KEELE UNIVERSITY

DEPARTMENT OF ECONOMICS

Fin-40008

Financial Instruments

1 Module Details:

Module type: M.Sc. Finance and Management, Finance and Information Technology
Session: 2007/08
Semester: Second
Level: 4/M (Masters)
CATS Credits: 15

Compulsory for: None (Elective Module)
Pre-requisites: Financial Markets and Quantitative Methods in Finance
Co-requisites: None
Available to Socrates/Erasmus, exchange and visiting students: No

Teaching and learning methods: Lectures/Classes (2 hours lectures and per week and one hour class per fortnight)
Assessment method: Mixed (exam 70% and assignment 30%)
Pass Mark: 50% in both components
Hand-in Date: Tuesday 22nd April 2008, 10.00 a.m. - 1.00 p.m. School Postgraduate Office, Darwin Building
Study time: 150 hours (of which approximately 20 hours lectures, 5 hours tutorials, 25 hours class preparation, 100 hours independent study)

Module times: Friday 2.00-5.00 p.m. in DW.0.034

Module coordinator: Prof. Tim Worrall
Teaching staff: Tim Worrall
Contact details: Tim Worrall: Room CBA 2.021, E-Mail: t.s.worrall@econ.keele.ac.uk.

Consultation times: Thursday 10.30-11.30 and Friday 11.30-12.30.

2 Aims and Objectives:

Aim of Module: The aim of the module is to provide students with a systematic knowledge and understanding of the theory and practice of financial engineering, with an emphasis on the pricing and hedging use of derivative securities. Students will learn about derivative instruments (futures and options), their use as hedging instruments in risk management and develop an understanding of the valuation of derivative securities and its mathematical foundations.

Objectives of Module: This course deals with the valuation and hedging of options, forward and futures contracts, swaps and other derivatives. The pricing of options and other derivatives depends on three key factors: the volatility of the underlying asset, the extensive use of arbitrage arguments to price assets and the present value and discounting procedures to value streams of returns. Bringing these three elements together and deepening the understanding of each, it will be shown how complex derivatives, like index options, swaps and forward contracts can be analysed. Individuals who are skilled at analysing derivatives are in great demand.

Intended Learning Outcomes: By the end of this module you should know and understand the payoff structure of the main types of derivatives and be able to understand the principles of option and derivative pricing. In particular it will provide you with the opportunity to acquire the following skills:

Knowledge and Understanding

- Understand uncovered positions, hedges spreads, combinations, reverse hedges etc. and be able to explain and illustrate their payoffs.
- Be able to understand and calculate the payoffs from a variety of options and other derivatives.
- Understand the similarities and differences between forwards and futures.
- Understand risk and risk aversion and know about different measures of risk.
- Be able to recognize arbitrage opportunities in simple examples and be able to suggest trading strategies to exploit them.
- Know how option prices are displayed in the financial press and explain the pattern of put and call prices with maturity dates and strike prices.
- Be able to understand how option prices relate to the current stock price, the time to maturity, the strike price, the interest rate, the volatility and the expected dividends on the underlying stock.
- Know the meaning to the Greek letters in option pricing.
- Be able to describe a variety of exotic options, understand how some of them can be valued and why they are traded.
- Be able to discuss the Black-Scholes formula and explain its key features and ingredients and how it is derived.

- Be able to compute option prices and elasticity measures in the binomial model using delta hedging, replication and risk neutral pricing methods.

Practical, Professional and Subject-specific Skills

Note that the ability to understand the principles of option and derivative pricing is a highly prized skill in the finance profession which is rewarded with high salaries.

Cognitive and Intellectual Skills

In this module you can considerably enhance your numeracy skills by gaining an understanding of simple stochastic processes such as the binomial model and continuous time Brownian motion. Knowledge of calculus will be extended to stochastic calculus. You will be able to advance your problem solving skills through a series of assigned exercises and to test your communications skills by explaining the main properties of derivative pricing cogently and concisely and by being able to explain how simple examples can illustrate general principles.

Transferable and Key Skills and Attributes

You will also have the opportunity to work with others in groups to use web and other resources.

