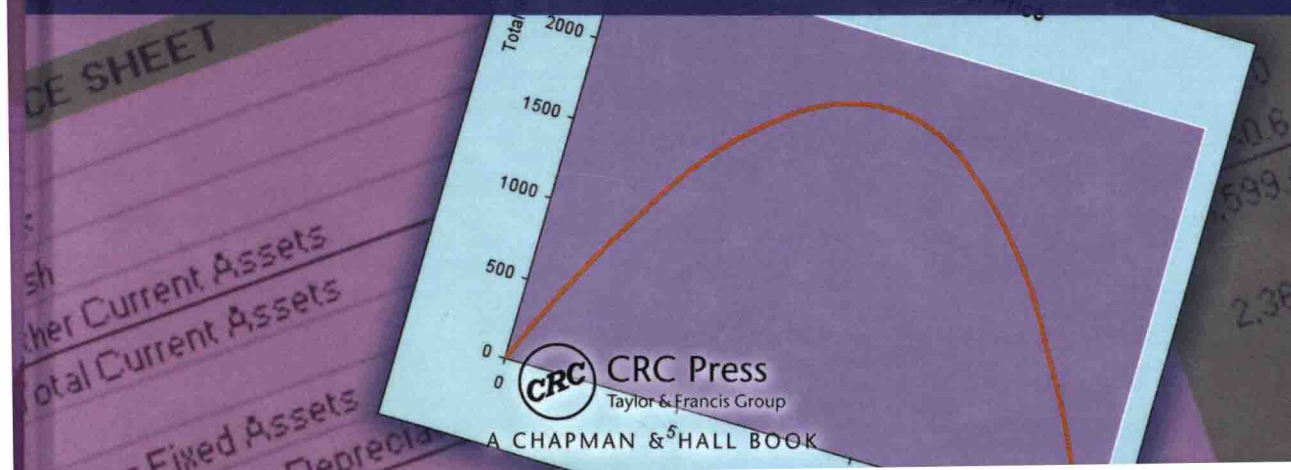
SECOND EDITION

Introduction to Financial Models for Management and Planning

James R. Morris
John P. Daley



CRC Press
Taylor & Francis Group
A CHAPMAN & HALL BOOK

Introduction to Financial Models for Management and Planning

Second Edition

James R. Morris and John P. Daley

CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business
A CHAPMAN & HALL BOOK

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works

Printed on acid-free paper

International Standard Book Number-13: 978-1-4987-6503-9 (Hardback)

Library of Congress Cataloging-in-Publication Data

Names: Morris, James R. (James Russell), 1944- author. | Daley, John P., author.
Title: Introduction to financial models for management and planning / James R. Morris and John P. Daley.
Description: Second edition. | Boca Raton : CRC Press, [2016] | Includes bibliographical references and index.
Identifiers: LCCN 2016046849| ISBN 9781498765039 (hardback : alk. paper) | ISBN 9781498765046 (ebook) | ISBN 9781498765060 (ebook)
Subjects: LCSH: Corporations--Finance--Computer simulation. | Corporations--Finance--Mathematical models. | Finance--Computer simulation. | Finance--Mathematical models.
Classification: LCC HG4012.5 .M673 2016 | DDC 658.1501/5195--dc23
LC record available at https://lccn.loc.gov/2016046849

Visit the Taylor & Francis Web site at
http://www.taylorandfrancis.com

and the CRC Press Web site at
http://www.crcpress.com

Printed and bound in the United States of America by Sheridan Books, Inc. (a Sheridan Group Company).

To my family: JAM, RSM, and KDM.
Thanks for your love and support.

—Jim

To my wife and partner for life, Cynthia. Her untiring support made my contribution possible.

—John

Preface to the Second Edition

This book is an introduction to the fascinating world of corporate financial modeling. It offers an overview of the power and flexibility of financial models and their role in financial planning. This book is intended for financial managers who wish to improve their financial decision making and for students who wish to become financial managers. In our increasingly complex world, the relationships between the choices faced by a manager and their subsequent outcomes have been obscured. A properly structured financial model can take into account much of this increased complexity and provide decision makers with a powerful planning tool, one that helps them identify the consequences of their decisions before they are put into practice.

