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CONTEMPORARY ENGINEERING ECONOMICS

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For Sophie and Alexander

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PREFACE

What is "Contemporary" About Engineering Economics?

Decisions made during the engineering design phase of product development determine the majority of the costs associated with the manufacturing of that product (some say that this value may be as high as 85%). As design and manufacturing processes become more complex, engineers are making decisions that involve money more than ever before. Thus, the competent and successful engineer in the twenty-first century must have an improved understanding of the principles of science, engineering, and economics, coupled with relevant design experience. Increasingly, in the new world economy, successful businesses will rely on engineers with such expertise.

Economic and design issues are inextricably linked in the product/service life cycle. Therefore, one of my strongest motivations for writing this text was to bring the realities of economics and engineering design into the classroom and to help students integrate these issues when contemplating many engineering decisions. Of course, my underlying motivation for writing this book was not simply to address contemporary needs, but to address as well the ageless goal of all educators: to help students to learn. Thus, thoroughness, clarity, and accuracy of presentation of essential engineering economics were my aim at every stage in the development of the text.

New to the Sixth Edition

Much of the content has been streamlined to provide materials in depth and to reflect the challenges in contemporary engineering economics. Some of the highlighted changes are as follows:

- All the chapter opening vignettes—a trademark of *Contemporary Engineering Economics*—have been updated or completely replaced with more current and thought-provoking issues. Selection of vignettes reflects the important segment of global economy in terms of variety and scope of business as well. With more than 80% of the total GDP (Gross Domestic Product) in the United States provided by the service sector, engineers work on various economic decision problems in the service sector as well. For this reason, many engineering economic decision problems from the service sector are presented in this sixth edition.
- Excel spreadsheet modeling techniques are incorporated into various economic decision problems to provide many "what-if" solutions to key decision problems.
- About 20% of end-of-chapter problems are either new or revised. There are a total of 618 end-of-chapter problems and 65 short case-study questions. There are also 196 fully worked-out examples and 40 carefully selected and fully worked out Fundamentals of Engineering Exam Review Questions in Appendix A.

Chapter Opening Vignettes				
Chapters	**Vignettes**	**Company**	**Sector**	**Industry**
1	• Electric vehicles	Tesla	Consumer Goods	Auto Manufacturers
2	• Communication chips	Broadcom	Technology	Semiconductor—Integrated Circuits
3	• Powerball—Lottery winning	Cindy and Mark Hill	Services	Lottery
4	• Financing home mortgage	Personal Finance	Financial	Banking/Housing
5	• Football stadium expansion	University of Colorado	Services	Sports
6	• Industrial robots	Delta	Industrial	Manufacturing
7	• Investment in antique car	Personal	Personal	Automobile
8	• iPhone manufacturing	Apple	Consumer Goods	Electronic Equipment
9	• Airline baggage handling	Delta Airlines	Services	Airlines
10	• Aircraft manufacturing	Eclipse	Industrial Goods	Aerospace
11	• Big Mac index	Personal	Services	Restaurants
12	• Aluminum auto body	Alcoa	Basic Materials	Aluminum
13	• Insurance	Personal	Services	Travel
14	• Replacing absorption chiller	UCSF Medical Center	Healthcare	Hospitals
15	• Capital budgeting	Laredo Petroleum	Energy	Oil drilling
16	• Auto inspection program	State of Pennsylvania	Public	Government

• Some other specific changes in each chapter are summarized as follows:

Chapters	
1	• Revised Section 1.3 by providing one of contemporary issues—electric vehicle and battery manufacturing.
2	• Replaced all financial analyses (including financial ratios) based on the financial statements by Broadcom Corporation. • Provided two chapter examples and solutions to improve the understanding of financial analysis.
3	• Redesigned all Excel worksheets to take advantage of its financial functions in solving various economic equivalence problems.