3 Syllabus

The crowning glory of options pricing theory is the Black-Scholes Pricing Formula (properly formulae since there is more than one), which shows how to price any option with given strike price and maturity if the interest rate, the current price of the underlying stock and the volatility of the underlying stock is known. The Black-Scholes formula can be use to assess the value and risk of an option. In conjunction with a model of asset pricing, such as the CAPM it can be used to form optimal portfolios of stocks and options. We shall concentrate on the valuation or pricing of options. To do this it will be necessary to make repeated use of arbitrage arguments, a process known as dynamic hedging, and to know how to value uncertain return streams in continuous time. We will try to bring all these elements together. We will consider the restrictions on option prices implied by arbitrage before considering how an exact option pricing formula can be obtained. This uses the method of risk-neutral valuation. It requires knowledge of the process that determines the future course of the price of the underlying stock. This is not such a difficult task as might be expected since it doesn't require a superior forecasting ability or an understanding of the fundamental variables that cause the underlying price to change. Rather it assumes that the idea of an efficient market imposes sufficient structure on the possible course of future prices. A key simplification is to use a binomial model for stock prices where it is assumed that in a given trading period, the stock price either goes up by a given percentage or goes down by a given percentage. We shall see how this method can be used in a simple one period model and how it might be ultimately extended to a continuous time model.

From the textbook, we will concentrate on chapters 1-3, 5, 7-13, 15-16, 18. You should read these chapters.

Topics to be covered:

- **Introduction**

What are options and futures? Puts and Calls will be defined and profits or losses from the six possible uncovered positions (long stock, short stock, sell put, buy put, sell call, buy call) considered. Read Ch 1.

- **Risk and Risk Management**

What is risk and how is it measured? We look at stochastic dominance, value at risk and conditional value at risk. How can investors and firms manage risk by the use of derivatives? Should firms manage risk? Read notes and Ch 3.

- **Forwards and Futures**

How are forwards and futures used to manage risk? What is hedging? How are forward and futures prices determined? How are forward and futures prices related to spot prices? What is the difference between forwards and futures? Read Ch 5.

- **Options and Trading Strategies**

A common trading strategy is the *hedge* which involves buying the underlying stock and selling a call option. But other common trading strategies are *spreads* which involve trades in two or more calls or two or more puts and combinations which involve portfolios of puts and calls. Understanding trading strategies is a good way to make sure you've understood the six uncovered positions (long stock, short stock, sell put, buy put, sell call, buy call) and helps to understand the relationship between call and put prices. Read Ch 10.

- **Arbitrage Restrictions for Options**

We shall see how the price of call is related to the price of puts - the put-call parity condition; how the price of an option is related to the price of the underlying asset, the strike price, the interest rate, the possible dividends on the underlying stock during the life of the option and the date of maturity of the option. European and American options will be considered. Read Ch. 9.

- **Exotic Options**

We learn about binary, barrier and Asian options and see how they are related to standard call and put options. Read Ch 22.

- **The Binomial Model**

We discuss the binomial model and how options can be exactly priced using replication, delta hedging and risk neutral valuation methods. We examine option risk and the differences between American and European options. Read Ch. 11.

- **"The Midas Formula"**

We examine the lognormal property for returns and efficient markets. The Black-Scholes Formula. Its uses and abuses and how it is derived. Maintaining a covered position involves changing positions over time. Various measures are used to do this. They all have Greek letters: Delta, Gamma, Vega, Theta and Rho. Read Ch. 12-13 and 15-16.

4 Organisation and Assessment

Organisation: The module consists of approximately 20 lectures plus 6 tutorial classes plus one revision class and feedback session. The course outline is available in week 1. Lectures begin in week 1 with two lectures per week. Roughly 25 hours are given over to class preparation and 100 hours to private study. Attendance at lectures and tutorials will be monitored.

Teaching and learning methods: Lectures will cover all the main material and emphasizes the topics for study. Class sessions and will go through some problem solving of examples.