The purpose of this book is to help the reader learn how to develop and use computer-based models for financial planning. By financial planning we mean planning the investment and financing decisions for a firm. We provide the reader with tools for his or her financial toolbox, and then show how to use those tools to build models. Throughout this book, we emphasize the structure of the models—models consistent with the theory of finance that are practical and usable. It is not the intent of this book to instruct the reader about the various software programs that we use. It is assumed that the reader either knows how to use most of the software or can find software instruction from other sources.

The main focus of this book is on modeling the problems of financial management, those associated with the planning and decisions faced by a firm's financial manager. Even though our primary emphasis is on models related to corporate financial management, we also introduce the reader to a variety of models related to security markets, stock and bond investments, portfolio management, and options.

This book introduces tools that relate to the financial management of the operating business. These tools include interactive cash budgets, dynamic pro forma financial statements that balance even under the most extreme assumptions, valuation techniques, forecasting techniques that range from simple averages to time series methods, Monte Carlo simulation, linear programming, and optimization. The toolbox is used to solve the problems of planning the firm's investment and financing decisions that lend themselves to financial modeling. These include evaluating capital projects, planning the financing mix for new investments, capital budgeting under capital constraints, optimal capital structure, cash budgeting, working capital management, mergers and acquisitions, and constructing efficient security portfolios.

One particularly valuable aspect of this book is that we continually focus the models on firm valuation. It makes little sense to build a financial model unless it provides a link between the decision being analyzed and the desired objective. Maximizing firm value is our objective; financial theory supplies the links. Therefore, firm value is the nexus of a model structure and the theory of finance.

An ancillary benefit of our focus on firm value is that by developing models that include valuation sectors, the reader learns about the theory of valuation and how to apply it to practical problems—how to build models that are consistent with the theory of valuation and simultaneously enhance one's understanding about how numerous financial decisions influence firm value.

One of the challenges of writing a book such as this is deciding what to include and what to exclude. As we wrote each chapter, we would say to ourselves, "but we did not cover this topic, and we need to elaborate on that." However, if we covered all the great topics in finance that were amenable to modeling, we would have to write several volumes. Unfortunately, we had to leave more out than we could include. The primary consideration about what to include was what volume of material could be covered in a one-semester university course. In addition, the topics chosen were primarily the corporate financial management topics that the student is likely to face in the environment of financial management. In each case, our coverage and models can only scratch the surface. For the material we have included in this text, the intent is to teach the student about building models, enough to get him or her started. Later he or she can provide the necessary details and elaborations as his or her professional tasks require.

ORGANIZATION

This book is organized into five major sections. Section I (Chapters 2 and 3) introduces the *tools* for financial planning. These include basic financial analysis (Chapter 2) and the different concepts of cash flow and growth (Chapter 3).

Section II explains the structure of a financial simulation model (Chapter 4), the equity and invested capital approaches to valuation (Chapter 5), and Monte Carlo simulation (Chapter 6). Chapter 4, "Financial Statement Simulation," is the core of this book. In it we explain the structure of a financial statement simulation model. The student learns how to develop a simple flexible model that balances under all scenarios with a structure that is consistent with the theory of finance. Valuation is a focus for most of our models, and it is important to link decisions to value. Chapter 5 shows how to model the value of equity and deals with more specialized questions such as how to model value per share for a firm that is issuing new equity.

One problem with basic financial models is that they produce point estimates of their objective, be it intrinsic value, internal rate of return, or any number of other measures of financial performance. Such point estimates hide the uncertainty lurking beneath them. We introduce Monte Carlo simulation in Chapter 6 to make this implicit uncertainty explicit and then go on to show how it can be used to explore the consequences of our decisions. Although we noted earlier that this text is not intended to give software instruction, this chapter is an exception. As most students have not been exposed to Monte Carlo

simulation or the software necessary to perform it, we introduce the Monte Carlo software @RISK. With this diverse set of tools in hand, the student is equipped to proceed with the remaining chapters of this book. Access to @RISK software for Monte Carlo simulation is provided with this book.

