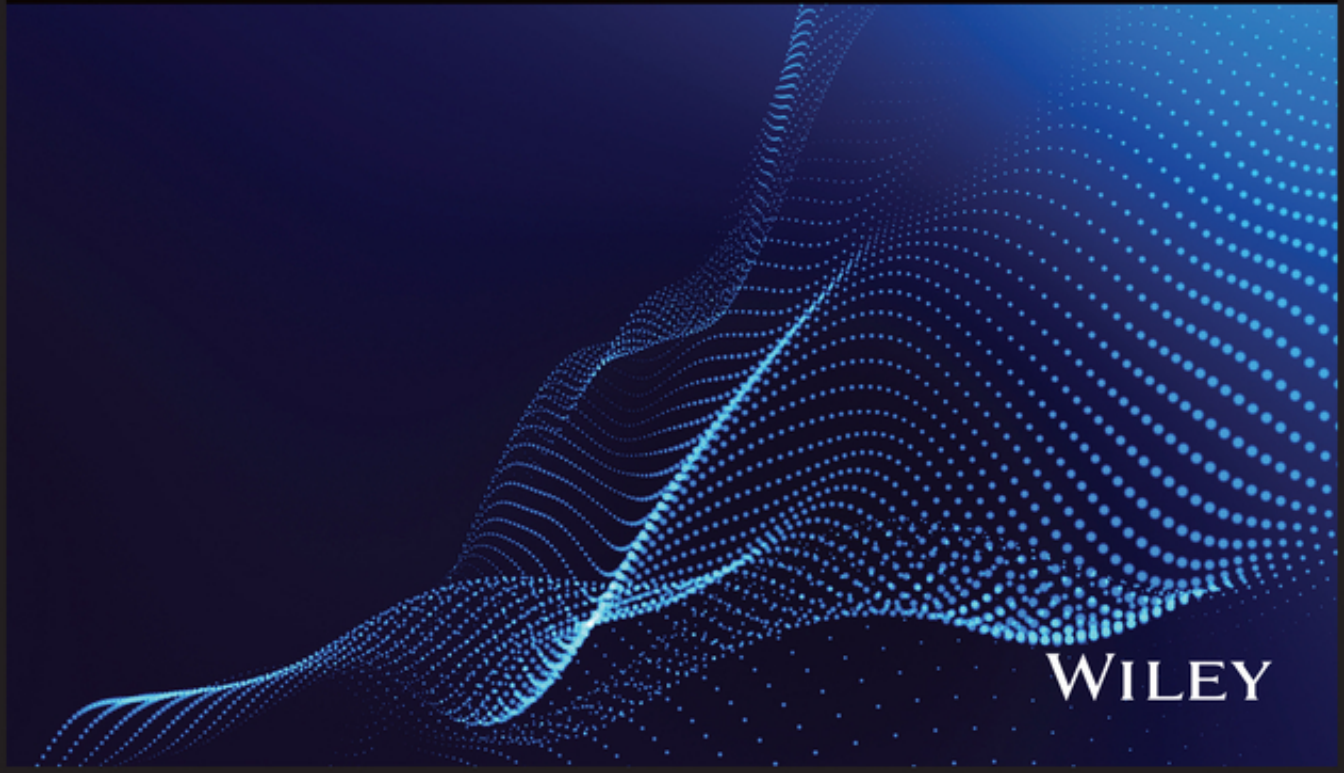


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SIXTH EDITION

RISK MANAGEMENT AND FINANCIAL INSTITUTIONS

JOHN C. HULL



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Risk Management and Financial Institutions

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Risk Management and Financial Institutions

Sixth Edition

John C. Hull

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To Michelle, Peter, and David

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Preface

The sixth edition of *Risk Management and Financial Institutions* has been fully updated with many improvements to the presentation of material. Like my other popular book, *Options, Futures and Other Derivatives*, it is designed to be suitable for practicing managers as well as university students. Those studying for professional qualifications such as FRM and PRM will also find the book useful.

There are no prerequisites, except a knowledge of basic statistics. In producing the sixth edition I re-sequenced the chapters to create a more logical flow of material. Financial institutions, financial markets, and the management of different types of risk are now discussed in the first 24 chapters, with the regulation of financial institutions being covered toward the end of the book. Instructors who do not want to cover regulation will find the new structure easier to deal with. Those who do cover regulation will probably agree that students should have a good understanding of the risks first.

There is a new chapter (Chapter 23) on climate risk, ESG, and sustainability. We have now reached the stage where all companies, including financial institutions, cannot ignore environmental risks. Increasingly, it is necessary for them to provide information to investors on the way they are managing these risks. This chapter describes the nature of environmental risks and the key role that financial institutions can play in saving the planet.

Improvements have been made to material throughout the book. The level of mathematical sophistication and the way material is presented have been managed carefully so that the book is accessible to as wide an audience as possible. For example, when covering copulas in Chapter 9, I present the intuition followed by a detailed numerical example; when covering maximum likelihood methods in Chapter 8 and extreme value

theory in Chapter 12, I provide illustrative numerical examples. I have also provided Excel spreadsheets for many of the applications in the book on my website:

www-2.rotman.utoronto.ca/~hull

Ancillary Material

Several hundred PowerPoint slides can be downloaded from my website or from the Wiley Higher Education website. Adopting instructors are welcome to adapt the slides to meet their own needs. The RMFI software that accompanies the book is also available from my website.

