Cass Business School
CITY UNIVERSITY LONDON

A decade as Cass Business School

# Specialist Masters Programme

## Course handbook
## MSc in Mathematical Trading & Finance

September 2012

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# Section 1 Course Director's Welcome

On behalf of Cass Business School, I am delighted to welcome you to the MSc Mathematical Trading and Finance.

Financial innovation and globalisation have created new investment opportunities, risks and instruments. In order to exploit these opportunities, control such risks and understand the complex structure of derivative securities, participants should be at ease with sophisticated mathematical models and statistical techniques.

Since its launch in 1995, with the generous support of the Corporation of London, the MSc in Mathematical Trading and Finance has developed to a market-leading specialist master's programme. Its graduates work as derivatives traders, brokers, quantitative analysts, financial engineers, treasurers, fund managers and risk managers. Such a variety of functions that our graduates are able to perform reflects the breadth of the programme and the flexibility of the qualification. This is an international programme, both in its content and its student population, combining academic rigour with a strong practical orientation.

I would like to offer you my very best wishes for a successful and enjoyable year at the Cass Business School.

**Professor John Hatgioannides**

**September 2012**

# Section 2 Programme information

## Programme aims

The course's principal aim is to provide a sound understanding of the principles and applications of mathematical finance and advanced derivative securities valuation. The one-year (full-time) course launched with the generous support of the Corporation of London, combines academic rigour with a strong practical orientation. It is designed to provide students who already possess excellent mathematical skills with a solid foundation in financial mathematical theory and practice to enable them to participate fully in the ever challenging derivatives markets.

The two-year course aims to provide part-time students with specialised knowledge, which will give them a competitive edge in the market place and enable them to seek senior positions.

All students acquire a deep knowledge of mathematical finance and stochastic calculus, derivatives' valuation, financial engineering, quantitative risk modelling, numerical methods, econometric techniques.

Thanks to the excellent reputation of the course, and our site in the heart of the City of London, the course complements theory with current market practice; leading practitioners from quantitative and trading departments of financial institutions teach regularly on the course. Moreover, our Bloomberg, Reuters and TraderMate facilities provide trading applications using real-time data. Students are also given the opportunity to liaise with companies for short-term assignments or for their business research projects.

On completing the course the students will have:

- A deep understanding of the theory and application of mathematical techniques in finance
- A sound knowledge of the derivatives markets and the process of structuring tailor-made derivative products
- An ability to apply numerical methods in practice
- A thorough understanding of issues related to the discipline of financial engineering

## Programme structure

We review all our courses regularly to keep them up-to-date on issues of both theory and practice. Therefore, there may be some change to the detailed content of the modules and occasionally to module titles.

## One-year course (Full-Time)

The one-year (full-time) course is made up of three terms. After a two-week intensive induction course, students take nine core modules in Terms one and two, and one or five electives in Term three, each of which is a combination of lectures, seminars and case studies. In Term three, students may have to write a 10,000-word Business Research Project on any subject relating to mathematical trading and finance (depending on the option chosen). Preparation starts at the beginning of Term two when students follow a compulsory course on research methods. A member of the academic staff of the Business School supervises each student who chooses the topic in consultation with the academic supervisor. On selective Business Research Project topics, students are also given the opportunity to work with well-known financial institutions.

## Foundation modules

- Advanced Mathematics and Statistics
- Computing
- Introduction to Databases and Datastream

## Term one: Four core modules

- Mathematical Finance and Stochastic Calculus
- Quantitative Asset Pricing
- Advanced Financial Econometrics
- Derivatives 1;  Forwards, Futures, Swaps: Theory and Dealing Room Applications

## Term two: Five core modules

- Derivatives 2; Beyond Black&Scholes Valuation of Plain-Vanilla Options and the Pricing of Exotic Derivatives
- Numerical Methods
- Risk Analysis and Modelling
- Structured Equity and Energy Derivatives
- Research Project Management Skills

## Term three

**Option one** (available to full-time and part time students)

- Elective study only by taking five x 18 hours specialist electives of 10 credits each

**Option two** (available to full and part-time students)

- A Business Research Project (SMM527), with a credit value of 40 and a maximum of 10,000 words, taken in tandem with one specialist elective of 10 credits.

Any one/five (depending on which option you select) from specialist elective modules such as the below previously offered modules:

- Advanced Financial Engineering and Credit Derivatives
- Fixed Income Arbitrage and Trading
- Technical Analysis and Trading Systems
- Advanced Options Trading
- Trading and Hedging in the Foreign Exchange Markets
- Advanced Financial Modelling and Forecasting
- Matlab
- Introduction to C/C++

**In addition and in consultation with the course director, students will be able to choose from a range of (Term three) electives taught across the Specialist Masters Portfolio.**

## Two-year part-time course

This course runs over two academic years and involves two evenings per week for core teaching plus a third evening (typically, every fortnight) for practical applications, tutorials etc. Evening teaching starts at 6:10pm and ends at 9:00pm. The two-year option is open to students in full-time employment who would like to specialise in derivatives valuation, financial engineering and quantitative risk analysis, management and modelling. The modules available in the first and second year of study are identical in content to the ones offered in the one-year course and are arranged as follows:

### Year one

**Foundation modules:** (Intensive three weeks compulsory programme - September)

- Advanced Mathematics and Statistics
- Computing
- Introduction to Databases and Datastream

### Term one: Two core modules

- Mathematical Finance and Stochastic Calculus (50 hours)
- Derivatives 1; Forwards, Futures, Swaps: Theory and Dealing Room Applications (30 Hours)

### Term two: Two core modules

- Derivatives 2; Beyond Black Scholes Valuation of Plain-Vanilla Options and the Pricing of Exotic Derivatives (30 Hours)
- Numerical Methods (30 Hours)

