英文版

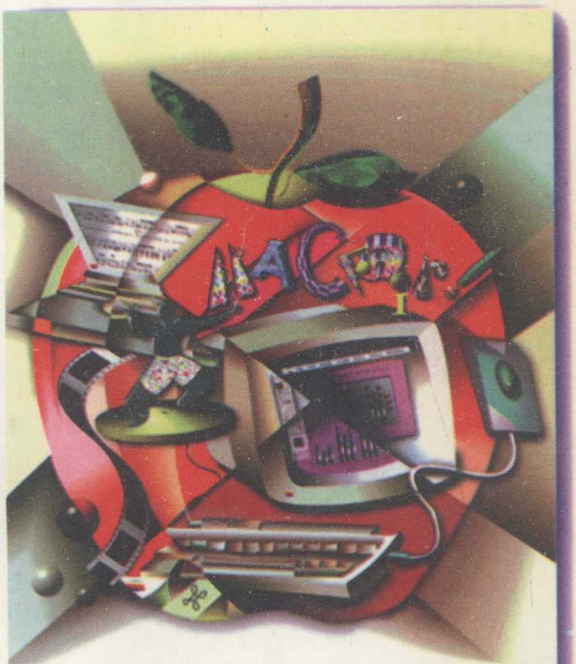
财务与会计系列

公司理财基础（第四版）

FUNDAMENTALS OF CORPORATE FINANCE

(FOURTH EDITION)

STEPHEN A. ROSS
RANDOLPH W. WESTERFIELD
BRADFORD D. JORDAN



世界财经与管理教材大系

东北财经大学出版社
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世界财经与管理教材大系

财务与会计系列·英文

公司理财基础

（第四版）

Fundamentals of Corporate Finance
Fourth Edition

斯蒂芬·A. 罗斯
伦道夫·W. 韦斯特菲尔德
布拉德福德·D. 乔丹

Stephen A. Ross
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Bradford D. Jordan

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出 版 者 的 话

但凡成事，均缘于势。得势则事成，失势则事不顺。顺势而行，如顺水行舟；借势而动，如假梯登高；造势而为，如太空揽月。治学、从政、经商、置业，均不可一日失势。势者，长处、趋势也。

今日中国，是开放的中国；当今世界，是开放的世界。改革开放，大势所趋，势不可挡。经济开放、文化开放、政治开放，世界需要一个开放的中国，中国更要融入开放的世界。借鉴国际惯例，学习他人之长，已经到了不可不为之时。

借鉴国际惯例，学习他人之长，已属老生常谈，但学什么、如何学、以何为蓝本为众多志士仁人所关注。可喜的是，由赤诚图文信息有限公司精心策划，ITP、McGraw-Hill 及 Simon & Schuster 等国际出版公司特别授权，东北财经大学出版社荣誉出版的“世界财经与管理教材大系”现已隆重面世！她以“紧扣三个面向，精选五大系列，奉献百部名著，造就亿万英才”的博大胸襟和恢弘气势，囊括经济学、管理学、财务与会计学、市场营销学、商务与法律等财经、管理类主干学科，并根据大学教育、研究生教育、工商管理硕士（MBA）和经理人员培训项目（ETP）等不同层次的需要，相应遴选了具有针对性的教材，可谓体系完整，蔚为大观。所选图书多为哈佛、斯坦福、麻省理工、伦敦商学院、埃维商学院等世界一流名校的顶尖教授、权威学者的经典之作，在西方发达国家备受推崇，被广为采用，经久不衰，大有“洛阳纸贵”之势。

借鉴国际惯例，毕竟只是因势而动；推出国粹精品，才是造势而为。在借鉴与学习的同时，更重要的是弘扬民族精神，创建民族文化。“民族的，才是国际的”。我们提倡学他人之长，但更希望立自己之势。

势缘何物，势乃人为。识人、用人、育人、成人，乃人本之真谛。育人才、成能人，则可造大势。育人、成人之根本在教育，教育之要件在教材，教材之基础在出版。换言之，人本之基础在书本。