Chapters	
4	• Revised Section 4.3.2 to enhance the understanding of continuous-funds flow with continuous compounding. • Revised Section 4.6.3 to reflect the current bond market.
5	• Revised all Excel worksheets. • Streamlined the presentation.
6	• Revised Section 6.3.3 with a new make-buy example. • Introduced a new example of HVAC retrofit life-cycle-costing analysis.
7	• Created a new section (7.3.5) on modified internal rate of return.
8	• Streamlined the presentation. • Updated all data related to cost of owning and operating a vehicle.
9	• Updated tax information. • Updated all Excel worksheets of generating depreciation schedules.
10	• Revised all cash flow statement tables by using Excel.
11	• Updated all data related to consumer price index as well as other cost data to reflect the current trend in inflation as well as deflation in various economic sectors. • Revised all cash flow statements by using Excel.
12	• Revised Excel worksheet related to sensitivity analysis.
13	• Revised all financial options examples by providing many graphical illustrations to explain complex conceptual financial as well as real option problems. • Extended Example 13.14 on how to estimate project volatility.
14	• Created a new graphical chart (Figure 14.8) to facilitate the understanding of overall replacement strategies under infinite planning horizon.
15	• Created a new figure (Figure 15.1) to illustrate the capital structure of a typical firm. • Extended Section 15.4.3 to include an example on how to find the optimal capital budget if projects cannot be accepted in part (Example 15.12).
16	• Streamlined the presentation. • Provide a new detailed vehicle inspection program on cost-benefit analysis. • Added a new section (16.5.3) on cost-utility analysis to improve the pedagogical aspect of healthcare decisions.

Overview of the Text

Although it contains little advanced math and few truly difficult concepts, the introductory engineering economics course is often curiously challenging for the sophomores, juniors, and seniors. There are several likely explanations for this difficulty.

- The course is the student's first analytical consideration of money (a resource with which he or she may have had little direct control beyond paying for tuition, housing, food, and textbooks).

- The emphasis on theory may obscure the fact that the course aims, among other things, to develop a very practical set of analytical tools for measuring project worth. This is unfortunate since, at one time or another, virtually every engineer—not to mention every individual—is responsible for the wise allocation of limited financial resources.
- The mixture of industrial, civil, mechanical, electrical, and manufacturing engineering students, as well as other undergraduates who take the course, often fail to "see themselves" using in the skills the course and text are intended to foster. This is perhaps less true for industrial engineering students for whom many texts take as their primary audience. But other disciplines are often motivationally shortchanged by a text's lack of applications that appeal directly to their students.

Goal of the Text

This text aims not only to provide sound and comprehensive coverage of the concepts of engineering economic but also aims to address the difficulties of students as outlined previously, all of which have their basis in inattentiveness to the practical concerns of engineering economics. More specifically, this text has the following chief goals:

- To build a thorough understanding of the theoretical and conceptual basis upon which the practice of financial project analysis is built.
- To satisfy the very practical needs of the engineer toward making informed financial decisions when acting as a team member or project manager for an engineering project.
- To incorporate all critical decision-making tools—including the most contemporary, computer-oriented ones that engineers bring to the task of making informed financial decisions.
- To appeal to the full range of engineering disciplines for which this course is often required: industrial, civil, mechanical, electrical, computer, aerospace, chemical, and manufacturing engineering, as well as engineering technology.

Prerequisites

The text is intended for undergraduate engineering students at the sophomore level or above. The only mathematical background required is elementary calculus. For Chapters 12 and 13, a first course in probability or statistics is helpful but not necessary, since the treatment of basic topics there is essentially self-contained.

Taking Advantage of the Internet

The integration of computer use is another important feature of *Contemporary Engineering Economics*. Students have greater access to and familiarity with the various spreadsheet tools and instructors have greater inclination either to treat these topics explicitly in the course or to encourage students to experiment independently.

A remaining concern is that the use of computers will undermine true understanding of course concepts. This text does not promote the use of trivial spreadsheet applications as a replacement for genuine understanding of and skill in applying traditional solution methods. Rather, it focuses on the computer's productivity-enhancing benefits for complex

project cash flow development and analysis. For spreadsheet coverage, the emphasis is on demonstrating a chapter concept that embodies some complexity that can be much more efficiently resolved on a computer than by traditional long-hand solutions.

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- MyEngineeringLab is now available with *Contemporary Engineering Economics*, Sixth Edition and provides a powerful homework and test manager which lets instructors create, import, and manage online homework assignments, quizzes, and tests that are automatically graded. You can choose from a wide range of assignment options, including time limits, proctoring, and maximum number of attempts allowed. The bottom line: MyEngineeringLab means less time grading and more time teaching.
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Resources for Instructors and Students

- MyEngineeringLab, myengineeringlab.com, which is also available as MyEngineeringLab with Pearson eText, a complete online version of the book. It allows highlighting, note taking, and search capabilities.
- Excel files of selected example problems from the text as well as end-of-chapter problems.
- Instructor's Solutions Manual in both WORD and PDF versions.
- PowerPoint lecture notes.