**Term three:** Any two (depending on the chosen exit route - *see Year two below*) from specialist elective modules such as:

- Advanced Financial Engineering and Credit Derivatives
- Fixed Income Arbitrage and Trading
- Technical Analysis and Trading Systems
- Advanced Options Trading
- Trading and Hedging in the Foreign Exchange Markets
- Advanced Financial Modelling and Forecasting

## Year two

**Term one:** Two core modules (Ten weeks each, October to December)

- Quantitative Asset Pricing (30 Hours)
- Advanced Financial Econometrics (30 Hours)

**Term two:** Three core modules (Ten weeks each, January to March)

- Risk Analysis and Modelling (30 Hours)
- Structured Equity and Energy Derivatives (30 Hours)
- Research Project Management Skills (18 Hours)

**Term three:**

Any one of five (depending on which option you select) from specialist elective modules that students did not take in year one of their studies (Six weeks May – June, 18 hours each)

- Advanced Financial Engineering and Credit Derivatives
- Fixed Income Arbitrage and Trading
- Technical Analysis and Trading Systems
- Advanced Options Trading
- Trading and Hedging in the Foreign Exchange Markets
- Advanced Financial Modelling and Forecasting

**In addition and in consultation with the course director, students will be able to choose from a range of (Term three) electives taught across the Specialist Masters Portfolio.**

**Option one** (available to full-time and part time students only)

- Elective study only by taking 5 x 18 hours specialist electives of 10 credits each

**Option two** (available to full and part-time students only)

- A Business Research Project (SMM527), with a credit value of 40 and a maximum of 10,000 words, taken in tandem with one specialist elective of 10 credits.

Assessment Matrix

| Module Title | Module Code | Credits | Assessment weightings used to calculate module mark | |
|---|---|---|---|---|
| | | | Coursework | Examination |
| **Term One** | | | | |
| Derivatives 1 | SMM603 | 15 | 25% | 75% |
| Mathematical Finance | SMM604 | 15 | 25% | 75% |
| Quantitative Asset Pricing | SMM607 | 15 | 25% | 75% |
| Advanced Financial Econometrics | SMM601 | 15 | 25% | 75% |
| **Term Two** | | | | |
| Structured Equity & Energy Derivatives | SMM610 | 15 | 25% | 75% |
| Derivatives 2 | SMM615 | 15 | 25% | 75% |
| Numerical Methods | SMM608 | 15 | 100% | |
| Risk Analysis & Modelling | SMM615 | 15 | 100% | |
| Research Project Management Skills | SMM522 | 10 | 100% | |
| **Term Three** | | | | |
| **Option One** | | | | |
| Elective 1 | SMMXXX | 10 | 100% | |
| Elective 2 | SMMXXX | 10 | 100% | |
| Elective 3 | SMMXXX | 10 | 100% | |
| Elective 4 | SMMXXX | 10 | 100% | |
| Elective 5 | SMMXXX | 10 | 100% | |
| **Option Two** | | | | |
| Business Research Project | SMM527 | 40 | 100% | |
| Elective 1 | SMMXXX | 10 | 100% | |
| Degree Total | | 185 | | |

## ECTS equivalencies

Each MSc course is worth between 180 - 210 CAPS credits. As a general rule two CAPS credits equal one ECTS credit. (For example, a course with 180 CAPS credits is worth 90 ECTS credits.)

*CAPS (Credit Accumulation of Programme Specification)

*ECTS *(European Credit Transfer and Accumulation System)*

## Term Dates and Assessment Periods

### Induction

17 – 28 September 2012

### Term One

01 October – 07 December 2012

### Term One Examinations

14 – 25 January 2013

### Term Two

28 January – 09 April 2013

### Term Two Examinations

29 April – 10 May 2013

### Term Three

13 May – 28 June 2013

### Term Three Assessments

01 – 12 July 2013

### Re-sit Examinations and Assessments (terms one, two and three)

19 – 30 August 2013

### Business Research Project Submission Date

02 September 2013

Students are expected to be in attendance at lectures and other classes during term time; attend all invigilated tests and examinations. Students should not make travel arrangements during term time or assessment periods. Any absence from any form of assessment, which does not constitute valid extenuating circumstances, will result in the student re-sitting the module as a second attempt.

# Section 3 Module Descriptions

## Advanced Financial Econometrics
## SMM601

| | | |
|---|---|---|
| **Module Leader** | Professor Giovanni Urga | |
| **Sessions** | 10 x 3 hour sessions and 2 x 3 hour practical classes | |
| **Module Assessment** | Coursework | **25**% |
| | Examination | **75**% |

### Educational aims

The module provides an extended introduction of the econometric techniques developed in the past decades to model the main characteristics of economic and financial time series. The course covers extensively the multivariate linear regression model and estimation methods, mainly OLS (and GLS and IV) and maximum likelihood. Univariate and multivariate models are extensively introduced: autoregressive and moving average representations, stationary and non-stationary time series, unit roots testing procedures and simple cointegration analysis, and conditional and unconditional forecasts. In a multivariate framework, VAR models, multivariate cointegration analysis and equilibrium correction model are covered. In the final part of the course, it is provided an introduction to ARCH and GARCH models of wide used in finance to estimate time varying variances and covariances, and the GMM estimation method of wide used in finance to estimate asset pricing models. Empirical exercises on term structure and the bond market, the foreign exchange market and the stock price volatility accompany the presentation of theoretical models.

The course will:

- Provide a detailed knowledge of the analytical tools of econometrics
- Illustrate the techniques with actual examples of empirical finance.

### Learning outcomes

Upon completion participants will acquire:

- Knowledge of how econometrics can be applied to get useful insights about real-world behaviour
- Familiarity with the techniques by studying empirical papers, and undertaking practical works which may be asked to most applied financial economists to model the main characteristics of financial time series.