凡事均需讲效益，所谓成事，亦即有效。高效可造宏基，无效难以为继，此乃事物发展之规律。基于此，我们崇尚出好书、出人才、出效益！

东北财经大学出版社

1998 年 8 月

intheirownwords

CHAPTER 1

Clifford Smith Jr., *University of Rochester*
On Market Incentives for Ethical Behavior

CHAPTER 4

Robert C. Higgins, *University of Washington*
On Sustainable Growth

CHAPTER 7

Edward I. Altman, *New York University*
On Junk Bonds

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Samuel Weaver, *Hershey Chocolate North America*
On Capital Budgeting at Hershey Foods Corporation

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On Capital Market History

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CHAPTER 17

Fischer Black
On Why Firms Pay Dividends

Stephen A. Ross
Sterling Professor of Economics and Finance
Yale University
Consulting Editor

Irwin McGraw-Hill

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Flannery and Flood's ProBanker:
A Financial Services Simulation

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Studies in Financial Institutions:
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Sirmans
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International Risk and Insurance

Williams, Smith and Young
Risk Management and Insurance
Eighth Edition

Dedication

To our families and friends with love and gratitude.

S.A.R. R.W.W. B.D.J.

abouttheauthors

Stephen A. Ross, Yale University

Stephen A. Ross has held the position of Sterling Professor of Economics and Finance at Yale University since 1985. One of the most widely published authors in finance and economics, Professor Ross is recognized for his work in developing the Arbitrage Pricing Theory. He has also made substantial contributions to the discipline through his research in signaling, agency theory, portfolio theory, derivatives, and the theory of the term structure of interest rates. Previously the president of the American Finance Association, he serves as an associate editor of the *Journal of Finance* and the *Journal of Economic Theory*. He is co-chairman of Roll and Ross Asset Management Corporation, a trustee of Cal Tech, a director of CREF, and a director of GenRe.

Randolph W. Westerfield, University of Southern California

Randolph W. Westerfield is Dean of the University of Southern California's Marshall School of Business and holder of the Robert R. Dockson Dean's Chair of Business Administration.

From 1988 to 1993, Professor Westerfield served as the chairman of the School's finance and business economics department and the Charles B. Thornton Professor of Finance. He came to USC from The Wharton School, University of Pennsylvania, where he was the chairman of the finance department and member of the finance faculty for 20 years. He was the senior research associate at the Rodney L. White Center for Financial Research at Wharton. His areas of expertise include corporate financial policy, investment management and analysis, mergers and acquisitions, and stock market price behavior.

Professor Westerfield has served as a member of the Continental Bank trust committee, supervising all activities of the trust department. He has been consultant to a number of corporations, including AT&T, Mobil Oil and Pacific Enterprises, as well as to the United Nations, the U.S. Departments of Justice and Labor, and the State of California.

Bradford D. Jordan, University of Kentucky

Bradford D. Jordan is Ashland Oil Research Professor of Finance at the University of Kentucky. He has a long-standing interest in both applied and theoretical issues in corporate finance, and he has extensive experience teaching all levels of corporate finance and financial management policy. Professor Jordan has published numerous articles on issues such as cost of capital, capital structure, and the behavior of security prices.

fromtheauthors

When the three of us decided to write a book, we were united by one strongly held principle: Corporate finance should be developed in terms of a few integrated, powerful ideas. We felt that the subject was all too often presented as a collection of loosely related topics, unified primarily by virtue of being bound together in one book, and we thought there must be a better way.

One thing we knew for certain was that we didn't want to write a "me-too" book. So, with a lot of help, we took a hard look at what was truly important and useful. In doing so, we were led to eliminate topics of dubious relevance, downplay purely theoretical issues, and minimize the use of extensive and elaborate calculations to illustrate points that are either intuitively obvious or of limited practical use.