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PART

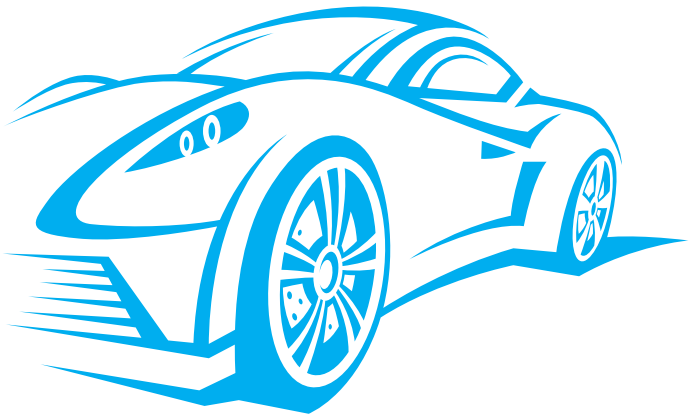
ONE

BASICS OF FINANCIAL DECISIONS

CHAPTER

Engineering Economic Decisions

Are Electric Cars Finally the Next Big Thing? Tesla Motors was founded in 2003 by a group of engineers and venture capitalists. Tesla designs, develops, manufactures, and sells premium electric vehicles (EVs) and advanced electric vehicle powertrain components by order only. Tesla's business plan recognizes that innovative technology is often very expensive and that the very rich are usually the first people to adopt it. Once prices come down, the technology can move down into the market. That's why Tesla's first car is a high-end sports car only made in limited numbers. In its 10 years since founding, Tesla has launched both a high-end limited edition "Tesla Roadster" and its "Model S" production car, and introduced "Model X," a sport utility vehicle with seating for seven adults in 2015. Despite a public controversy about its limited driving range before recharging, the Model S had received the coveted Car of the Year Award and earned the highest rating that Consumer Reports ever gave to a car, saying that "The mere fact the Tesla Model S exists at all is a testament to innovation and entrepreneurship, the very qualities that once made the American automobile industry the largest, richest, and most powerful in the world."[1] While some of its most visible EV competitors went bankrupt or halted



Source: Alexkava/Shutterstock

[1] Angus MacKenzie, "2013 Motor Trend Car of the Year: Tesla Model S," *MotorTrend*, January 2013.

production, Tesla became a darling of many investors and Wall Street analysts. Tesla's goal is to be a mass manufacturer of electric cars.

The story of how the Tesla founders got motivated to develop a series of luxury electric cars and eventually transformed their invention to a multibillion-dollar business is a typical one. Companies such as Google, Facebook, and Microsoft all produce computer-related products and have market values of several hundred billion dollars. These companies were all started by highly motivated young college students. One thing that is also common to all these successful businesses is that they have capable and imaginative engineers who constantly generate good ideas for capital investment, execute them well, and obtain good results. You might wonder what kind of role these engineers play in making such business decisions. In other words, what specific tasks are assigned to these engineers, and what tools and techniques are available to them for making such capital investment decisions? We answer these questions and explore related issues throughout this text.

CHAPTER LEARNING OBJECTIVES

After completing this chapter, you should understand the following concepts:

- The role of engineers in business.
- Types of business organization.
- The nature and types of engineering economic decisions.
- What makes the engineering economic decisions difficult.
- How a typical engineering project idea evolves in business.
- Fundamental principles of engineering economics.

1.1 Role of Engineers in Business

Facebook, Google, and Microsoft produce computer products and have a market value of several hundred billion dollars each, as stated earlier. These companies were all started by young college students with technical backgrounds. When they went into the computer business, these students initially organized their companies as proprietorships. As the businesses grew, they became partnerships and were eventually converted to corporations. This chapter begins by introducing the three primary forms of business organization and briefly discusses the role of engineers in business.

1.1.1 Types of Business Organization

As an engineer, you should understand the nature of the business organization with which you are associated. This section will present some basic information about the type of organization you should choose should you decide to go into business for yourself. The three legal forms of business, each having certain advantages and disadvantages, are proprietorships, partnerships, and corporations.

Proprietorships

A **proprietorship** is a business owned by one individual. This person is responsible for the firm's policies, owns all its assets, and is personally liable for its debts. A proprietorship has two major advantages. First, it can be formed easily and inexpensively. No legal and organizational requirements are associated with setting up a proprietorship, and organizational costs are therefore virtually nil. Second, the earnings of a proprietorship are taxed at the owner's personal tax rate, which may be lower than the rate at which corporate income is taxed. Apart from personal liability considerations, the major disadvantage of a proprietorship is that it cannot issue stocks and bonds, making it difficult to raise capital for any business expansion.

Partnerships

A **partnership** is similar to a proprietorship, except that it has more than one owner. Most partnerships are established by a written contract between the partners. The contract normally specifies salaries, contributions to capital, and the distribution of profits and losses. A partnership has many advantages, among which are its low cost and ease of formation. Because more than one person makes contributions, a partnership typically has a larger amount of capital available for business use. Since the personal assets of all the partners stand behind the business, a partnership can borrow money more easily from a bank. Each partner pays only personal income tax on his or her share of a partnership's taxable income.

