

# **Risk Management: Principles and Applications**

## **Module Introduction and Overview**

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# 1 Introduction to the Module

Welcome to this module on *Risk Management: Principles and Applications*. This module has four main aims, to:

- illustrate the main types of risk
- present the most important ideas and methods used in the analysis of portfolios of financial securities, including stocks and bonds
- explain how rational investors can use financial derivatives (mainly, futures and options) in order to alter the risk of their investment position
- illustrate some more specialised risk management techniques, such as Value at Risk and Credit Risk.

The emphasis throughout is on the *general principles* behind the investment decisions, rather than on case studies or anecdotal evidence. Thus, you will study, for instance,

- the main features of portfolios, which include stocks and bonds
- how to calculate their risk, and
- how investors can combine their holdings of different securities to reduce their overall risk without sacrificing return.

Similarly, when you deal with futures and options, you will explore how these instruments can be used to manage risk and to expand the opportunity set of investors.

All firms face risks, although the types of risks they face and their extent differ. Consequently, management requires a strategy for dealing with risk and appropriate techniques for implementing the strategy. It may be tempting to think simply that risk is undesirable and that strategies are chosen to minimise risk, but that is not the assumption that underlies risk management principles because, in general, low levels of risk imply low levels of expected profits (expected returns).

Instead, we assume that firms choose some level of risk that gives them a desirable combination of risk and return, a desirable risk–return ratio. Some firms’ managers choose a high-risk strategy in the belief that high expected profits are associated with high risk; others choose a conservative (low-risk, low-expected-returns) strategy. In order to achieve their desired risk–return combination, management needs to be able to calculate risk, to value it, and to change the combination of risk and expected return by buying and selling assets and liabilities. The assets and liabilities in firms’ portfolios include those that take the form of derivatives contracts (such as options), which powerfully facilitate strategies that reduce risk (‘hedging’) or increase it (‘speculation’).

This module focuses on the concepts and techniques that managers use to achieve desired risk–return combinations. The module gives particular attention to the techniques and concepts associated with derivatives. That includes hedging techniques using options and futures contracts.

Many of the principles in risk management were developed by financial firms, such as banks and investment fund managers, but they are also applicable to non-financial firms in commerce, manufacturing or other sectors. In this module we focus on the management of risk by non-financial firms in two ways. One is by showing how the principles used by financial firms are also useful for non-financial firms' risk management. Another is by showing how risk-management principles used by banks and investment funds affect their loans to, or investment in, non-financial firms so that those non-financial firms have to take them into account in their own management decisions.

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## 2 The Module Authors

**Pasquale Scaramozzino** is a Professor of Economics at the Centre for Financial and Management Studies, SOAS University of London. Professor Scaramozzino has taught at the University of Bristol, at University College London and at Università di Roma 'Tor Vergata'.

His research articles in finance and in economics have been published in academic journals, including *Applied Economics*, *Economica*, *The Economic Journal*, *Empirical Economics*, *Journal of Comparative Economics*, *Journal of Development Economics*, *Journal of Environmental Economics and Management*, *Journal of Industrial Economics*, *Journal of Population Economics*, *The Manchester School*, *Metroeconomica*, *Oxford Bulletin of Economics and Statistics*, *Oxford Economic Papers*, *Oxford Review of Economic Policy* and *Structural Change and Economic Dynamics*. He has also published extensively in medical statistics.

Professor Scaramozzino has taught *Risk Management* for the on-campus MSc in Finance and Financial Law in London and has contributed to several off-campus CeFiMS modules, including *Mathematics and Statistics for Economists*, *Portfolio Analysis and Derivatives*, *Quantitative Methods for Financial Management*, *Managerial Economics* and *Derivatives*.