Please make use of the consultation times and other resources that are listed below. You will find the books, articles, course materials and web-based materials extremely helpful. You should note that you will need to work steadily and continuously throughout the module. Experience suggests that those who do not work steadily but leave study until a few weeks before the exam fail this course.

Assessment: Two hour unseen exam in April/May examination period worth 70% of total mark for the module. The pass mark for the exam is 50%. A sample paper will be available on the course webpage. There will also be an assignment worth 30% of the final mark. The assignment will be the equivalent of approximately 2500 words and will have a pass mark of 50%. The assignment will be given out in week 2 or 3.

Assignment Hand-in: The hand-in date for the assignment is Tuesday 22nd April 2008. The assignment should be handed into the School Postgraduate Office in the Darwin Building between 10.00am and 1.00pm so that a receipt can be issued.

5 Resources

It is important that you read and comprehend all the relevant material from the course textbook and study the other course materials.

Note: The Campus bookshop has been notified of the course textbook but if the books listed are not in the Campus bookshop, they can also be ordered from a variety of online bookstores.

Course Textbook: The course textbook is

> John C. Hull**: Futures and Options Markets (6th ed.). Prentice Hall, 2006.**
> **ISBN 0-13-149908-4**

This is an extremely good textbook at exactly the right level. There are many other good texts that cover similar material. I recommend Hull as it is the most widely-used and recognized textbook on the subject of financial derivatives.

Course Materials: Other course materials including the assignment, exercises and some lecture handouts are also available on WebCT The relevant URL is **https://www.vle.keele.ac.uk/webct/logon/32622395001**. You should bookmark that page and return to it frequently as the course materials will be updated at regular intervals. An alternative site with easy off campus access will also be provided at **http://www.keele.ac.uk/depts/ec/t_worrall/fin-40008/** (available later in the course).

Other Textbooks: No one textbook is ever sufficient and you will gain valuable understanding by consulting other texts that may present similar material in slightly different ways. Here are a few suggestions.

> **John C. Hull**: Futures and Options Markets (6th ed.). Prentice Hall, 2006.
> *Covers similar material but exercises are much harder.*
>
> **David A. Dubofsky and Thomas W. Miller:** Derivative Valuation and Risk Management, Oxford University Press, 2003.
> *Similar coverage but with more emphasis on risk management.*
>
> **Robert A. Jarrow and Stuart M. Turnbull:** Derivative Securities (2nd ed.) South-Western, 2000.
> *Similar coverage to Hull and equally good.*
>
> **John C. Cox and Mark Rubinstein**: Options Markets. Prentice Hall, 1985.
> *The original and perhaps still the best book on options. Covers similar material on options. A classic book but out of print.*

Mark Joshi: The Concepts and Practice of Mathematical Finance. CUP, 2003.
A very good book but is terse in places.

Marek Capinski and Tomasz Zastawniak: Mathematics for Finance: An Introduction to Financial Engineering. Springer, 2003.
A good and straightforward text but rather terse in places.

Sheldon M. Ross: An Introduction to Mathematical Finance. CUP, 1999
Covers exactly right material, but is mathematical in nature and structure.

Neil A. Chriss: Black-Scholes and Beyond. McGraw Hill, 1997.
In depth look at option pricing theory from portfolio manager

Salih N. Neftci: Principles of Financial Engineering. Academic Press, 2004.
Another good derivatives text.

Paul Wilmott, Sam Howison and Jeff Dewynne: The Mathematics of Financial Derivatives: A Student Introduction. CUP, 1995.
Fine book but mathematical and concentrates on continuous time model.

Keith Cuthbertson and Dirk Nitzsche: Financial Engineering: Derivatives and Risk Management: Wiley, 2001.
Good coverage of derivatives and risk management. A follow-up to Cuthbertson's general text listed below.

Keith Cuthbertson: Quantitative Financial Economics. Wiley, 1996.
A general finance textbook.

David Luenberger: Investment Science. OUP, 1997.
A general finance textbook.

Paul Wilmott: Introduction to Quantitative Finance. Wiley, 2001.
Does what it says on the cover. Has cartoons too.