On the negative side, under partnership law, each partner is liable for a business's debts. This means that the partners must risk all their personal assets—even those not invested in the business. And while each partner is responsible for his or her portion of the debts in the event of bankruptcy, if any partners cannot meet their pro rata claims, the remaining partners must take over the unresolved claims. Finally, a partnership has a limited life, insofar as it must be dissolved and reorganized if one of the partners quits.

Corporations

A **corporation** is a legal entity created under provincial or federal law. It is separate from its owners and managers. This separation gives the corporation four major advantages:

1. It can raise capital from a large number of investors by issuing stocks and bonds.
2. It permits easy transfer of ownership interest by trading shares of stock.
3. It allows limited liability—personal liability is limited to the amount of the individual's investment in the business.
4. It is taxed differently than proprietorships and partnerships, and under certain conditions, the tax laws favor corporations.

On the negative side, it is expensive to establish a corporation. Furthermore, a corporation is subject to numerous governmental requirements and regulations.

As a firm grows, it may need to change its legal form, because the form of a business affects the extent to which it has control of its own operations and its ability to acquire funds. The legal form of an organization also affects the risk borne by its owners in case of bankruptcy and the manner in which the firm is taxed. Apple Computer, for example, started out as a two-man garage operation. As the business grew, the owners felt constricted by this form of organization: It was difficult to raise capital for business expansion; they felt that the risk of bankruptcy was too high to bear; and as their business income grew, their tax burden grew as well. Eventually, they found it necessary to convert the partnership into a corporation. With a market value of close to $700 billion in 2014, it is the largest corporation in the United States.

In the United States, the overwhelming majority of business firms are proprietorships, followed by corporations and partnerships. However, in terms of total business volume (dollars of sales), the quantity of business transacted by proprietorships and partnerships is several times less than that of corporations. Since most business is conducted by corporations, this text will generally address economic decisions encountered in that form of ownership.

1.1.2 Engineering Economic Decisions

What role do engineers play within a firm? What specific tasks are assigned to the engineering staff, and what tools and techniques are available to it to improve a firm's profits? Engineers are called upon to participate in a variety of decisions, ranging from manufacturing, through marketing, to financing decisions. We will restrict our focus, however, to various economic decisions related to engineering projects. We refer to these decisions as **engineering economic decisions**.

In manufacturing, engineering is involved in every detail of a product's production, from conceptual design to shipping. In fact, engineering decisions account for the majority (some say 85%) of product costs. Engineers must consider the effective use of capital assets such as buildings and machinery. One of the engineer's primary tasks is to plan for the acquisition of equipment (**capital expenditure**) that will enable the firm to design and produce products economically.

With the purchase of any fixed asset—equipment, for instance—we need to estimate the profits (more precisely, cash flows) that the asset will generate during its period of service. In other words, we have to make capital expenditure decisions based on predictions about the future. Suppose, for example, you are considering the purchase of a deburring machine to meet the anticipated demand for hubs and sleeves used in the production of gear couplings. You expect the machine to last 10 years. This decision thus involves an implicit 10-year sales forecast for the gear couplings, which means that a long waiting period will be required before you will know whether the purchase was justified.

An inaccurate estimate of the need for assets can have serious consequences. If you invest too much in assets, you incur unnecessarily heavy expenses. Spending too little on fixed assets, however, is also harmful, for then the firm's equipment may be too obsolete to produce products competitively, and without an adequate capacity, you may lose a portion of your market share to rival firms. Regaining lost customers involves heavy marketing expenses and may even require price reductions or significant product improvements, both of which are costly.

1.1.3 Personal Economic Decisions

In the same way that an engineer can play a role in the effective utilization of corporate financial assets, each of us is responsible for managing our personal financial affairs. After we have paid for nondiscretionary or essential needs, such as housing, food, clothing, and transportation, any remaining money is available for discretionary expenditures on items such as entertainment, travel, and investment. For money we choose to invest, we want to maximize the economic benefit at some acceptable risk. The investment choices are virtually unlimited and include savings accounts, guaranteed investment certificates, stocks, bonds, mutual funds, registered retirement savings plans, rental properties, land, business ownership, and more.

