QUANTITATIVE RISK MANAGEMENT: CONCEPTS, TECHNIQUES AND TOOLS BY ALEXANDER J MC NEIL, RUDIGER FREY, PAUL EMBRECHTS

This book provides a well-rounded introduction to the modelling of financial risk with primary focus on the statistical behaviour of portfolios of risky instruments.

The book is divided into ten chapters.

The first chapter “Risk In Perspective”
(a) Introduces the reader to the basic concepts of risk management,
(b) Provides a brief history of financial risk management including the salient aspects of the current and emerging regulatory framework; and
(c) Discusses the reasons for measuring and managing financial risk.

The second chapter “Basic Concepts in Risk Management” is divided into three sections. The first section illustrates how typical risk management problems can be modelled using a probabilistic framework. The second section covers the approaches to risk measurement such as the factor-sensitivity measures, risk measures based on loss distributions and risk measures based on scenarios. The third section presents the standard methods for measuring market risk over a short time horizon such as the variance – covariance method, the historical simulation method and Monte Carlo Simulation methods. This section also discusses the use of scaling rules for transforming one period risk measures into estimates for longer time horizons.

The third chapter “Multivariate Models” is laid out in three sections. The first section discusses the multivariate normal distribution for modelling empirical return data. The second section illustrates the use of elliptical distributions in modelling asymmetric data such as the asset return data. The third section provides a brief description of the dimension reduction techniques such as factor modelling and principal component analysis which are used for reducing large sets of risk factors to smaller sub sets of essential risk drivers.

The fourth chapter “Financial Time Series” discusses the empirical properties of financial time series and the application of ARCH and GARCH (Generalized auto conditional heteroscedastic) processes for capturing the varying volatility of financial time series. This chapter also covers the multivariate GARCH models such as CCC (Constant Conditional Correlation) GARCH model and Vector GARCH models.

The fifth chapter “Copulas and Dependence” focuses on measuring dependence (for e.g., dependence among the components of a random vector of financial risk factors) using the concept of copulas. This chapter provides a detailed description of the dependence measures such as linear correlation, rank correlation and the coefficients of tail dependence. The coefficient of tail dependence is particularly important because it addresses the phenomenon of joint extreme values in several risk factors, which is a key concern in financial risk management. The chapter also covers the properties of Normal Mixture Copulas and Archimedean Copulas. The chapter concludes with a discussion on the approaches for fitting copulas to data.

The sixth chapter “Aggregate Risk” covers the issue of measuring the risk of a portfolio. The chapter begins with a discussion on the axioms which a coherent risk measure should satisfy and evaluates the suitability of VaR [Value at Risk] and Expected Shortfall as coherent risk measures. The chapter also addresses the problem of finding the upper and lower bounds for aggregate risk; and the issue of allocating a portfolio’s risk capital to individual risks in the portfolio.

The seventh chapter “Extreme Value Theory” provides a fairly detailed discussion of the statistical methods underlying the Extreme Value Theory. The first and second sections of this chapter cover the properties of the Block Maxima Models (the traditional models) and the more widely used Threshold Exceedance Models. The third section of this chapter discusses the theorems concerning the tails of the distributions such as mixture distributions, spherical distributions and strictly stationary GARCH models. The chapter concludes with a discussion on the key properties multivariate maxima and multivariate threshold exceedance models.

The eighth chapter “Credit Risk Management” provides an extensive discussion of the static credit risk models. This chapter is divided into six sections. The first section provides an overview of the credit risk models and outlines the challenges in credit risk modelling. The second and third sections of this chapter cover the features of the static structural or firm value models. The fourth and the fifth sections describe the static portfolio versions of the reduced form models. The sixth section explores the linkages between mixture models and generalized linear models (GLMs) in order to devise efficient methods of statistical inference for portfolio models.

The ninth chapter “Dynamic Credit
Risk Models and Credit Derivatives” presents a description of credit risk models in continuous time and pricing of credit derivatives in the framework of reduced form models. The chapter begins with a brief introduction of credit derivatives followed by a primer on the mathematical tools that are necessary to understand and analyse the reduced form models. The later sections of this chapter focus on the reduced- form models using for pricing defaultable securities; and applications of reduced- form models for modelling portfolio credit risk. The discussion on modelling portfolio credit risk covers both models with conditionally independent defaults and models where there is an interaction between defaults.

The tenth chapter “Operational Risk and Insurance Analytics” is divided into two parts. The first part introduces the concept of Operational Risk and presents the elementary approaches for measuring operational risk like the Basic Indicator (BI) approach and the Standardized (S) approach. The section also contains a discussion on the relatively advanced measurement approaches for measuring operational risk. The second part of this chapter [Insurance Analytics] discusses the relevance of actuarial methodology in Quantitative Risk Modelling (QRM). This section underscores the point that many modelling tools used in the context of financial risk management were first applied by actuaries in the realm of insurance. The section illustrates how the risk models used in the context of non-life insurance can be applied to calculate risk measures like VaR.

Overall this book provides a rigorous yet accessible technical treatment of the subject. Clearly a working knowledge of probability and statistics, calculus, and linear algebra are fundamental pre requisites for gaining a better understanding of the quantitative models presented in this book.

The book can be considered as a required reading for all risk management professionals seeking to gain a holistic understanding of quantitative risk management. The Faculty and Institute of Actuaries have included selected chapters of this book as part of the required reading for the subject ST9 (Enterprise Risk Management).