Jaska Cvitanic and Fernando Zapero: Economics and Mathematics of Financial Markets. MIT Press, 2004.
General finance book but with a good coverage of derivatives.

Pablo Koch Medina and Sandro Merino: Mathematical Finance and Probability. Birkhauser, 2003.
Very good book but for those with good mathematical background.

Stephen F. LeRoy and Jan Werner: Principles of Financial Economics. CUP, 2001.
A very good mathematical finance text. Good on risk but little coverage of derivatives.

Stephen A. Ross: Neoclassical Finance. Princeton University Press, 2005.
A general discussion of some of the founding principles of finance.

Alesy Cerny: Mathematical Techniques in Finance. Princeton University Press, 2004.
A more idiosyncratic text but good on the binomial model and computation.

Jean-Pierre Danthine and John B. Donaldson: Intermediate Financial Theory. Prentice Hall, 2002.
Similar to LeRoy and Werner in coverage and style.

Yvan Lengwiler: Microfoundations of Financial Economics. Princeton University Press, 2004.
A good general finance text. Good on risk but little coverage of options and derivatives.

Gabrielle Demange and Guy Laroque: Finance and the Economics of Uncertainty. Blackwell, 2006.
Written from an economics perspective. Good coverage of risk and risk aversion but little coverage of derivatives.

Steven Shreve: Stochastic Calculus for Finance I: The Binomial Asset Pricing Model. Springer, 2005.
A good small book on the binomial model written by one of the world's leading experts. There is also a Volume II which covers continuous time models.

Mark P. Kritzman: Puzzles of Finance: Six Practical Problems and Their Remarkable Solutions Wiley 2000.
A valuable read and for under a tenner!

Journal Articles which are Accessible: In Level III courses you are expected to read some of the original articles where these are at an appropriate level as well as secondary textbook treatments. You are not expected to read all these articles but you should read some of them. Some articles can be accessed directly via JSTOR as pdf files from any Keele terminal.

Cox, Ross and Rubinstein: Option Pricing: A Simplified Approach, *Journal of Financial Economics*, 7, p.229-63. 1979.

LeRoy: Efficient Capital Markets and Martingales, *Journal of Economic Literature*, 27, p.1583-1621. 1989.

Rendleman and Bartter Two-State Option Pricing, *Journal of Finance*, 34, p.1092-1110. 1979.

Slivka: Call Option Spreading, *Journal of Portfolio Management*, 7, p.71-76. 1981.

Leland: Who Should Buy Portfolio Insurance, *Journal of Finance*, 35, p.581-594. 1980.

Jarrow: In Honour of the Nobel Laureates Robert C. Merton and Myron S. Scholes: A Partial Differential Equation that Changed the World, *Journal of Economic Perspectives*, 13, p.229-248. Fall 1999.

Web Resources: There are lots of web resources for finance especially for options and derivatives. Here are just a few. If you find some other useful finance and/or derivatives links, let me know.

http://www.rotman.utoronto.ca/~hull/
The textbook website

http://www.blobek.com/black-scholes.html
An online calculator for Black-Scholes formula

http://www.in-the-money.com/
Mark Rubinstein's homepage (has an online options textbook)

http://www.afajof.org/
American Finance Association homepage with great links page

http://dybfin.wustl.edu/
Phil Dybvig's homepage

http://www.paulwilmott.com/
The cult derivative lecturer's homepage

http://www.euronext.com/
For information about prices of options futures and stocks. Has online trading game.

http://bankofengland.co.uk/
Bank of England webpage with lots of city links

6 Guidance and Feedback:

General Guidance: Work steadily and consistently. Ask for help when needed. Make sure you understand the basics of options and futures early on in the module otherwise you may get completely lost.

Dissertation Topics: The module is highly complementary to Fin-40003 financial modelling and there is an opportunity to undertake a dissertation which looks at valuing exotic or other derivatives studied in this module using the computational and numerical techniques studied in Fin-40003.

Feedback: This is quite a challenging course so it is necessary to work steadily and continually. Nevertheless it is possible to score highly on this course and the proportion of first class marks last year was over 40%.