## Syllabus

- The general linear regression model. The general linear regression model. Economic and econometric models. Least squares estimators (OLS): classical assumptions and properties. Restricted least-squares estimators. Goodness of fit and the analysis of variance. Hypothesis testing: Student's t-test, the F-test. DW statistic. Departures from the classical assumptions. Non-scalar covariance matrix and generalized least squares (GLS). Stochastic regressors (endogeneity, omitted variables, and errors in variables) and Instrumental variables (IV) estimation method.

- Alternative functional forms. Use of dummy variables. Specification errors. Method of instrumental variables and two-stage least squares. Identification, predetermined and exogenous variables, structural and reduced forms. Limited information Vs full information estimation methods.

- Maximum likelihood estimation and asymptotic properties. Three test procedures asymptotically equivalent: likelihood ratio test (LR), the Wald test (W) and Lagrange Multiplier test (LM). A transformation of the LM test as $TR^2$. Empirical applications to modelling linear factor models.

- Time series models and empirical applications. AR, MA, ARMA and ARIMA modelling. Vector Autoregression (VAR) models. VARMA representation. Empirical applications to modelling financial assets.

- Econometric methodologies. Alternative econometric methodologies. Dynamic specifications and tests for validating the models: misspecification tests. Non-nested models, encompassing and model selection. Exogeneity and causality in econometrics.

- Dynamic modelling 1. Models of non-stationary time series. Spurious correlation. Difference stationary and stochastic trends. Trend stationary and deterministic trends. Unit roots. Dickey and Fuller and Phillips and Perron tests. Empirical applications to modelling the term structure.

- Dynamic modelling 2. General-to-specific dynamic specification. Co integration in single equations: Engle-Granger (OLS). Co integration systems: Johansen (Maximum Likelihood). Empirical applications to testing for co movements in stock markets.

- Univariate and multivariate financial times series models. Autoregressive conditional heteroscedasticity. Measuring volatility over time. ARCH, GARCH, ARCH-M, E-GARCH models. Lagrange multiplier test for ARCH. Empirical application to modelling asset pricing and foreign exchange rates.

- GMM estimation method and applications in finance. Properties. Empirical applications in estimating intertemporal asset pricing models, linear factors models and short rate processes.

## Reading List

No single textbook or paper covers the topics to be presented in class. The relevant reading material and notes prepared by the lecturer will be distributed at the beginning of course. However, the following are important as reference material.


- Campbell, J.Y., Lo, A. and A.C. MacKinley (1997), *The Econometrics of Financial Markets*, Princeton University Press.
- Cochrane, J.H. (2004), *Asset Pricing*, Princeton: Princeton University Press.
- Enders,W. (2003), *Applied Econometric Time Series*, 2nd Edition, John Wiley & Sons.
- Greene, W.H. (2012), *Econometric Analysis*, 7th Edition, Prentice Hall International.
- Gourieroux, C. and J. Jasiak (2001), *Financial Econometrics*, Princeton University Press.
- Hall, A. (2005), *Generalized Methods of Moments*, Oxford University Press.
- Hamilton, J. D. (1994), *Time Series Analysis*, Princeton University Press.
- Hayashi, F. (2000), *Econometrics*, Princeton University Press, Princeton.
- Hendry, D.F. (1995), *Dynamic Econometrics*, Oxford University Press.
- Hendry, D. F. and B. Nielsen (2007), *Econometric Modelling: A Likelihood Approach*, Princeton University Press.
- Tsay, R. S. (2010), *Analysis of Financial Time Series*, 3rd Edition, Wiley & Sons, New York.
- Verbeek, M. (2012), *A Guide to Modern Econometrics*, 4th Edition, Wiley & Sons, New York.

## Business Research Project
## SMM527

**Module Leader** A project supervisor will be allocated

**Sessions** This is an individual project which students will develop in their own time with support from their project supervisor.

**Module Assessment** Coursework 100%

Delivery of the final project, indicative length: 10,000 words

### Educational aims

- To train students to undertake individual research and provide them with an opportunity to specialise in a contemporary business or finance topic related to their future career aspirations

- To integrate and apply concepts from different aspects of their MSc.

### Learning outcomes

On completing the project students will be able to:

- Identify specific business or finance related issues which would be useful to research and shape an achievable research question around them.

- Develop a research question and plan and carry out a research programme to address the question.

- Understand the theories and recent research relating to the project topic.

- Understand how to apply research methodologies to practical business and commercial issues.

- Show confidence in overcoming problems raised in the course of a practical research project and

- Accept the challenge of carrying out a piece of research with elements of originality.

### Project requirements

The choice of project is **your** responsibility. It is most important that you choose an area you are happy to work in, and in which you are confident of your abilities.

Students are encouraged to start thinking about project ideas at the beginning of their studies. By the end of the first term you will have gained sufficient knowledge to start to develop ideas that can be discussed with faculty. We expect you to identify the basic idea or research question, though this is likely to be modified after discussion with academic staff.

Make effective use of the RPMS module. This module can be used to help to formulate your ideas and design an appropriate methodology. It can also help you develop a specific project topic – the greater clarity you have about the topic of your project the more successful it is likely to be.

The types of project allowed are:

| What you can do. | What you can't do |
|---|---|
| • Business report on a contemporary issue<br>• Business plan<br>• Statistical test of literature driven hypothesis<br>• Empirical feasibility of a financial strategy<br>• Development of a new product/ service / finance strategy<br>• Market survey<br>• Case study on a specific issue within a particular company / organisation<br>• Numerical project that describes and implements one or more numerical methods for pricing, hedging or reserving for derivatives or portfolios. | • Pure literature surveys<br>• Some evidence that the writer has learnt a new subject, a sort of extra elective<br>• A synthesis of other writing or a piece of journalism<br>• A mere compendium of facts and statistics<br>• Projects totally unrelated to relevant academic discipline and literature. |

## Reading list

Student research and reading list will be defined by the subject matter of the project.