As a result of this process, three basic themes became our central focus in writing *Fundamentals of Corporate Finance*:

- **An Emphasis on Intuition.** We always try to separate and explain the principles at work on a common sense, intuitive level before launching into any specifics. The underlying ideas are discussed first in very general terms and then by way of examples that illustrate in more concrete terms how a financial manager might proceed in a given situation.
- **A Unified Valuation Approach.** We treat net present value (NPV) as the basic concept underlying corporate finance. Many texts stop well short of consistently integrating this important principle. The most basic and important notion, that NPV represents the excess of market value over cost, often is lost in an overly mechanical approach that emphasizes computation at the expense of comprehension. In contrast, every subject we cover is firmly rooted in valuation, and care is taken throughout to explain how particular decisions have valuation effects.
- **A Managerial Focus.** Students shouldn't lose sight of the fact that financial management concerns management. We emphasize the role of the financial manager as decision maker, and we stress the need for managerial input and judgment. We consciously avoid "black box" approaches to finance, and, where appropriate, the approximate, pragmatic nature of financial analysis is made explicit, possible pitfalls are described, and limitations are discussed.

In retrospect, looking back to our 1991 first edition IPO, we had the same hopes and fears as any entrepreneurs. How would we be received in the market? At the time, we had no idea that just seven years later, we would be working on a fourth edition. We certainly never dreamed that in those years we would work with friends and colleagues from around the world to publish country-specific Australian, Canadian, and South African editions, an International edition, Chinese and Spanish language editions, and an entirely separate book, *Essentials of Corporate Finance*.

Today, as we prepare to once more enter the market, our goal is to stick with the basic principles that have brought us this far. However, based on an enormous amount of feedback we have received from you and your colleagues, we have made many additions and improvements to this edition. These improvements are described in the next several pages of this preface.

Stephen A. Ross

Randolph W. Westerfield

Bradford D. Jordan

fromthepublisher

It is with great pleasure that we at Irwin/McGraw-Hill introduce Ross, Westerfield, and Jordan, *Fundamentals of Corporate Finance*, Fourth Edition. Over the past eight years, *Fundamentals* has become one of the mostly widely used finance texts in the world. There are many reasons for this success, which we hope to capture in the following pages of this preface. But first, we'd like to thank those instructors and students who participated in the RWJ Tour. It has been a great success - with many of you taking time to examine the Fourth Edition, having your students participate as well, and ultimately deciding to switch to *Fundamentals!* We thank each of you for your time.

And if you didn't take the RWJ Tour, here's your opportunity to tour the new Fourth Edition. We're confident you'll be pleased with the numerous features and enhancements of this edition. **Enjoy!**

Gina M. Huck

Gina M. Huck
Senior Sponsoring Editor

Katie Rose Matthews

Katie Rose Matthews
Senior Marketing Manager

INTENDED AUDIENCE

The authors designed and developed this book explicitly for a first course in business or corporate finance. The typical student will not have previously taken a course in finance, and no previous knowledge of finance is assumed. Since this course is frequently part of a common business core, the text is intended for majors and non-majors alike. In terms of background or prerequisites, the book is nearly self-contained. Some familiarity with basic accounting principles is assumed, but even these are reviewed very early on. The only other tool the student needs is basic algebra. As a result, students with very different backgrounds will find the text very accessible.

COVERAGE

From the start, *Fundamentals of Corporate Finance* contained innovative coverage on a wide variety of subjects. For example, Chapter 2 introduces the cash flow identity, the key to understanding what cash flow really means. Chapter 4 on long-term financial planning contains a thorough discussion of the sustainable growth rate as a planning tool. Chapter 11 on project analysis and evaluation contains an extensive discussion on how to evaluate NPV estimates. Chapter 12 on capital market history discusses in detail the famous Ibbotson-Sinquefield study and the nature of capital market risks and returns. Chapter 15 on selling securities to the public provides a modern, up-to-date discussion of IPOs and the costs of going public. International Corporate Finance (Chapter 21, Standard Edition; Chapter 25, Alternate Edition) introduces the global economy. It covers key international relationships and their valuation effects. Chapter 21, Alternate Edition, on Risk Management presents material on this increasingly important topic at a level appropriate for an introductory class.