**Dr Jonathan Simms** provided revisions and additional material. Dr Simms is a tutor for CeFiMS, and has taught at University of Manchester, University of Durham and University of London. He has contributed to development of various CeFiMS modules including *Econometric Principles and Data Analysis*, *Econometric Analysis and Applications*, *Financial Econometrics*, *Introduction to Valuation*, *Advanced Topics in Valuation*, *Public Financial Management: Reporting and Audit*, *Banking Strategy*, and *Introduction to Law and to Finance*.

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## 3 Study Resources

The materials provided for this module comprise the module study guide, presented in eight units of text covering different topics.

The module units illustrate the main ideas underlying risk analysis and suggest how to proceed in the study of each issue. The units are designed in the

expectation that you will devote about 15–20 hours to studying each topic, including all the associated readings and the set exercises.

The study resources used to develop the topics comprise the module readings and three key texts.

### **Key texts**

Elton EJ, MJ Gruber, SJ Brown and WN Goetzmann (2014) *Modern Portfolio Theory and Investment Analysis*, 9th Edition, New York: Wiley.

Hull JC (2017) *Fundamentals of Futures and Options Markets*, 8th Edition, Harlow UK: Pearson.

Crouhy M, D Galai and R Mark (2014) *The Essentials of Risk Management*, 2nd Edition, New York: McGraw Hill.

The textbook by Elton, Gruber, Brown and Goetzmann offers a very thorough and up-to-date presentation of modern portfolio analysis. One of its main attractions is that it seeks to balance the formal aspects of theory with the demands of practitioners. Although the text does not dwell on many institutional details, it discusses very clearly the relevance of the various theoretical results for the actual implementation of security analysis and portfolio management, and provides a number of useful examples. You will make extensive use of this book by Elton et al. for Unit 1–Unit 3 of the module, dealing with the analysis of portfolios of stocks and bonds.

Hull's textbook provides a clear treatment of futures and options markets. You will be required to study a number of chapters of the text, but if you develop a professional interest in derivatives, you will find it useful to study the whole book. For this module on Risk Management, you will use this book mainly for Unit 4–Unit 6, which deal with futures and options.

Note that the textbook author John Hull has developed software called DerivaGem, which enables you to compute directly the prices of futures, options and other derivatives. The software and details on how to install and run DerivaGem are provided on the author's website at: <http://www-2.rotman.utoronto.ca/~hull/software/index.html>.

The textbook by Crouhy, Galai and Mark presents a comprehensive analysis of the various sources of risk in financial markets. The authors are academics with long-standing professional expertise, and they successfully bridge the gap between the general principles and the practice of risk management. For this module, you will use their book for Unit 1 and then for Unit 7 and Unit 8, which cover two more specialised techniques of risk management: Value at Risk and Credit Risk.

### **Module readings**

We also provide you with academic articles, papers and reports, which are assigned as core readings in the study guide. You are expected to read them as an essential part of the module. We have selected articles and reports which reinforce your understanding of the material in the study guide and

textbooks, and which also demonstrate how the methods you are studying are applicable and relevant in the evolving risk environment, including the financial crisis beginning 2007/08.

You will also see that some of the Module units refer you to a number of references online which you may find useful in giving these topics an extra dimension.

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## 4 Module Overview

### Unit 1 Introduction to Risk Management

- 1.1 Introduction to Portfolio Analysis
- 1.2 Risks Faced by Financial and Non-financial Institutions
- 1.3 Financial Securities and Financial Markets
- 1.4 The Mean-Variance Approach
- 1.5 The Opportunity Set under Risk – Efficient Portfolios
- 1.6 Short Sales and Riskless Lending and Borrowing
- 1.7 How to Compute the Efficient Set
- 1.8 Conclusion

### Unit 2 Portfolio Analysis

- 2.1 Introduction
- 2.2 The Single-Index Model
- 2.3 Methods for Estimating Betas
- 2.4 Fundamental Betas
- 2.5 Multi-Index Models
- 2.6 Fundamental Multi-Index Models
- 2.7 Conclusions