## Derivatives 1: Forwards, Futures, Swaps: Theory and Dealing Room Applications SMM603

| | | |
|---|---|---|
| **Module Leader** | Dr Giorgio Consigli | |
| **Sessions** | 3 x 10 hour sessions<br>Sessions are constructed of lectures, seminars, workshops and trading simulations. Private study is to involve reading the set texts, solving problems and computer modelling. . | |
| **Module Assessment** | Coursework<br>Examination | **25**%<br>**75**% |

### Educational aims

The course will develop an in-depth understanding of forwards, futures, swaps and option contracts and their application in market and risk management situations, to develop student knowledge to the level of a highly valued professional qualification. The course will:

- Develop student appreciation of the ubiquity of derivative securities throughout commercial life
- Develop student understanding of risk management
- Introduce students to basic valuation principles

### Learning outcomes

Upon completion, students will be able to:

- Select the appropriate derivative security for different risk management applications; determine the payoffs to risk management strategies as market conditions evolve
- Value the different derivative securities and arbitrage mis-pricings discovered in the market
- Understand the risks carried by derivatives portfolios

### Syllabus

FUTURES

- Interest rate futures: forward rates, FRA, Treasury bond futures, Eurodollar
- Futures the term structure of interest rates, LIBOR zero curve.
- Stock Index Futures. Uses of index futures (asset allocation and risk management forestock pickers), hedging strategies using futures.

- Currency forward and futures contracts.

- Commodity Forwards and Futures: synthetic commodities; cost of carry, convenience yield; hedging, cross hedging.

- Summary: arbitrage conditions, hedging and speculative strategies in futures markets

SWAPS

- Interest rate swaps (IRS), Swap rates, Valuation of interest rate swaps: hedging and arbitrage with plain vanilla IRS

- Currency swaps and their valuation

- Equity swaps, equity default swaps, Credit risk and credit default swaps

OPTIONS

- Equity options, European options put-call parity. American options put-call inequality, Black&Scholes option pricing formula

- Fixed-income options, currency options and options on futures, Black pricing formula

- Market makers hedging strategies in option markets, Greeks

- Option portfolios, strategies based on options, straddles, strangles and butterflies

- Swaptions, hedging strategies based on swaptions

SUMMARY

- Arbitrage, hedging and speculation in derivatives markets

- What can go wrong in derivatives markets (some examples from recent financial history)

- Financial and model risk

- Mixed OTC-exchange based strategies

## Reading List

[H] John C. Hull (2005), *Options, Futures and Other Derivatives*, 6th edition, Prentice Hall, Upper Saddle River.

Lecture notes with exercises and solutions. Examples

## Derivatives 2
## SMM615

| | | |
|---|---|---|
| **Module Leader** | Professor John Hatgioannides | |
| **Sessions** | 10 x 3 sessions<br>In addition, students will be expected to devote an equivalent amount of learning time in private and group study of course material. | |
| **Module Assessment** | Coursework<br>Examination | **25**%<br>**75**% |

### Educational aims

The purpose of this course is to extend the standard Black&Scholes valuation framework to allow for early exercise features, dividends, stochastic/local volatility and jumps. It also introduces to students popular exotic derivative securities as Asian, Barrier and Lookback options and provides the theoretical framework for their valuation and hedging. It finally provides a primer on statistical arbitrage. The course builds on the Mathematical Finance module. Practical implementations of the theory presented in this module will be carried out in the Numerical Methods module.

The course will:

- Introduce students to the principles of exotic derivatives valuation and hedging
- Familiarise students with models and techniques to accommodate early exercise, stochastic volatility and jumps in derivatives valuation.

### Learning outcomes

On completing the course the students will:

- Have a comprehensive understanding of how to value and hedge popular exotic derivative instruments
- Understand how to incorporate early exercise, stochastic volatility and jumps in derivatives valuation.

### Syllabus

- Overview of derivatives pricing under the complete markets setting. The Black&Scholes framework using the partial differential equations approach.
- American Options – Characterisation of the optimal exercise boundaries, Analytic formulations
- Pricing options under stochastic volatility
- Local Volatility Models

- Pricing options in the presence of Jumps; Jump-Diffusion and Variance-Gamma processes

- Barrier Options

- Lookback Options

- Asian Options

- An introduction to Statistical Arbitrage.

### Reading List

No single textbook or paper covers the topics to be presented in class. The relevant reading material and notes prepared by the lecturer will be provided during each lecture. The following books are important as reference material.

*"Dynamic Hedging; Managing Vanilla and Exotic Options"* by Nassim Taleb, Wiley, 1997

*"Volatility and Correlation; The Perfect Hedger and the Fox"* by Riccardo Rebonato, Second Edition, Wiley, 2004.

*Exotic Options: A guide to Second Generation Options,* by Peter Zhang, 2nd edition, 1999, World Scientific Publications

## Mathematical Finance
## SMM604

**Module Leader** Dr Laura Ballotta

**Sessions** 10 x 3 hour sessions plus 6 x 3 (18 hours) tutorial sessions. In addition, students will be expected to devote an equivalent amount of learning time in private and group study of course material. The preparation of two pieces of coursework will involve additional time in private study and independent research.

**Module Assessment**

| | |
|---|---|
| Coursework | **25**% |
| Examination | **75**% |

### Educational aims

The course is designed to provide a thorough grounding to the modern mathematical techniques used for modelling and pricing financial derivative products. This includes linear and non-linear derivatives, vanilla and exotic products. The course offers the development of the central theoretical arguments in valuation and hedging theory along with the mathematical tools needed for their implementation.

