OPTIONS, FUTURES AND OTHER FINANCIAL DERIVATIVES (FM360)

Course duration: 54 hours lecture and class time (Over three weeks)

LSE Teaching Department: Department of Finance

Lead Faculty: Dr Jean-Pierre Zigrand and Dr Rohit Rahi

Pre-requisites: Calculus and statistics (intermediate undergraduate level). *More in main text.*

Course Description

The course is an introduction to the concepts and models underlying the modern analysis and pricing of financial derivatives, from vanilla calls and puts on stocks to complex exotics in the equity and fixed income arenas. The underlying philosophy of the course is to first provide firm foundations for understanding derivatives in general, rather than following a cookbook approach. This requires formal modeling and building the pricing tools from the ground up. The required technical tools will be explained carefully, allowing students to learn the language and to be able to converse with derivatives professionals. Once the tools are in place, they can then be applied to any derivative. Special emphasis will be put on those derivatives that shape the modern world, contributing to beneficial financial engineering innovations as well as to the potential for financial crises. Daily assignments complement the lecture material.

The first half of the course will be taught by Jean-Pierre Zigrand. This part deals mainly with a review of the required tools, the setup of the pricing framework, the intuition of the methodology and application to plain vanilla derivatives. The second half of the course, taught by Rohit Rahi, applies these techniques to more advanced topics: exotic options, volatility modeling (including local volatility and stochastic volatility models) and interest rate derivatives.

Course Material

The main reading material will be the detailed handouts distributed at the beginning of the course. Optionally, the following MBA-level books are standard textbooks in the financial industry:

- J.C. Hull, *Options, Futures and Other Derivatives*, 9th edition, Pearson (2015).
- R.L. McDonald, *Derivatives Markets*, 3rd edition, Pearson (2013).
- K. Redhead, *Financial Derivatives*, Prentice Hall (1997).
- P. Veronesi, *Fixed Income Securities*, Wiley (2010).

Further (and more difficult but beautiful) readings are:

- M. Baxter, A. Rennie, *Financial Calculus: An Introduction to Derivative Pricing*, Cambridge University Press (1996).
- J. Gatheral, *The Volatility Surface: A Practitioner's Guide*, Wiley Finance (2006).
- P. Wilmott, *On Quantitative Finance,* Wiley, 3 volumes (2006).

As far as mathematics go, the student should feel comfortable with calculus, probability and statistics at the intermediate undergraduate level. The two main mathematical tools used repeatedly in this course are the expectation (integration) of random variables and the second-order Taylor expansion (which underpins Ito's Lemma). A prior review of such concepts would be fruitful. Prior knowledge of stochastic calculus is not required.

Problem sets will be distributed at the beginning of the course. Students are expected to prepare the daily problem set before attending classes that day.

Course Content

1. Introduction
2. Arbitrage and Risk-Neutral Pricing
3. Basic Properties of Forwards and Options
4. The Binomial Model of Cox, Ross and Rubinstein
5. A Primer on Stochastic Calculus and Continuous-Time Modelling
6. The Model of Black and Scholes
7. Greeks and Hedging Schemes
8. Forwards and Futures
9. American Options
10. Exotic and Path-Dependent Options, Structured Products
11. Historical Volatility and Implied Volatility
12. Local Volatility and Heston's Stochastic Volatility Model
13. Introduction to Fixed Income and Linear Interest Rate Derivatives
14. Interest Rate Options

Key points

After sections 1 and 2, you should understand the concept of a derivative security, and how derivatives are linked to the underlying securities.

After section 3, you will have seen the two basic categories of derivatives: the forward-like derivatives and the option-like derivatives.

After sections 4 and 5, the major pricing tools and methodologies will have been covered: the discrete-time trees as well as the continuous-time mathematics.

After sections 6 and 7, you should understand the exact workings of the replication argument in continuous time, as applied in the famous Black-Scholes-Merton model for European options. You should understand how risky positions exposed to tradable factors can be hedged. Pricing and hedging, or immunisation, are two faces of the same coin.

After sections 8, 9 and 10, you should understand how the replication argument can be phrased in terms of martingales, and you should see how these techniques can be applied to derivatives that are more elaborate than plain vanilla calls.

After sections 11 and 12, you will have seen the volatility skew/smile as well as models with local or stochastic volatility, which address some shortcomings of the Black-Scholes-Merton model. You will know how to tweak or reverse-engineer models such that they replicate the empirical patterns of the implied volatility surface.

After sections 13, 14 and 15, you will be familiar with the language and the major concepts of fixed income; you should be able to price interest rate derivatives such as swaps, caps and swaptions; and you should understand the use and working of basic term structure models where the short-term interest rate or forward rates are taken as the underlying processes.

Credit Transfer: If you are hoping to earn credit by taking this course, please ensure that you confirm it is eligible for credit transfer well in advance of the start date. Please discuss this directly with your home institution or Study Abroad Advisor.

As a guide, our LSE Summer School courses are typically eligible for three credits within the US system and 7.5 ECTS in Europe. Different institutions and countries can, and will, vary. You will receive a digital transcript and a printed certificate following your successful completion of the course in order to make arrangements for transfer of credit.

If you have any queries, please direct them to summer.school@lse.ac.uk