equity structure.

Readings: (E) Chapter 12, (K) Chapter 1, 3 & 9, (D) Chapter 4 & 5, (Kn) Part II Equity Structures.