The course will:

- Introduce students to the quantitative elements of modern valuation theory of financial derivatives
- Familiarise students with the complex mathematical techniques used in valuation and hedging of vanilla to exotic products
- Equip students with the technical skills needed in order to solve valuation problems involving complex derivative products

### Learning outcomes

Upon completion students will be able to:

- Have a clear and thorough understanding of both equilibrium and risk neutral methodologies in derivatives valuation and hedging
- Be able to use stochastic calculus in complex valuation and hedging problems

### Syllabus

The topics to be covered are as follows:

- The no-arbitrage principle
- Introduction to probability theory and stochastic processes
- Pricing of non-linear derivatives: Discrete Time framework

- Stochastic calculus for Brownian motions: Ito's Lemma and the Girsanov Theorem.
- Pricing of non-linear derivatives: Continuous Time framework
- The Black-Scholes-Merton option pricing paradigm
- Change of numeraire: numeraire pairs and applications to pricing complex contingent claims

### Reading List

In addition to detailed lecture notes, there are a number of useful books that provide a good supplementary reading to the topics covered in this module. The following is an indicative list:


- Bjork, T., *Arbitrage Theory in Continuous Time*, OUP, 2nd Edition, 2004
- Hull, J.H., *Options, Futures and Other Derivatives*, Prentice Hall, 5th Edition, 2004
- Shreve, S. E., *Stochastic Calculus for Finance I: The Binomial Asset Pricing Model,* Springer-Verlag, 2004.
- Shreve, S. E., *Stochastic Calculus for Finance II: Continuous-Time Models*, Springer-Verlag, 2004.

## Numerical Methods
## SMM608

**Module Leader** Dr Mike Staunton

**Sessions** 10 x 3 hour sessions or workshops/labs

**Module Assessment** Coursework **100**%

### Educational aims

To use Excel VBA to complement the theory underlying the valuation of equity and bond derivatives; to implement the option pricing models described in the Mathematical Finance and Derivatives Valuation modules.

### Learning outcomes

Participants will at the end of the course be able to:

- Select the best papers in numerical methods for a topic.
- Extract the equations and formulas needed for the option pricing model.
- Program the model in VBA
- Test that the program code agrees with the original paper

### Syllabus

- Workshop 1 – Writing VBA Functions and ExcelDNA
- Workshop 2 – Visual Studio for C++
- Workshop 3 - European Calls
- Workshop 4 - Binomial Trees
- Workshop 5 – Greeks and Implied Volatility
- Workshop 6 – Gram-Charlier Expansions and Jump Models
- Workshop 7 – Barrier Options and American Puts
- Workshop 8 - Stochastic Volatility Models

- Workshop 9 - Monte Carlo Simulation
- Workshop 10 – Normal Interest Rate Models

# Quantitative Asset Pricing
# SMM607

| | | |
|---|---|---|
| **Module Leader** | Dr Dirk Nitzsche | |
| **Sessions** | 10 x 3 hour sessions | |
| **Module Assessment** | Coursework | **25**% |
| | Examination | **75**% |

## Educational aims

This course introduces students to the basic concepts used for pricing and analyzing financial securities, focusing on spot markets. The efficiency of financial markets is discussed together with the question whether stock prices/stock returns are predictable. The importance of risk in the financial sector and its trade off with return will be analysed in depths. Portfolio theory and equilibrium asset pricing models such as the CAPM and Fama-French three factor models are introduced. Some basic utility analysis is also covered at the beginning of the course which is important to understand different 'attitudes' towards risk. The module finished off by looking at some applied topic of performance and persistence of performance of financial mutual funds. The course is both rigorous in outlining the theoretical models, but also focuses on the practical applications and empirical finding.

## Learning outcomes

On completion of this module students will:

- Demonstrate broad knowledge of the functioning and behaviour of equity markets
- Understand in depth portfolio theory and the principals of asset management and its application to real-world contexts
- Understand systematically asset pricing models and their application to practical situations
- Understand the framework of stock price behaviour
- Understand sophisticated approaches to analyse asset return performance, persistence of performance and market timing.

## Syllabus

- Financial Securities, Financial Markets : The Basics
- Utility Analysis
- Valuation of Spot Securities
- Efficient Markets and Predictability of Stock Returns

- Efficient Frontier, Diversification and Portfolio Theory
- Factor Models : CAPM, Fama-French and Carhart
- Mutual Fund Performance

### Reading List

Cuthbertson, K. and Nitzsche, D. (2004) *Quantitative Financial Economics*, 2nd edition, J.Wiley.

Elton, E.J. and Gruber, M.J. (1995) *Modern Portfolio Theory and Investment Analysis*, 5th edition, J.Wiley

Cuthbertson, K. and Nitzsche, D. (2008) *Investments*, J.Wiley

## Research Project Management Skills
## SMM522

**Module Leader** Professor John Hatgioannides

**Sessions** 6 x 3 sessions

**Module Assessment** Coursework **100**%

### Educational aims

The aim of this module is to examine the various methods of undertaking empirical research. The module starts by presenting historical developments in research in a chosen field and then develops qualitative and quantitative research methods, including event studies, cross-sectional analysis, valuations of various assets, analysis of business and market trends, application of theory into practical business issues.

The module also reviews the interpersonal skills necessary for conducting effective research projects in a real business environment.

The course will make it possible for participants to:

- Understand methods used to generate ideas for relevant projects
- Understand the recent developments in the field
- Appreciate the use of statistical techniques in testing the research questions
- Develop analytical skills to evaluate the impact to major institutional, market or organisational changes.
- Develop an understanding of commonly used sources of data/literature available
- Develop interpersonal skills required to undertake business research projects
- Appreciate the links between academic theory and practical relevance.