ORGANIZATION OF THE TEXT

Based on their extensive teaching experience, the authors know that the phrase "so much to do, so little time" accurately describes an introductory finance course. For this reason, they designed *Fundamentals of Corporate Finance* to be as flexible and modular as possible. There are a total of eight parts in the Standard edition (nine in the Alternate edition), and, in broad terms, the instructor is free to decide the particular sequence. Further, within each part, the first chapter generally contains an overview and survey. Thus, when time is limited, subsequent chapters can be omitted. Finally, the sections placed early in each chapter are generally the most important, and later sections frequently can be omitted without loss of continuity. For these reasons, the instructor has great control over the topics covered, the sequence in which they are covered, and the depth of coverage.

Part One of the text contains two chapters. Chapter 1 considers the goal of the corporation, the corporate form of organization, the agency problem, and, briefly, financial markets. Chapter 2 succinctly discusses cash flow versus accounting income, market value versus book value, and taxes. It also provides a useful review of financial statements. After Part One, either Part Two, on financial statements analysis, long-range planning, and corporate growth, or Part Three, on time value and stock and bond valuation, follows naturally. Part Two can be omitted entirely if desired. After Part Three, most instructors will probably want to move directly into Part Four, which covers net present value, discounted cash flow valuation, and capital budgeting.

Part Five contains two chapters on risk and return. The first one, on market history, is designed to give students a feel for typical rates of return on risky assets. The second one discusses the expected return/risk trade-off, and it develops the security market line in a highly intuitive way that bypasses much of the usual portfolio theory and statistics. The first chapter of Part Six covers cost of capital, followed by chapters on raising capital, capital structure, and dividend policy. The chapter on dividends can be covered independently, if desired, and the chapter on capital structure can be omitted without creating loss of continuity.

Part Seven covers issues in short-term financial management. The first of the three chapters is a general survey of short-term financial management, which is very useful when time does not permit a more in-depth treatment. The next two chapters provide greater detail on cash, credit, and inventory management.

In the Standard edition, Part Eight contains a single chapter on international finance which concludes the text. In the Alternate edition, Part Eight contains two chapters dealing with risk management and options. Part Nine in the Alternate edition contains coverage of important topics including mergers, leasing, and international finance.

fourconvenientversions... maximumflexibility!

To provide instructors with maximum flexibility, the Fourth Edition of Fundamentals of Corporate Finance is available in a variety of convenient versions:

1 Standard Edition (21 chapters);

2 Alternate Edition (25 chapters);

3 The Wall Street Journal Edition (Standard Edition); and

4 The Wall Street Journal Edition (Alternate Edition).

(Of course, we'll continue to provide an Annotated Instructor's Edition for your convenience.)

As you can see from the Table of Contents shown here, the Standard Edition includes 21 key chapters for the introductory course, while the Alternate Edition includes a more expansive selection of topics (see Parts VIII and IX). Take a look for yourself, and see which option best fits your teaching needs!

RWJ Standard Edition Contents

Standard Edition
Alternate Edition
The Wall Street Journal Editions: Standard and Alternate

RWJ Alternate Edition Additional Chapters

RWJ Standard Edition Features

- **21 chapters cover the key topics for your introductory course.**
- **Proven organizational framework!**

New! Time Value of Money is broken into two accessible chapters (Chapters 5 & 6)—enabling students to follow a well-paced, building-block approach to this difficult concept.

New! Stocks and bonds are now covered in two separate chapters (Chapters 7 & 8). Chapter 7 includes all new material on bond yields and the term structure of interest rates, while Chapter 8 contains enhanced treatment of stock markets and their operation.

Enhanced! Based on reviewer feedback, Cost of Capital (Chapter 14) now follows the Risk & Return coverage (Chapters 12 & 13). Former Chapter 12 on Long-Term Financing was eliminated, with material integrated into Chapters 7, 8 and 15. Retitled Chapter 15 now includes coverage of the venture capital process.