Most financial planning models are driven by a forecast of a basic input variable such as sales. So an important part of modeling is an ability to develop a forecast. Section III (Chapters 7 through 9) is a practical introduction to methods for forecasting a firm's sales and costs. As forecasting is a discipline unto itself, the most that we can hope to accomplish in a few chapters in a book devoted to modeling is to introduce the reader to a few basic forecasting methods. Forecasting is introduced in Chapter 7 with simple time trend extrapolation methods. This chapter also discusses how to assess and compare the results of different forecasts. Chapter 8 shows how to use linear regression to develop structural econometric forecasts. We show how to relate the firm's sales to measures of economic activity such as gross domestic product (GDP) and interest rates.

Chapter 9 covers smoothing methods such as moving averages, exponential smoothing, and seasonal adjustment. At the end of each of these chapters, there are forecasting problems for student practice.

Section IV (Chapters 10 through 12) elaborates on the basic financial planning model of Chapter 4, adding details and explaining how to expand the model to deal with more specialized questions. Chapter 10 expands our coverage of valuation to the investment in long-term assets. It explains how fixed assets should be handled in the planning model, how to model the capital budgeting decision, and finally how to model the decision to acquire and merge with another firm. It presents extended examples and models for analyzing the capital budgeting decision and the merger decision.

Part of the problem of analyzing capital investment revolves around the financing of the project, so Chapter 11 deals with the financing decision and the firm's capital structure. The first part of this chapter continues with the investment project modeled in Chapter 10 and shows how to model its financial structure. Then, we use Monte Carlo simulation to show how to model a firm's optimal capital structure. The last section of this chapter provides models dealing with the more specialized topic of duration and debt swaps.

The last topic of Section IV is working capital in Chapter 12. Chapter 12 delves into the modeling of working capital accounts. We develop different models for managing cash, marketable securities, and receivables.

Section V is devoted to modeling investment securities and investment portfolios. Chapter 13 shows how to model security prices as a binomial process and as a random walk Weiner process. Armed with the models of security prices, Chapter 14 models the portfolio decision and shows how to construct a mean-variance efficient portfolio and model the efficient frontier. Chapter 15 explains basic option models using both the binomial model and the continuous time Black–Scholes model.

The last section, Section VI (Chapters 16 and 17), is about optimization—how to use linear programming to find the best investment and financing decisions. We introduce linear programming in Chapter 16 with a Weingartner type capital rationing model. We expand that model so that the student understands the transition from an investment model to a

complete planning model. Chapter 17 is devoted to the application of linear programming to working capital planning. We use an Orgler type model to show how to plan short-term investment and financing decisions. These optimization chapters provide the student with detailed help in using the Solver optimization add-in to Excel. Shortly after this book was published, the user interfaces for Excel and @RISK changed dramatically. As a result, many of the exhibits in the first edition were quickly out of date. This edition uses the latest versions of Excel (Office 2016) and @RISK (v.7). In addition, we added cash control decision variables that control the internal and external flows of free cash flow. Finally, we extend the coverage of valuation techniques to include time-varying market-value based costs of capital and both the equity cash flow and value of invested capital approaches to firm valuation.

HOW TO USE THIS BOOK IN THE UNIVERSITY SETTING

At the university level, this book can be used for a graduate level or advanced undergraduate level course in finance. Our course that uses this material is part of our MS-Finance program, after the students have taken courses in financial management, investments, statistics, and operations management.