### Learning outcomes

On successful completion of the course the participants will:

- Know how to undertake empirical research and be able to prepare good projects
- Understand how to set up and test topical research questions
- Understand the use of statistical techniques in research
- Contrast the various theories to set up the hypotheses and link the theories to practice.

## Syllabus

### Research Process

Research is gathering the information needed to provide an understanding of some problems in order to change deeper beliefs of reader/listener. Although research involves hard work, it provides a pleasure in solving a puzzle or gaining an in-depth understanding of a particular question. Research usually starts from the definition of the research questions, followed by an understanding of literature search, data collection and definition of the methodologies, the analysis of the results and finally the setting up of the conclusions. A recently published paper will be used to illustrate this typical research process.

### Business research methodologies

Business research projects use various methodologies including event study, performance analysis, valuation survey questionnaires, personal interview and case study approaches.

### The use of Extel Database

Empirical research involves collecting and analysing financial data. Such data can be extracted from Financial Extel, DataStream, London Share Price Database (LSPD). Reuters etc. The session will review such databases and will concentrate on Financial Extel, which provides share prices, accounting and information released by a large number of UK and international companies.

### Data/information sources

This session focuses on literature search and data collection. It seeks to provide students with information on widely used electronic paper collections such as SSRN and RePec. It places emphasis on macroeconomic data sources such as DataStream, Eurostat and BIS.

### Personal skills

This session will focus on core ‘soft skills’, providing students with effective communication and presentation skills; good selling skills to include self-marketing; articulating competencies; personal grooming and business etiquette.

### Reading List

The course is based on a number of recently published research papers. The papers will be made known to students by individual lecturers.

## Risk Analysis and Modelling
## SMM609

**Module Leader** Dr. Gianluca Fusai

**Sessions** 10 x 3 hour sessions
In addition, students are expected to devote an equivalent amount of time to studying the recommended texts and solving the exercises proposed in class. Group projects are presented in class during the final lecture.

| **Module Assessment** | | |
|---|---|---|
| | Individual coursework | **50**% |
| | Group coursework | **50**% |

### Educational aims

The purpose of this course is to provide students with a solid base from which to analyse, model and manage financial risks faced by a variety of institutions: banks, insurance companies, asset managers, pension funds, commodity traders, etc. The link between risk and capital management is emphasised throughout the module.

### Learning outcomes

On completing the course the students should:

- Uderstand the sources of potential financial loss and the meaning of Expected Loss, unexpected Loss, Risk Capital and Economic Capital
- Be able to build quantitative models of portfolio expected profit and loss
- Be able to evaluate risk with several metrics – Value at Risk, Expected Shortfall, etc. in a variety of contexts.

### Syllabus

- Sources of risk, views of risk
- Market risk and Value at Risk
- Parametric VAR and VAR approximations
- Estimation issues
- Simulation VAR: Historical Simulation and Monte Carlo Simulation
- Scenario analysis, Backtesting and Stress Testing of risk models
- Issues related to hedging derivatives positions

- RiskMetrics
- Other approaches to measuring risk: Expected Shortfall, Extreme Value Theory
- Credit risk models and measuring Counterparty risk: credit and debt value adjustment (CVA & DVA)

### Reading List

There are many texts that cover risk topics but the most useful resources are:

Jorion, P. (2007). *Value at Risk, McGraw-Hill*, 3rd Edition.

Bomfim, A N, (2005). *Understanding Credit Derivatives and Related Instruments*, Academic Press.

*RiskMetrics Technical Document*, from http://pascal.iseg.utl.pt/~aafonso/eif/RM.html

*Credit Metrics Technical Document from*

www.msci.com/resources/technical_documentation/CMTD1.pdf

*Elements of Financial Risk Management* [Hardcover] Peter Christoffersen Academic Press, 2003

*Measuring Market Risk* + CD-ROM , 2nd Edition [Hardcover] Kevin Dowd Wiley; 2 edition, 2005

## Structured Equity and Energy Derivatives
## SMM610

**Module Leader** Prof. John Hatgioannides and Prof. Nikos Nomikos

**Sessions** 10 x 3 sessions

Sessions are constructed of lectures, seminars, workshops and trading simulations. Private study is to involve reading the set texts and journal papers, computer modelling, solving assigned problems and keeping abreast of empirical developments through reading practitioner magazines.

**Module Assessment**

| | |
|---|---|
| Coursework | **25**% |
| Examination | **75**% |

### Educational aims

The course will:

- Develop an engineering approach to the design of equity-linked products and energy derivatives.
- Develop student knowledge to the level required in joining structured and energy departments of major investment banks
- Develop student appreciation of the ubiquity of structured derivative products throughout commercial life and
- Develop student understanding of valuation, trading/hedging of structured products and hybrid securities and their use in sophisticated risk management applications.

### Learning outcomes

Upon completion students will be able to:

- Create their own derivatives solutions to a wide variety of investment and risk management problems
- Use structured equity notes and equity-linked securities for the management of exposure to a large variety of risks, the enhancement of yields or the reduction of funding costs, the exploitation of the tax, accounting and regulatory environment
- Model energy prices (oil, gas, electricity), construct forward curves and value exotic energy derivatives
- Arbitrage mis-pricings discovered in the market.

## Syllabus

- An Introduction to the World of Structured Products.
- The general structure of a Note Issue, Unprotected Bull Notes, Principal Protected Bull Notes, Practical considerations.
- Timing market exit (principal protected Lookback and Ladder Notes, principal protected Asian Bull Note, principal protected Cliquet Bull Note). Notes for non-bullish views. Notes offering improved asset allocation.
- Digitalized Notes, Notes with intermediate coupons.
- Overview of Oil, Gas and Energy markets.
- Modelling energy prices: A mean-reverting jump diffusion approach.
- Construction of the forward volatility curve. Market curves and smiles/smirks.

