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Risk Management

风险管理

[加] 米歇尔·克劳伊 (Michel Crouhy) 著
丹·加莱 (Dan Galai)
罗伯特·马克 (Robert Mark)

★诺贝尔经济学奖获得者罗伯特·诺顿为本书作序

★加拿大帝国商业银行(CIBC)主席兼首席执行官撰写导言

——市场风险、信用风险和操作风险的全面阐述

——突出完整的VaR框架

——降低风险的对冲策略

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FOREWORD

Risk is the fundamental element that influences financial behavior. In its absence, the financial system necessary for efficient allocations of resources would be vastly simplified. In that world, only a few institutions and financial instruments would be needed, and the practice of finance would require relatively elementary analytical tools. But, of course, in the real world, risk is ubiquitous. Much of the structure of the financial system we see serves the function of the efficient distribution of risk. Much of the financial decision making by households, business firms, governments, and especially financial institutions is focused on the management of risk. Measuring the influence of risk, and analyzing ways of controlling and allocating it, require a wide range of sophisticated mathematical and computational tools. Indeed, mathematical models of modern finance practice contain some of the most complex applications of probability, optimization, and estimation theories. Those applications challenge the most powerful of computational technologies.

Risk Management provides a comprehensive introduction to the subject. Presented within the framework of a financial institution, it covers the design and operation of a risk-management system, the technical modeling within that system, and the interplay between the internal oversight and the external regulatory components of the system. That its authors, Michel Crouhy, Dan Galai, and Robert Mark, are significant contributors to the science of finance, active practitioners of finance, and experienced teachers of finance is apparent from both its substance and form. The range of topics is broad but evidently carefully chosen for its applicability to practice. The mathematical models and methodology of risk management are presented rigorously, and they are seamlessly integrated with the empirical and clinical evidence on their applications. The book also patiently provides readers without an advanced mathematical background the essential analytical foundations of risk management.

The opening four chapters provide a fine introduction to the function of the risk management system within the institution and

on the management of the system itself. Recent regulatory trends are presented to illustrate the expanded role that the internal system plays in informing and meeting the requirements of the external overseers of the institution.

With this as background, the book turns to the core substance of a risk management system with the analysis and modeling of risk measurement and control. Market risk is the first topic explored, including the ubiquitous VaR models and stress testing for identifying and measuring risk exposures to stock market, interest rate, currency, and commodity prices. The analysis shows how to incorporate option, derivative and other "nonlinear" security exposures into those models.

Nearly a third of the book is devoted to the management of credit risk, and for good reason. Banks are in the business of making loans and they also issue guarantees of financial performance for their customers. They enter into bilateral contractual agreements such as swaps, forward contracts, and options on enormous scales that expose them to the risk that their counterparts to those contracts will not fulfill their obligations. Similarly, insurance companies hold corporate bonds that may default and some guarantee the performance of bonds issued by municipal governments. The credit derivatives business is one of the fastest growing areas for financial products. However, credit risk analysis has even greater importance to risk management in its application to the soundness of the institution itself. Indeed, for financial institutions with principal businesses, which involve issuing contingent-payment contracts such as deposits, annuities, and insurance to their customers, creditworthiness is the central financial issue. The mere prospect of a future default by an institution on its customer obligations can effectively destroy those businesses. Unlike investors in an institution, its customers do not want to bear its credit risk, even for a price. The book presents the major competing models for measuring and valuing credit risk and evaluates them, both theoretically and empirically.

In addition to market and credit risk exposures, a comprehensive approach to risk measurement and risk management must also include operational risks, which is the subject of Chapter 13. Furthermore, no risk management system can be effective without well-designed performance measurement and testing. This is

needed both to estimate the risk exposures ex ante and to provide an ex post assessment of those estimates relative to predictions, as a feedback on the performance of the system. As laid out in Chapter 14, the system's risk estimates provide the basis for capital attribution among the activities and the accuracy of those estimates determine the amount of equity capital "cushion" needed as a whole.

Mathematical models of valuation and risk assessment are at the core of modern risk management systems. Every major financial institution in the world, including sovereign central banks, depends on these models and none could function without them. Although mainstream and indispensable, these models are by necessity abstractions of the complex real world. Although there is continuing improvement in those models, their accuracy as useful approximations to that world varies significantly across time and situation. Thus, a dimension of risk management that by definition is outside the formal risk management model is *model risk.* Chapter 15 explores that issue. It drives home the point that there is no "safe harbor" in model error, whether complex mathematical models or traditional measures with rules of thumb. For example, in the case of financial institutions, the traditional accounting leverage ratio measured by total assets/equity can be cut in half by using a "borrow-versus-pledge" method to finance security inventory versus using a "repo-reverse repo" method even though the economic risk of the two methods is identical. Furthermore, the institution can use derivative securities to greatly alter its measured leverage ratio without changing its economic risk. The risk-measurement approaches emphasized in the book are ones that give consistent readings among these different institutional ways of taking on the same risk exposure.