### Unit 3 Management of Bond Portfolios

- 3.1 Introduction
- 3.2 Returns on Bonds
- 3.3 The Term Structure of Interest Rates
- 3.4 Default Risk and Callable Bonds
- 3.5 Duration
- 3.6 Convexity
- 3.7 Passive Bond Portfolio Management – Matching, Immunisation, Indexation
- 3.8 Active Bond Portfolio Management – Index Models
- 3.9 Active Bond Portfolio Management – Swaps
- 3.10 Conclusion

### Unit 4 Futures Markets

- 4.1 Introduction
- 4.2 Description of Financial Futures
- 4.3 Pricing of Financial Futures
- 4.4 Futures Strategies
- 4.5 Examples of Using Futures
- 4.6 Interest Rate Futures

- 4.7 Currency Futures
- 4.8 Conclusion

## **Unit 5 Options Markets**

- 5.1 Introduction
- 5.2 Features of Options Contracts
- 5.3 Options on Stocks and Futures
- 5.4 Risk Exposure and Profit Potential of Options and Futures
- 5.5 The Put–Call Parity Formula
- 5.6 Option Pricing – The Black–Scholes–Merton Formula
- 5.7 Pricing of Options on Futures
- 5.8 Price Volatility
- 5.9 Conclusion

## **Unit 6 Risk Management with Options**

- 6.1 Introduction
- 6.2 Speculation with Options – Combinations of Calls and Puts
- 6.3 Hedging with Options – Against a Price Increase
- 6.4 Hedging with Options – Against a Price Decline
- 6.5 Sensitivities of Option Prices
- 6.6 Delta Hedging
- 6.7 The 2007 Credit Crisis and the Role of Derivatives
- 6.8 Conclusion

## **Unit 7 Value at Risk**

- 7.1 Introduction
- 7.2 Definition of Value at Risk
- 7.3 Calculation of Value at Risk – the Variance-Covariance Approach
- 7.4 Delta-Normal VaR
- 7.5 Historical Simulations Approach
- 7.6 Incremental-VaR and DeltaVaR
- 7.7 Stress Testing and Scenario Analysis
- 7.8 Limitations of VaR – EVaR
- 7.9 Conclusion

## **Unit 8 Credit Risk**

- 8.1 Introduction
- 8.2 Credit Rating Systems
- 8.3 Internal Risk Rating
- 8.4 CreditMetrics
- 8.5 Analysis of Credit Migration
- 8.6 Valuation of Bonds
- 8.7 Forward Distribution of Changes in the Value of Bonds
- 8.8 Credit VaR for a Bond or Loan Portfolio
- 8.9 Credit VaR and Calculation of Capital Charge
- 8.10 Conclusion

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## 5 Learning Outcomes

When you have completed your study of this module, you will be able to:

- outline the most important strategies of risk management
- explain how stocks and bonds can contribute to the risk and return of a financial portfolio
- discuss the key principles of diversification of financial investment
- correctly measure the risk of financial portfolios
- explain the risk profile involved in financial derivatives, such as futures and options
- discuss the importance of Value at Risk and scenario analysis
- define and use the principles of credit risk analysis.

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## 6 Study Advice

When you study each unit, it is essential that you:

- read the module units when you approach the topic
- study the relevant sections of the textbooks
- read the suggested articles and module readings
- solve the problems as you are advised.

You must read and think about the assigned chapters and articles from the module readings you are asked to read at the points indicated. It is important that you understand each topic well, before moving on to the next one. The material presented in the module follows a logical sequence, and you will find it difficult to understand the later topics if you do not fully understand the previous ones.

The exercises and problems require that you answer some specific questions on risk management, and solve numerical problems. They are designed to test your understanding of the issues, and are also meant to provide useful practice in preparation for your examination. It is crucial that you take great care in thinking through the exercises, and answer the questions as carefully and thoroughly as you can before you proceed to the following reading.

The answers to the numerical problems are usually provided at the end of each unit.