## Reading List

Bouzoubaa, M. and A. Osseiran, *"Exotic Options and Hybrids: A Guide to Structuring, Pricing and Trading"*, Wiley, 2010.

Kat, Harry M., "*Structured Equity Derivatives',* Wiley, 2001.

Clewlow, Les and Strickland, Chris, " *Energy Derivatives, Pricing and Risk Management*", Lacima Publications, 2000.

## Elective Information

Cass Business School provides an extensive range of elective modules for the different MSc programmes. A special elective handbook, regarding your term three selection of modules, will be distributed in the second term and will provide further information.

Electives which have previously been provided by MSc Mathematical Trading and Finance include:

Advanced Financial Engineering and Credit Derivatives

Fixed Income Arbitrage and Trading

Advanced Options Trading

Trading and Hedging in the Forex Market

Advanced Financial Modelling and Forecasting

Apart from these electives, students will also be able to choose from preselected modules offered by other MSc programmes. In the past these have included, among others:

Technical Analysis and Trading Systems

Matlab

Introduction to C/C++

Please note the School reserves the right to withdraw an elective if demand is insufficient and to add new electives if they are available. Space restrictions and timetable availability may also apply.

# Section 4 Regulations

Described below are the rules governing the award of a master degree in MSc Mathematical Trading and Finance. For further information, the City University's complete set of "Ordinances and Regulations", including the Assessment Regulations (Regulation 19), are published on the University's website http://www.city.ac.uk/about/education/academic-services/senate-regulations

## Periods of Registration

The periods allowed for completion of the qualifications are:

- Four years for a masters degree, full or part time
- Two years for a postgraduate diploma, full or part time

## Degree Requirements

To qualify for a Masters degree a candidate must achieve at least 50% as an aggregate mark for each module and an overall degree average mark of 50%. This will result in the acquisition of185 credits, which is the number required to achieve a master's degree in MSc Mathematical Trading and Finance.

## Assessment Calculations

The rules governing calculation of module and overall degree marks are as follows;

- To receive credits for a MSc all modules must be passed
- There are no minimum mark requirements for separate assessment components (unless specifically stated). However, it is compulsory to complete all components and no module mark can be awarded until these are completed.
- A module mark is calculated by aggregating marks for all assessment components as stated in the module outline (section three).
- Where modules are assessed by both exam and coursework, these are weighted to calculate the module mark. Please see the assessment matrix in section two for the relative weightings.
- Where there are several pieces of coursework, the coursework results are calculated according to the relevant weightings.
- To calculate the overall degree mark, module marks are combined using weightings in line with the relative credit value of each module.

## Coursework

All coursework and invigilated tests are compulsory and count towards the final degree. In some modules presentations or invigilated tests may replace written coursework assignments.

Some subjects may be assessed by coursework only. Precise details concerning examined and non examined modules are provided in the module outlines.

Please note coursework is required to be submitted for assessment by the specified deadline date. Late coursework will receive imposed penalties. Late coursework will immediately receive a deduction of five marks on the first day of lateness, with one further mark deducted for each day of lateness, for a maximum of five days. After this point coursework will not be accepted and a mark of zero will be awarded.

All coursework should be submitted electronically via the virtual learning environment, Moodle. **It is essential that you keep a copy of all coursework submitted**.

All sources used should be cited using the Harvard referencing system. Further information about this can be found on the Cass website:

http://www.cass.city.ac.uk/intranet/student/learning-resource-centre/citing-references

Coursework will be returned to students as quickly as possible with the aim of students receiving feedback within three to four weeks of their submission

## Failure and the Re-sitting of Modules

- Any module with an aggregate mark of less than 50% is deemed to have been failed and will have to be re-sat.

- To re-sit a failed module, a candidate must re-do all assessment components which gained marks of less than 50%.

- Candidates may re-sit a module only once.

- A candidate who successfully completes a re-sit shall be awarded the credits for the module. The mark awarded for the components will be capped at 50%. The mark awarded for other components will be the original mark. This mark will also be used in calculating the overall degree mark

- A candidate who does not pass his or her re-sit by the date specified by the Assessment Board will not progress on the programme and the Assessment Board will normally make a recommendation that they withdraw.

## Award of Distinction

To calculate the overall degree mark all module marks are combined using the weighting in the assessment matrix table. The award of distinction for the masters is based on:

- An overall degree mark of at least 70% with no modules failed at first attempt.

## Award of Merit

To calculate the overall degree mark all module marks are combined using the weighting in the assessment matrix table. The award of merit for the masters is based on:

- An overall degree mark between 65% - 69.9% inclusive and no modules failed at first attempt

- Or an overall degree mark of 70% or more and one module failed at first attempt

## Postgraduate Diploma

A student who has not accumulated enough credits to be awarded a masters degree may be awarded a postgraduate diploma provided they have satisfied the following conditions:

- The total number of credits gained is equal to or greater than the minimum credits stipulated in the programme specification for the award of a diploma

For the award of a diploma a student may compensate a maximum of twenty core or core elective credits provided the following conditions are met:

- The mark achieved for the module(s) to be compensated is at least 40%

- The average mark of all modules to be counted towards the diploma, including those modules to be compensated, is at least 50%

Note that:

- The diploma average will be calculated in the same way as the masters average as specified in the programme specification;

- The award of distinction and merit will also be calculated in the same way for the masters degree, as specified in the programme specification