RWJ Alternate Edition Features

- **25 chapters designed to provide maximum flexibility!**
- **Chapters 21-24 are unique to the Alternate Edition – providing you with coverage of additional finance topics, if desired.**

The Wall Street Journal Editions

- **For a description of this unique offering, see page xix of this Preface.**

attention to pedagogy

Check out these Fourth Edition enhancements – found in all versions of the text

New! *Chapter-opening vignettes* from real-world events introduce students to the chapter concepts. Questions about this vignette are posed to the reader to ensure understanding of the concepts at chapter's end. Check out these engaging applications (see Chapter 5, page 112; Chapter 6; page 132; Chapter 9, page 232; and Chapter 13, page 366).

Eastman Kodak dominates the U.S. market for photo film and related products. Fuji Film, a Japanese manufacturer, is Kodak's major international competitor, and Fuji dominates the Japanese market. Each wants to gain market share in the other's country. In 1996, Fuji took a big step, investing $100 million in a Greenwood, South Carolina, plant that will take raw Fuji film imported from the Netherlands and cut, spool, and package it for sale in the United States. The plant initially will package 5 million rolls of film a month, expanding to package more than 10 million rolls a month in 1997.

Fuji's decision is an example of a capital budgeting decision. Spending $100 million to build a plant in another country, especially one with a competitor as formidable as Kodak, is obviously a major undertaking, and the potential risks and rewards must be carefully weighed. In this chapter, we discuss the basic tools used in making such decisions.

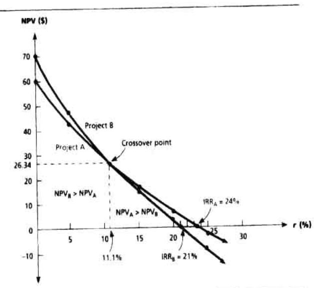
In Chapter 1, we identified the three key areas of concern to the financial manager. The first of these involved the question: What fixed assets should we buy? We called this the *capital budgeting decision*. In this chapter, we begin to deal with the issues that arise in answering this question.

The process of allocating or budgeting capital is usually more involved than just deciding on whether or not to buy a particular fixed asset. We will frequently face broader issues like whether or not we should launch a new product or enter a new

Pedagogical use of color. This learning tool continues to be an important feature of Fundamentals of Corporate Finance. In almost every chapter, color plays an extensive and largely self-evident role. A guide to the functional use of color is found on the endsheets of both the Annotated Instructor's Edition (AIE) and student version.

FIGURE 9.8

NPV profiles for mutually exclusive investments



Year	Investment A	Investment B
0	$400	-$500
1	250	320
2	280	340

What's the crossover rate?

To find the crossover, first consider moving out of Investment A and into Investment B. If you make the move, you'll have to invest an extra $100 ($500 − 400). For this $100 investment, you'll get an extra $70 ($320 − 250) in the first year and an extra $60 ($340 − 280) in the second year. Is this a good move? In other words, is it worth investing the extra $100?

Based on our discussion, the NPV of the switch, NVP(B − A) is:

$$NPV(B - A) = -\$100 + [70/(1 + r)] + [60/(1 + r)^2]$$

In addition to illustrating pertinent concepts and presenting up-to-date coverage, Fundamentals of Corporate Finance strives to present the material in a way that makes it coherent and easy to understand. To meet the varied needs of the intended audience, Fundamentals of Corporate Finance is rich in valuable learning tools and support.

In Their Own Words boxes. Located throughout the Fourth Edition, this popular, unique series consists of articles written by distinguished scholars or practitioners on key topics in the text. Boxes include essays by Merton Miller on capital structure, Fischer Black on dividends, and Roger Ibbotson on capital market history. A complete list of "In Their Own Words" boxes appears on page xxxii.

IN THEIR OWN WORDS . . .

Clifford W. Smith Jr. on Market Incentives for Ethical Behavior

Ethics is a topic that has been receiving increased interest in the business community. Much of this discussion has been led by philosophers and has focused on moral principles. Rather than review these issues, I want to discuss a complementary (but often ignored) set of issues from an economist's viewpoint. Markets impose potentially substantial costs on individua... ...tions that engage

Second, the higher the sanctions imposed if cheating is detected, the less likely an individual is to cheat. Hence, a business transaction that is expected to be repeated between the same parties faces a lower probability of cheating because the lost profits from the forgone stream of future sales provide powerful incentives for contract compliance. However, if conti... corporate exis... is

if disclosed in the United States would be labeled a bribe might be viewed as a standard business practice in a third-world market. The costs imposed will be higher the greater the consensus that the behavior was unethical.