The pace of financial innovation has been extraordinary over the past quarter century and there is no sign of abatement in either product and service innovation or changes in the institutional structures of the providers. As discussed in Chapter 16, a major growth area will be in providing integrated risk management to nonfinancial firms. More generally, from individual households to government users, the trend in financial services lies with integrated products that are smarter, more comprehensive, simpler to understand, and more reliable for those users. The future of risk management, as articulated in Chapter 17, rests in helping the pro-

ducer handle the greater complexity of creating and maintaining those products. The prescriptions contained herein will age well.

To the reader: Learn and enjoy.

Robert C. Merton
Harvard Business School

INTRODUCTION

The traditional role of the risk manager as corporate steward is evolving as organizations face an increasingly complex and uncertain future. The mandate to clearly identify, measure, manage, and control risk has been expanded and integrated into best practice management of a bank. Today's risk manager is a key member of the senior executive team who helps define business opportunities from a risk-return perspective, presents unique ways of looking at them, has direct input into the configuration of products and services, and ensures the transparency of all the risks. Innovation necessitates new yardsticks for measuring and monitoring the resulting activities. The savvy corporate leader uses risk management as both a sword and a shield.

At the end of the last millennium, financial institutions and investors experienced increased volatility in the major financial and commodity markets, with many financial crises. At the start of the new millennium, we are in the midst of a technological revolution resulting in changes in the operation of markets, increased access to information, changes in the types of services available to investors, as well as major changes in the production and distribution of financial services.

If there is concern about an institution's ability to manage risk, then its share price will be penalized. Risk is a cost of doing business for a financial institution and consequently best practice risk management is a benefit to our shareholders. To manage the risks facing an institution we must have a clearly defined set of risk policies and the ability to measure risk. But what do we measure? And how do we measure such risks? We must also have a best practice infrastructure. The starting point is that we need a framework.

This book provides such a framework. The content of the book is consistent with our own risk management strategy and experience. Our risk management strategy is designed to ensure that our senior management operates together in partnership to control risk while ensuring the independence of the risk management function. Improvements in analytic models and systems technology have

greatly facilitated our ability to measure and manage risk. However, the new millennium brings new challenges. There are risks that we can identify and measure and there is the uncertainty of the unknown. The challenge facing risk managers is to minimize the consequences of the unknown. This book should help all risk and business managers address the issues arising from risk and uncertainty.

John Hunkin
Chairman & Chief Executive Officer
Canadian Imperial Bank of Commerce

PREFACE

Risk Management introduces, illustrates, and analyzes the many aspects of modern risk management in both financial institutions and nonbank corporations. It consolidates the entire field of risk management from policies to methodologies as well as data and technological infrastructure. It also covers investment, hedging, and management strategies.

The shift to flexible exchange rates in the late 1960s has led to more volatility in exchange rates. As volatility increased, financial markets began to offer a new breed of securities, that is, derivatives such as futures and options, to allow institutions to hedge their exposures to currency fluctuations. The increase in inflation in the early 1970s and the advent of floating exchange rates soon began to generate interest rate instability. Again, the market responded by offering new derivative products to hedge and manage these new risks. Banks found themselves increasingly engaged in risk intermediation and less in traditional maturity intermediation. Banks also started to innovate and offer new customized derivative instruments, known as over-the-counter (OTC) products, that both compete with and complement traded derivatives.

In 1988 the Bank for International Settlements (BIS) set the capital adequacy requirements for banking worldwide to account for credit risk. This was the first international effort to deal with the growing exposure of financial institutions to risk and volatilities, and especially to risk of off-balance sheet claims such as derivative instruments. The 1988 BIS Accord was followed by the 1998 BIS Accord, accounting for market risks in the trading book, as well as by many documents of the BIS discussing the many facets of risk management. The SEC implemented its risk exposure disclosure requirements in 1998 for all exchange traded companies in the United States.

Risk management is not an American phenomenon. Today it covers all continents and all countries. What we observe today is a convergence of regulation and disclosure requirements across the

globe. More than in any other field, the tools and reporting requirements of risk management are universal.

This book is based on our academic as well as practical work in the field of risk management. We try to cover both institutional aspects and organizational issues, while not forgetting that risk management is based on statistical and financial models.

The book is a comprehensive treatment of all aspects of risk management. It starts by discussing the new regulatory framework that is shaping best practice risk management in the banking industry worldwide. The risk management techniques that have been developed by and for banks are now migrating to the corporate sector. There is mounting pressure from regulators, such as the SEC in the United States, financial analysts, and investors for more and better disclosures of financial risks and the techniques and instruments being adopted to control these risks.