## Grade Related Criteria

| Class | % | Literary | | Knowledge | Independent thought, uses of sources and research materials | Presentation | Professional |
|---|---|---|---|---|---|---|---|
| Distinction | 85-100 | A | Outstanding | Comprehensive and informative knowledge of subject area, may include - new knowledge derived from which the marker and wider community may learn; addresses the learning outcomes/ assessment criteria in full | Where relevant, evidence of independent reading, thinking and analysis and strong critical ability | Well-constructed | Distinction |
| | 80-84 | | Excellent | | | | |
| | 75-79 | | Very good | Sophisticated or strong - shows knowledge of complex issues or a broad range of issues and addresses the learning outcomes/assessment criteria well. | Where relevant, show evidence of wide and comprehensive reading and critical ability | Clearly written | |
| | 70-74 | | | | | | |
| Merit | 65-69 | B | Good | Sound knowledge of a broad range of issues or detailed knowledge of a smaller number of issues; makes a good attempt to address the learning outcomes/assessment criteria, realising all to some extent and some well | Evidence of thorough research of the topic(s) but some answers may not be complete or arguments sufficiently explored. Some critical ability will be evident. | Well-structured and logically written | Merit |
| Pass | 50-64 | C | Satisfactory | Adequate knowledge of important issues – some level of response to all learning outcomes/assessment criteria but may not include important elements or information that is fully accurate. | Where relevant, development of ideas is limited but attempts will be made to analyse materials critically | Expression and structure may lack clarity | Pass |
| Fail (0%-49%) | 41-49 | D | Poor | Unsatisfactory work - inadequate knowledge of the important issues and doesn't succeed in grasping key issues, therefore learning outcomes/ assessment criteria will not be realised | No real development of ideas and critical analysis will be very limited. | Presentation is confused or incoherent | Fail (0%-49%) |
| | 20-40 | E | Very poor | Knowledge is lacking either through omission, the inclusion of large amounts of irrelevant information or evidence of significant misunderstanding - totally inadequate attempt to address the learning outcomes/ assessment criteria | No critical ability will be displayed | Confused, incoherent or unstructured presentation | |

# Section 5 Additional Information

## MSc Course Office

The MSc course office is here to support both staff and students and each MSc course has its own dedicated Course Officer who you will get to know over the course of your time here at Cass. The Course Office team will provide you with course related information, material and your grades, advice relating to other areas of City University and support throughout the duration of your studies.

### Location

The course office is located on the 3rd floor of Cass Business School, 106 Bunhill Row, London EC1Y 8TZ

### Contact

You can contact the course office team either in person at the office, by email, telephone or via Moodle, our virtual learning environment.

The MSc Mathematical Trading and Finance Course Officer is Sharron Charles and can be contacted directly via telephone 020 7040 8850 or by email s.s.charles@city.ac.uk

### Office Opening Hours

During term time the course office is open to students:

| | |
|---|---|
| Monday | 1300 – 1830 |
| Tuesday | 1300 – 2000 |
| Wednesday | 1300 – 1830 |
| Thursday | 1300 – 2000 |
| Friday | 1030 – 1530 |

Outside of term time the course office is open to students:

| | |
|---|---|
| Monday to Thursday | 1300 – 1700 |
| Friday | 1030 – 1530 |

## Moodle: Your Virtual Learning Environment

Moodle is the virtual learning environment used at City University and it provides a wide variety of information and interactive environments to students, including the following:

- Module material and supplementary learning documents, including areas for the submission of coursework and the release of coursework results
- Timetables, including teaching and examination

- Specialist Masters, MSc specific and module pages providing information relating to each area with supporting documents and forums

- Links to the Learning Resource Centre, Careers, Student Advice and Clubs and Societies

Students are responsible for checking their Moodle pages and their City email account regularly. This is how all information, including changes to teaching, is communicated. Course Officers manage the communications sent to students via Moodle and all administrative enquiries should be directed to them for assistance.

## Personal Tutors

Postgraduate Taught students are assigned a personal tutor at the beginning of the year. This personal tutor will be available to provide general academic, professional and pastoral support and will also ensure students are aware of the additional and more specialised support mechanisms available within the University.

Students should have the opportunity to see their personal tutor at least once a term, however it is the student's responsibility to contact their personal tutor to make an appointment.

The Course Office team is also here to assist should you need any support during the course of your studies.

## Academic Staff Contact Details

In addition to their main teaching responsibilities academics also engage in research, administration and external work. As a result staff members may not be able to see you without an appointment.

If the matter is non-urgent please make an appointment or make use of the office hours many academics hold. If the matter is urgent please make this clear when contacting the member of staff to request an appointment.

Lecturer's contact details and office hours can be found on Moodle.

## Programme Disclaimer

The information in this Specialist Masters Programme Handbook is correct at the time of going to press in August 2012. The University reserves the right to make amendments to:

a) the contents of the Programme Handbook and in particular to the timetable, location and methods of delivery or the content, syllabus and assessment of any of its programmes as set out in the programme and module specifications in this Handbook and/or on the University's website; and

b) its statutes, ordinances, regulations, policies, procedures and fee structures,

provided that such amendments are (i) as a result of student demand (or lack thereof), (ii) as a result of unforeseen events or circumstances beyond the University's control or (iii) are deemed reasonably necessary by the University.

In the event that amendments are made, the University shall take reasonable steps to notify you as soon as is reasonably possible.

**Cass Business School**
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**www.cass.city.ac.uk/masters**

**Cass Business School**
In 2002, City University's Business School was renamed Sir John Cass Business School following a generous donation towards the development of its new building in Bunhill Row. The School's name is usually abbreviated to Cass Business School.

**Sir John Cass's Foundation**
Sir John Cass's Foundation has supported education in London since the 18th century and takes its name from its founder, Sir John Cass, who established a school in Aldgate in 1710. Born in the City of London in 1661, Sir John served as an MP for the City and was knighted in 1713.