Establishing and maintaining a reputation for ethical behavior is a valuable corporate asset in the business community. This analysis suggests that a firm co... about the ethical con-

Enhanced! *Real-world examples* are integrated throughout the text—tying chapter concepts to real life through illustration and reinforcing the relevance of the material. Some examples tie into the Chapter-Opening Vignette for added reinforcement.

CHAPTER 3 • Working with Financial Statements 67

General Motors provides a good example of how Du Pont analysis can be very useful and also illustrates why care must be taken in interpreting ROE values. In 1989, GM had an ROE of 12.1 percent. By 1993, its ROE had improved to 44.1 percent, a dramatic improvement. On closer inspection, however, we find that, over the same period, GM's profit margin had declined from 3.4 to 1.8 percent, and ROA had declined from 2.4 to 1.3 percent. The decline in ROA was moderated only slightly by an increase in total asset turnover from .71 to .73 over the period.

Given this information, how is it possible for GM's ROE to have climbed so sharply? From our understanding of the Du Pont identity, it must be the case that GM's equity multiplier increased substantially. In fact, what happened was that GM's book equity value was almost wiped out overnight in 1992 by changes in the accounting treatment of pension liabilities. If a company's equity value declines sharply, its equity multiplier rises. In GM's case, the multiplier went from 4.95 in 1989 to 33.62 in 1993. In sum, the dramatic "improvement" in GM's ROE was al-

Concept Building. Chapter sections are intentionally kept short to promote a step-by-step, building block approach to learning. Each section is then followed by a series of short concept questions that highlight the key ideas just presented. Students use these questions to make sure they can identify and understand the most important concepts as they read through the chapter.

Summary Tables. These tables succinctly restate key principles, results, and equations. They appear whenever it is useful to emphasize and summarize a group of related concepts.

TABLE 2.5

Cash flow summary

I. The cash flow identity

Cash flow from assets = Cash flow to creditors (bondholders)
+ Cash flow to stockholders (owners)

II. Cash flow from assets

Cash flow from assets = Operating cash flow
− Net capital spending
− Change in net working capital (NWC)

where

Operating cash flow = Earnings before interest and taxes (EBIT)
+ Depreciation − Taxes

Net capital spending = Ending net fixed assets − Beginning net fixed assets
+ Depreciation

Change in NWC = Ending NWC − Beginning NWC

III. Cash flow to creditors (bondholders)

Cash flow to creditors = Interest paid − Net new borrowing

IV. Cash flow to stockholders (owners)

Cash flow to stockholders = Dividends paid − Net new equity raised

Labeled Examples. Separate numbered and titled examples are extensively integrated into the chapters as indicated below. These examples provide detailed applications and illustrations of the text material in a step-by-step format. Each example is completely self-contained so students don't have to search for additional information. Based on our classroom testing, these examples are among the most useful learning aids because they provide both detail and explanation.

There are tables for present value factors just as there are tables for future value factors, and you use them in the same way (if you use them at all). Table 5.3 contains a small set. A much larger set can be found in Table A.2 in the book's appendix.

In Table 5.3, the discount factor we just calculated (.6575) can be found by looking down the column labeled "15%" until you come to the third row.

Example 5.7 Deceptive Advertising?

Recently, some businesses have been saying things like "Come try our product. If you do, we'll give you $100 just for coming by!" If you read the fine print, what you find out is that they will give you a savings certificate that will pay you $100 in 25 years or so. If the going interest rate on such certificates is 10 percent per year, how much are they really giving you today?

Key Terms. Key Terms are printed in blue type and defined within the text the first time they appear. They also appear in the margin with the definition for easy location and identification by the student.

