Proposed Syllabus for New MSc in Quantitative Risk Management

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The new MSc will be offered for the first time in the academic year 2008–9. Certain modules (Credit Risk Management, Introduction to Credit Derivatives) will be offered as optional modules to students on our existing MSc courses (Actuarial Science and Financial Maths) in the academic year 2007–08.

Part I
Semester One Modules

1 Enterprise Risk Management

15 credits. A compulsory module providing motivation for the whole course at a relatively non-technical level. May be followed by students from other Schools, e.g. Management.

1.1 Financial Risk in Perspective

What is risk? How do we model and measure it? Why do we manage it? Historical development of risk management. The regulatory process and the Basel Accords. Developments in the banking, insurance and other industries. The main categories of financial risk: market, credit, operational, other. Regulatory capital. Economic capital

1.2 Basic Concepts in Risk Management

Risks, risk factors and loss distributions. Risk measures. Value at Risk, expected shortfall and other examples. Scenario losses and stress testing.

1.3 Market Risk

Regulatory requirements. Mapping positions. Standard approaches: variance covariance/delta normal; historical simulation; Monte Carlo.

1.4 Credit Risk

Regulatory requirements. Basic elements of credit risk models: exposure, default, loss given default. The Basel II regulatory capital formula.

1.5 Operational Risk

Regulatory requirements: basic indicator approach; standardized approach; advanced measurement approach.

2 Statistical Models for Market Risk

15 credits. A module focusing on the statistical models for financial time series that are necessary for a deeper understanding of market risk modelling and management. Will closely resemble the current module on Quantitative Risk Management in the MSc in Financial Mathematics.

2.1 Financial Market Returns and Their Distribution

Log-returns and relative returns. Arguments for normality and empirical evidence of non-normality (non-Gaussianity). Non-Gaussian distributions: Student; generalized hyperbolic; stable. Brief introduction to multivariate extensions of standard distributions (multivariate normal).

2.2 Financial Time Series Analysis

Basic concepts: stationarity, autocorrelation, estimation in time domain. Compact review of classical ARMA models. Models for volatility (GARCH, stochastic volatility). Exponentially-weighted moving average procedures.

2.3 Extreme Value Theory

Limit laws for maxima. Limit laws for excess losses over high thresholds. The POT (peaks-over-thresholds) method.

2.4 Role of Statistical Models in Market Risk

Mapping positions (stock portfolios, fixed income portfolios, derivative portfolios). Standard methodology (variance/covariance, historical simulation, Monte Carlo) critically examined. Extensions to standard methodology.

3 Credit Risk Management

15 credits. A module on models of portfolio credit risk that will enable students to understand what lies behind current regulation and to appreciate the methodology at the heart of industry solutions.

3.1 Introduction to Credit Risk

Credit risky instruments (loans, bonds, credit derivatives). Defaults and ratings. Merton's structural model of default. Industry models (KMV and CreditMetrics) descending from Merton's model.

3.2 Basic Analysis of Portfolio Models

Calculating the portfolio loss from defaults, exposures and losses given defaults. Reducing industry threshold models to their simplest form. Modelling dependence using factor models. One-factor and multi-factor models.

3.3 Mixture Models of Default

Bernoulli and Poisson mixtures. CreditRisk+. Threshold Models as mixture models. Large portfolio asymptotics. Understanding the derivation of the Basel II regulatory capital formula. Granularity and concentration risk issues.

3.4 Calculating the Loss Distribution

Calculating the loss distribution, making capital allocations. The Monte Carlo approach and importance sampling.

3.5 Calibration and Statistical Inference

Calibration of portfolio credit risk models and model risk issues. Statistical inference for portfolio credit risk models.

4 Special Topics 1

15 credits. Two topics should be chosen from the list in Part III. One should be treated in an essay and one in a presentation.

Part II
Semester Two Modules

5 Advanced Principles of Quantitative Risk Management

15 credits. A more theoretical module concerning risk measures and their properties, models of dependence and capital allocation principles.

5.1 Risk Measures

Properties of risk measures. Coherent and other classes of risk measures (convex, spectral/distortion). Study of prominent industry risk measures (VaR, expected shortfall).

5.2 Modelling Dependent Risks

Dependence concepts: correlation, other dependence measures, dependence orderings. Copulas. Use of copulas in integrating loss distributions from different business lines.

5.3 Capital Allocation

The problem of allocating the measured overall risk to the business units "responsible". Euler principle, covariance principle, VaR and shortfall contributions. Performance measurement and return on risk-adjusted capital (RORAC).

6 Advanced Statistical Methodology for Risk Management

15 credits. In this module we deepen our knowledge of relevant statistical and econometric methods for modelling risk. Prerequisite: Statistical Models for Market Risk.

6.1 Multivariate Analysis of Financial Returns

Basic multivariate statistical analysis. The multivariate normal and its problems. Tests for multivariate normality. Other multivariate distributions (normal mixtures, generalized hyperbolic, elliptical). Robust correlation estimation.

6.2 Factor Models and Dimension Reduction

Revision of capital asset pricing model (CAPM). The three kinds of factor model (macroeconomic, fundamental, statistical). Principal components analysis. Role of dimension reduction in models of market and portfolio credit risk.

6.3 Advanced Time Series and Econometrics

Multivariate time series (basic principles, multivariate GARCH, factor GARCH). Cointegration models.

7 Introduction to Credit Derivatives

15 credits. This module will survey credit derivative products and give an introduction to the methods that are used to price them. It will be at a more technical level and prior experience of financial mathematics and derivative pricing will be very beneficial. Prerequisite: Credit Risk Management. Recommended: Prior Module on Financial Mathematics and Pricing

7.1 Overview of Credit Derivatives

Single name credit derivatives, credit default swaps (CDSs). Portfolio/basket credit derivatives, CDOs and first-to-default contracts.

7.2 Mathematical Tools

Reduced-form models. Random times and hazard rates. Doubly stochastic random times. A primer on copulas.

7.3 Pricing Single-Name Credit Derivatives

Actuarial versus financial pricing. The Risk-neutral approach. Pricing formulae. Dealing with recoveries. Affine models. Pricing a CDS.

7.4 Pricing Basket Credit Derivatives

Conditionally independent defaults. Copula models. Pricing a CDO tranche. Outlook on future methodological development.

8 Special Topics 2

15 credits. Two topics should be chosen from the list in Part III. One should be treated in an essay and one in a presentation.

Part III
List of Special Topics

- Case Study in Market Risk
- Case Study in Credit Risk
- Operational Risk
- Understanding Hedge Funds
- Interest Rate Risk Management
- Case Study in Credit Derivatives
- Energy and Commodity Risk
- Modern Portfolio Optimization