As the methods of financial modeling are learned by practice and experience, we view a course in financial modeling as a learning-by-doing course. We seldom give examinations. We structure our financial modeling course around a set of problems that require the student to construct models that help with planning and decision making. The imperative is that the models should be consistent with the theory of finance. To fulfill this imperative, it is necessary for the student to combine financial theory with modeling. To do this, the student needs to review the theory and figure out how to apply it at a practical level in a model. The result is that the student learns the theory and, more importantly, learns how that theory is applied in the real world.

The problems in this text provide the opportunity to apply the text material to a comprehensive set of fairly realistic situations. The problems posed to the students require them to set up the models and solve them. By the end of the course, the students will have enhanced their skills and knowledge of spreadsheet software, statistical software and methods, Monte Carlo simulation, and optimization. These are valuable skills that are in demand by the businesses that employ our students.

The solutions provide insights into business problems, of course, but it is the model structuring process and the linking of financial theory to real world scenarios that provide the important lessons. Students learn how to make the links between the business problem and the structure of a planning model. The ability to develop the structure of the planning model is the most valuable feature of our course. At the end of the course, we consistently get very positive feedback from the students, with comments such as "this has been the most valuable course in my finance program," "I've learned more from this class than any other class in my MBA program," and "this class really helped to bring the material together from my various other courses." The students' struggle to develop functioning models brings together the disparate ideas and theories they have learned in their business education programs. It is in the integration of the areas of study that we also get very

favorable feedback from our students. We have had comments such as "this course forced me to review my other courses such as statistics, operations management, and marketing, and really helped me bring them together."

It would be very difficult to cover every chapter in this book in a semester. Indeed, we only cover the first 10 chapters in our course. It takes plenty of time to explain the concepts to the students, and the students spend a great deal of time outside of class building their models. In our course, we usually require the students to complete 6–10 of the larger end of chapter problems during a term. This is a heavy workload. Consequently, there is not really sufficient time in a typical semester to cover all the chapters and have the students do the extended problems that accompany each chapter.

The instructor is encouraged to pick and choose which topics will be covered during the term. It is not necessary to cover all of the chapters, nor is it necessary to cover them in sequence. Most of the chapters stand on their own. However, the key chapters are as follows: the last section of Chapter 3 that covers sustainable growth; Chapter 4, financial statement simulation; Chapter 5, modeling value; and Chapter 6, Monte Carlo simulation. These chapters constitute the heart of the topic of financial modeling. They feed into material in the chapters that follow. If you cover these chapters, you can generally pick and choose the other chapters you cover without much loss of background or continuity.

The financial analysis Chapters 2 and 3 show the student how to set up models to analyze the firm's condition. In addition, Chapter 3 sets the stage for subsequent modeling chapters by explaining the details of cash flow and growth. Our students indicate that they think this material is valuable. However, if the students are already well versed in financial analysis and cash flow, these chapters can be skipped without losing much for understanding later chapters.

If students have already had substantial exposure to statistical forecasting methods, the forecasting Chapters 7 through 9, can be skipped. On the other hand, although most students have had a statistics course, the typical statistics course spends very little time on forecasting. Consequently, the students gain a lot from working the very practical problems in Chapters 7 through 9.

Most of chapter 10 is devoted to capital budgeting. This chapter and the problems give the student the opportunity to practice modeling the capital budgeting decision. However, most finance students have been exposed to these concepts in other courses. The last section of this chapter explains how to model a merger decision, and this is something students may not have covered elsewhere. Nevertheless, with scarce time, this chapter is not necessary for understanding subsequent material.

On the other hand, the debt financing chapter presents material many students have not been exposed to before. Of particular interest is the use of Monte Carlo simulation to analyze the debt financing decision. Although this chapter is not required for continuity, it is unique and is an important part of this book.

The security investment chapters in Section V are not necessary for continuity with other chapters, and this material can be covered independently of the earlier chapters. However, these topics are current, and students learn a lot by trying to model the concepts and methods they only see as theories in other courses. They may have learned about a

random walk, but it sinks in when the student builds a model. The same is true for the efficient frontier in Chapter 14 or options in Chapter 15.