End-of-chapter problems are divided into two groups: “Practice Questions and Problems” and “Further Questions.” Answers to the former are at the end of the book. Answers to the latter and accompanying worksheets are available to adopting instructors from the Wiley Higher Education website. This website also contains suggestions on the teaching of each chapter and course organization.

Acknowledgments

I have benefited from interactions with many academics and practicing risk managers when writing this book. I would particularly like to thank Jan Mahrt-Smith (Rotman), Jun Yuan (Royal Bank of Canada), and Beth Creller (GARP) who made suggestions on how Chapter 23 could be improved. I would also like to thank students in the MBA, Master of Finance, and Master of Financial Risk Management courses at the Rotman School, University of Toronto, who have made many useful suggestions.

Alan White, a long-time colleague at Rotman, deserves a special acknowledgment. Alan and I have been carrying out joint research and consulting for many years. We have spent countless hours discussing key issues. Many of the new ideas in this book, and many of the new ways to explain old ideas, are as much Alan’s as mine. Alan has done most of the development work on the RMFI software.

Special thanks are due to many people at Wiley, particularly Bill Falloon, Purvi Patel, Samantha Wu, Susan Cerra, and Premkumar for their enthusiasm, advice, and encouragement.

I welcome comments on the book from readers. My e-mail address is:

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Chapter 1

Introduction: Risk-Return Trade-offs

Imagine you are the Chief Risk Officer (CRO) of a major corporation. The Chief Executive Officer (CEO) wants your views on a major new venture. You have been inundated with reports showing that the new venture has a positive net present value and will enhance shareholder value. What sort of analysis and ideas is the CEO looking for from you?

As CRO it is your job to consider how the new venture fits into the company's portfolio. What is the correlation of the performance of the new venture with the rest of the company's business? When the rest of the business is experiencing difficulties, will the new venture also provide poor returns, or will it have the effect of dampening the ups and downs in the rest of the business?

Companies must take risks if they are to survive and prosper. The risk management function's primary responsibility is to understand the portfolio of risks that the company is currently taking and the risks it plans to take in the future. It must decide whether the risks are acceptable and, if they are not acceptable, what action should be taken.

Most of this book is concerned with the ways risks are managed by banks and other financial institutions, but many of the ideas and approaches we will discuss are equally applicable to nonfinancial corporations. Risk management has become progressively more important for all corporations in the last few decades. Financial institutions in particular are finding they have to increase the resources they devote to risk management. In spite of this, financial institutions still make mistakes. In March 2021, Archegos,

a hedge fund managing the assets of a rich private individual named Bill Hwang, went bankrupt as a result of highly levered risky investments. Several banks that the hedge fund had been dealing with lost huge sums. It is reported that Credit Suisse lost over \$5 billion and Nomura lost almost \$3 billion as a result of their dealings with Archegos.

Risk management is not about minimizing risks. It is about ensuring that the risks taken are manageable and that the expected returns are commensurate with the risks being taken. This chapter sets the scene. It starts by reviewing the classical arguments concerning the risk-return trade-offs faced by a well-diversified investor who is choosing a portfolio of stocks and bonds. It then considers whether the same arguments can be used by a company in choosing new projects and managing its risk exposure. The chapter concludes that there are reasons why all companies, including financial institutions, should be concerned with the total risk they face, not just with the risk from the viewpoint of a well-diversified shareholder.

1.1 Risk vs. Return for Investors

We now examine the theoretical trade-off between risk and return when money is invested. The first point to note is that the trade-off is actually between risk and *expected return*, not between risk and actual return. The term “expected return” sometimes causes confusion. In everyday language an outcome that is “expected” is considered highly likely to occur. However, statisticians define the expected value of a variable as its average (or mean) value. Expected return is therefore a weighted average of the possible returns, where the weight applied to a particular return equals the probability of that return occurring. The possible returns and their probabilities can be either estimated from historical data or assessed subjectively.

Suppose, for example, that you have \$100,000 to invest for one year. Suppose further that Treasury bills yield 5%. One alternative is to buy Treasury bills. There is then no risk and the expected return is 5%. Another alternative is to invest the \$100,000 in a stock. To simplify things, we suppose that the possible outcomes from this investment are as shown in Table 1.1. There is a 0.05 probability that the return will be +50%; there is a 0.25 probability that the return will be +30%; and so on. Expressing the returns in decimal form, the expected return per year is:

$$0.05 \times 0.50 + 0.25 \times 0.30 + 0.40 \times 0.10 + 0.25 \times (-0.10) + 0.05 \times (-0.30) = 0.10$$

This shows that, in return for taking some risk, you are able to increase your expected return per annum from the 5% offered by Treasury bills to 10%. If things work out well, your return per annum could be as high as 50%. But the worst-case outcome is a -30% return or a loss of \$30,000.

One of the first attempts to understand the trade-off between risk and expected return was by Markowitz (1952). Later, Sharpe (1964) and others carried the Markowitz