The book provides a consistent and comprehensive coverage of all aspects of risk management—organizational structure, methodologies, policies, and infrastructure—for both financial and nonfinancial institutions. It offers an up-to-date exposition of risk measurement techniques for market, credit risk, and operational risk. The risk measurement techniques discussed in the book are based on the latest research. They are presented, however, with considerations based on practical experience with the daily application of these new risk measurement tools. The book also elaborates on the issues that the next generation of risk measurement models will have to address, such as the full integration in a consistent multiperiod framework of liquidity, market, and credit risk; the measurement of risk for illiquid positions, as for example the merchant banking book; the risk assessment over a long-term horizon of structural positions, such as the "gap" of the corporate treasury in a financial institution; and stress testing to assess risk in periods of financial crises.

The book relies heavily on the experience of the authors in developing the risk management function in a bank from the ground up. It goes beyond the technical aspects of risk measurement. It proposes an integrated framework for managing risks and an organizational structure that has proven successful in practice.

We have incorporated the latest evolution of the regulatory framework and the current BIS proposal to reform the capital

Accord. The book offers a unique presentation of the latest credit risk management techniques. It provides clear guidance to implement a risk management group in a financial institution. It also discusses how to adapt to a nonfinancial corporation the risk management techniques that have been originally developed and implemented in banks. The book provides one-stop shopping for knowledge in risk management ranging from current regulatory issues, data, technological infrastructure, hedging techniques, and organizational structure.

STRUCTURE OF THE BOOK

The book is arranged according to the major subjects of modern risk management. Chapter 1 discusses the need for risk management systems. Chapter 2 presents the new regulatory framework that is shaping modern risk management in financial institutions and nonbank corporations. Chapter 3 provides an integrated framework for best-practice risk management. We explain how financial institutions should establish appropriate firm-wide policies, methodologies, and infrastructure in order to measure, price, and control risks in a comprehensive manner. Chapter 4 reviews the new BIS capital requirements for market risks and compares the "standardized approach" and the "internal models approach" that banks can use to report regulatory capital.

The topic of Chapters 5 and 6 is market risk measurement. We present the standard value-at-risk (VaR) approach. We also discuss some extensions of the VaR method: "incremental-VaR" and "delta-VaR" to isolate the component risks that contribute most to the total risk, "dynamic-VaR" to assess market and liquidity risks over a long time horizon, say a quarter, and "E-VaR," the expected loss in the tail, as an alternative risk measure to VaR. We also look at stress testing and scenario analysis to analyze extreme events that lie outside normal market conditions assumed by the standard VaR model. Finally, we discuss measurement errors and backtesting issues.

Chapters 7 to 12 cover credit risk. These six chapters constitute a unique and comprehensive coverage of topical credit risk-related issues: credit risk rating, credit risk measurement with a detailed presentation of the four industry-sponsored approaches

(credit migration, contingent claim, actuarial, and reduced form approaches), and credit mitigation techniques. Credit risk is currently the major risk to which banks are exposed, and yet techniques to model and mitigate credit risk are still in their infancy. Regulators with the new BIS Capital Adequacy Framework currently under discussion are setting new standards that will give a definitive competitive advantage to the banks that can achieve sophistication in credit risk assessment and credit risk management.

Chapter 13 proposes a framework for operational risk control. We describe four key steps in implementing bank operational risk, and highlight some means of risk reduction. Finally, we look at how a bank can extract value from enhanced operational risk management by improving its capital attribution methodologies.

Chapter 14 is devoted to capital allocation and performance measurement. This chapter presents the Risk Adjusted Return on Capital (RAROC) analysis to measure performance and allocate economic capital. It provides managers with the information they need to make the trade-off between risk and reward more efficient.

Chapter 15 elaborates on "model risk," that is, the special risk that arises when an institution uses mathematical models to value and hedge securities. We discuss some classic examples of what can go wrong when trading strategies are built on theoretical valuation models.

Chapter 16 is on risk management for nonfinancial corporations. In this chapter we discuss in detail the pros and cons of modern risk management techniques as applied to nonbank corporations. The relevant question is not whether corporations should engage in risk management but, rather, how they can manage risk in a rational way. We also discuss some new accounting standards that have been introduced to deal with the derivative and hedging activities of corporations.

Chapter 17 presents our views on risk management in the future. In this chapter we look at how risk management will be induced—and facilitated—by advances in technology, the introduction of more sophisticated regulatory measures, rapidly accelerating market forces, and an increasingly complex legal environment.

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We would like to extend our debt of gratitude to our outstanding editor Robert Jameson for the many valuable suggestions that substantially shaped the book, and to Catherine Schwent, acquisitions editor at McGraw-Hill, for her devotion and patience. Our special thanks go to all those that provided administrative and typing assistance. They have done a wonderful job considering the tough clients they had to serve. Parts of the book appeared previously in the working paper series of the Global Analytics group at CIBC and in a variety of journals, books, and specialized risk publications over the past many years.

Michel Crouhy

Dan Galai

Robert Mark

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