Chapters 16 and 17 introduce optimization. As with any of the topics, if you have time, students should be exposed to these methods and get the opportunity to build the optimization models.

In a nutshell, this book offers you a wide variety of topics that are amenable to modeling. All are practical. It is not necessary to cover this book from start to finish. You have great flexibility to choose from the smorgasbord of topics according to the interests of the instructor and the students. Whichever topics you choose to cover, the students will learn the rudiments of building financial models in Excel and the theory underpinning those models. The exposure to modeling different decision problems and to different methods gives the student a foundation to approach the wide variety of modeling tasks that would be impossible to cover in a single volume.

A WORD ABOUT SOFTWARE

The software that we use for our modeling includes spreadsheets, statistics programs, the Solver add-in to Excel, and the Monte Carlo add-in, @RISK. We find that most of our students are already proficient in the basics of using spreadsheets such as Excel, and they typically have been exposed to statistical packages such as MiniTab, or perhaps E-Views or SPSS in their statistics courses. In addition, they may have had some exposure to linear programming software such as the Solver add-in to Excel.

However, most students have not been exposed to @RISK, which is the software used in the Monte Carlo section of the course. It is a useful tool for a wide variety of modeling applications. The @RISK add-in for Excel is one of the most valuable parts of this book. As noted at the back of this book, the purchaser of this book has access to a one-year license for a fully functional version of @RISK, along with the range of other companion software by Palisade.

As most students have been exposed to much of the software we use, we do not focus this book on teaching the software. We try to give some guidance and instruction in the software as we go along, but we do not provide elementary software instruction. If the student needs an elementary introduction to the standard software such as Excel, it is assumed that they can get this from another source. On the other hand, for the more specialized software such as Solver and @RISK, we provide basic instruction in the chapters where these tools are used.

Our financial modeling course is one of the most popular courses in our graduate finance program. Students complain about the workload, but at the end, they consistently have high praise for the experience and the fact that they have learned to build a wide variety of very applicable models. We hope you will find this material equally valuable.

FOR THE INSTRUCTOR

At the end of each chapter, we have exercises for the students. Most of these are substantial problems that ask the student to build the models discussed in the chapter. All of the data

and the solutions to the problems are included in the instructor's disk. Although most of the data for the problems are shown with the problem at the back of the chapter, these data are included in the instructor's disk so that it can be given to the students without them having to copy all the data from the text. In addition, we have developed an extensive library of other problems plus solutions that are available on the instructor's disk. Many instructors will find ways to improve on our problems. We would invite you to share your problem sets with us so that they can be used widely. Finally, we have tried to eliminate mistakes in our text. However, inevitably there is much that we did not find and correct. We would appreciate corrections and suggestions for improvement.

Thank you for using our book. We hope that you find it instructive and useful.

—James R. Morris and John P. Daley

Authors

James R. Morris is a professor emeritus of finance at the University of Colorado, Denver, Colorado. He received his BS, MBA, and PhD degrees from the University of California, Berkeley, California. He has served previously on the faculties of the University of Houston, Houston, Texas, and the Wharton School of the University of Pennsylvania, Pennsylvania, Philadelphia. He has published research papers dealing with capital structure, cost of capital, working capital management, financial modeling, and firm valuation in top academic journals such as *Journal of Finance*, *Journal of Financial & Quantitative Analysis*, and *Management Science*. In addition, he is accredited in business valuation by the American Society of Appraisers and has published in its practitioner journal, *Business Valuation Review*.

John P. Daley is a senior instructor at the University of Colorado, Denver, Colorado, where he has been teaching finance and, more recently, risk management since 1999. He has earned the degrees of AB in psychology from Stanford University, Stanford, California, MM in trombone from the University of Southern California, Los Angeles, MBA from the University of Colorado, Denver, and PhD in finance and business economics from the University of Washington, Washington, Seattle. In 2010, he retired from his position as the principal trombone of the Colorado Symphony Orchestra, a position he had held since 1978.