Key Equations. Called out in the text, key equations are identified by a blue equation number. The list in Appendix B shows the key equations by chapter, providing students with a convenient reference.

Highlighted Concepts. Throughout the text, important ideas are pulled out and presented in a gold box—signaling to students that this material is particularly relevant and critical for their understanding.

9.3 The Discounted Payback

discounted payback period
The length of time required for an investment's discounted cash flows to equal its initial cost.

We saw that one of the shortcomings of the payback period rule was that it ignored time value. There is a variation of the payback period, the discounted payback period, that fixes this particular problem. The **discounted payback period** is the length of time until the sum of the discounted cash flows is equal to the initial investment. The *discounted payback rule* would be:

Based on the discounted payback rule, an investment is acceptable if its discounted payback is less than some prespecified number of years.

Chapter Summary and Conclusions. Every chapter ends with a concise, but thorough, summary of the important ideas—helping students review the key points and providing closure to the chapter.

Chapter Review and Self-Test Problems. Appearing after the Summary and Conclusions, each chapter includes a Chapter Review and Self-Test Problem section. These questions and answers allow students to test their abilities in solving key problems related to the chapter content and provide instant reinforcement.

New! Concepts Review and Critical Thinking Questions. This new end-of-chapter section facilitates your students' knowledge of key principles, as well as their intuitive understanding of the chapter concepts. A number of the questions relate to the chapter-opening vignette—reinforcing student critical-thinking skills and the learning of chapter material.

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. What effect would the following actions have on a firm's current ratio? Assume that net working capital is positive.
   a. Inventory is purchased.
   b. A supplier is paid.
   c. A short-term bank loan is repaid.
   d. A long-term debt is paid off early.
   e. A customer pays off a credit account.
   f. Inventory is sold at cost.
   g. Inventory is sold for a profit.
2. In recent years, Dixie Co. has greatly increased its current ratio. At the same time, the quick ratio has fallen. What has happened? Has the liquidity of the company improved?

End-of-Chapter Questions and Problems. The authors have found that many students learn better when they have plenty of opportunity to practice; therefore, extensive end-of-chapter questions and problems are provided. The end-of-chapter support greatly exceeds what is typical in an introductory textbook. The questions and problems are segregated into three learning levels: Basic, Intermediate, and Challenge. All problems are fully annotated so that students and instructors can readily identify particular types. Throughout the text, the authors have worked to supply interesting problems that illustrate real-world applications of chapter material. Answers to selected end-of-chapter material appear in Appendix C in both the student and AIE versions. The AIE includes the final answer as an annotation next to the problem.

QUESTIONS AND PROBLEMS

Basic
(Questions 1–18)

1. **Calculating Payback** What is the payback period for the following set of cash flows?

Year	Cash Flow
0	−$1,000
1	400
2	1,600
3	700
4	300

5. **Calculating Discounted Payback** An investment project costs $4,000 and has annual cash flows of $1,100 for five years. What is the discounted payback period if the discount rate is zero percent? What if the discount rate is 5 percent? If it is 15 percent?

Intermediate
(Questions 19–20)

19. **NPV and the Profitability Index** If we define the NPV index as the ratio of NPV to cost, what is the relationship between this index and the profitability index?
20. **Cash Flow Intuition** A project has an initial cost of I, a required return of r, and pays C annually for N years.
    a. Find C in terms of I and N such that the project has a payback period just equal to its life.
    b. Find C in terms of I, N, and r such that this is a profitable project according to the NPV decision rule.
    c. Find C in terms of I, N, and r such that the project has a benefit-cost ratio of 2.

Challenge
(Questions 21–23)

21. **Payback and NPV** An investment under consideration has a payback of six years and a cost of $150,000. If the required return is 12 percent, what is the worst-case NPV? The best-case NPV? Explain.
22. **Multiple IRRs** This problem is useful for testing the ability of financial calculators and computer software. Consider the following cash flows. How many different IRRs are there (hint: search between 20 percent and 70 percent)? When should we take this project?

Year	Cash Flow
0	−$ 252
1	1,431
2	− 3,035
3	2,850
4	− 1,000