How do you choose? The analysis of one's personal investment opportunities utilizes the same techniques that are used for engineering economic decisions. Again, the challenge is predicting the performance of an investment into the future. Choosing wisely can be very rewarding, while choosing poorly can be disastrous. Some investors in the energy stock Enron who sold prior to the fraud investigation became millionaires. Others, who did not sell, lost everything. A wise investment strategy is a strategy that manages risk by diversifying investments. With such an approach, you have a number of different investments ranging from very low to very high risk and are in a variety of business sectors. Since you do not have all your money in one place, the risk of losing everything is significantly reduced. (We discuss some of these important issues in Chapters 12 and 13.)

In this text, we will consider many types of investments—personal investments as well as business investments. The focus, however, will be on evaluating engineering projects on the basis of their economic desirability and on dealing with investment situations that a typical firm or a public institution faces.

1.1.4 Economic Decisions Versus Design Decisions

Economic decisions differ in a fundamental way from the types of decisions typically encountered in engineering design. In a design situation, the engineer utilizes known physical properties, the principles of chemistry and physics, engineering design correlations, and engineering judgment to arrive at a workable and optimal design. If the judgment is sound, the calculations are done correctly, and we ignore technological advances, the design is time invariant. In other words, if the engineering design to meet a particular need is done today, next year, or in five years' time, the final design would not change significantly.

In considering economic decisions, the measurement of investment attractiveness, which is the subject of this text, is relatively straightforward. However, the information required in such evaluations always involves predicting or forecasting product sales, product selling prices, and various costs over some future time frame—five years, 10 years, 25 years, etc.

All such forecasts have two things in common. First, they are never completely accurate compared with the actual values realized at future times. Second, a prediction or forecast made today is likely to be different from one made at some point in the future. It is this ever-changing view of the future that can make it necessary to revisit and even change previous economic decisions. Thus, unlike engineering design, the conclusions reached through economic evaluation are not necessarily time invariant. Economic decisions have to be based on the best information available at the time of the decision and a thorough understanding of the uncertainties in the forecasted data.

1.2 What Makes the Engineering Economic Decision Difficult?

The economic decisions that engineers make in business differ very little from the financial decisions made by individuals, except for the scale of the concern. For example, everyone who experienced the Great Blackout of 2003 remembers where they were when it happened that summer day. The blackout, which cut power to much of the Northeastern and Midwestern United States, as well as parts of Canada, brought home the reality that the electrical grid in the United States was outdated.[2] Updating the grid will not be cheap—estimates range as high as $2 trillion—but the massive effort will also present huge opportunities for U.S. manufacturers, with a market that could reach $1 trillion. The race is on to capitalize on smart-grid technologies, which would include building new power plants, transmission lines, and focus on conservation. (See Figure 1.1.)

Figure 1.1 A helicopter lowers towers for high-voltage power lines into place. Many say the country needs to build more of these lines to move renewable power and become more efficient.

[2]Frank Andorka, "Powering Up: The Smart Grid's Next Steps," *Industry Week*, April 2011.

Obviously, this level of engineering decision by electric power companies is far more complex and more significant than a business decision about when to introduce a new product. Projects of this nature involve large sums of money over long periods of time, and it is difficult to estimate the magnitude of economic benefits in any precise manner. Even if we decide to rebuild the electric grid systems, should we build in incremental steps, or should we build to withstand a demand to occur 20 years from now? Even if we can justify the project on economic reasoning, how to finance the project is another issue. Any engineering economic decision pertaining to this type of a large-scale project will be extremely difficult to make.

1.3 Large-Scale Engineering Projects

In the development of any product, a company's engineers are called upon to translate an idea into reality. A firm's growth and development depend largely upon a constant flow of ideas for new products, and for the firm to remain competitive, it has to make existing products better or produce them at a lower cost. We will present an example of how a large-scale engineering project evolves and what types of financial decisions have to be considered in the process of executing such a project.[3]

1.3.1 Are Tesla's Plans for a Giant Battery Factory Realistic?

Tesla Motors introduced the world's first luxury electrical vehicles whose engines cut air pollution to zero and boosted operating efficiency to significant levels. Tesla, in short, wanted to launch and dominate a new "green" era for automobiles and plans to build one of the world's largest factories of any kind in the U.S. But it wouldn't build its electric cars there—it would make the batteries to power them. The plant, slated for completion by 2017 at a cost of as much as $5 billion, would be able to turn out more lithium-ion batteries than all the battery factories in the world today. Tesla finally broke ground in June of 2014 on the site in Reno, Nevada, and expects to start producing batteries at the plant by 2017. It says the scale will help drive the cost of batteries down, in turn helping to make a mass-manufacturing within reach.

How Economical is Tesla's Plan?

The biggest question remaining about the mass production of the electric vehicle concerned its battery production cost. Costs would need to come down for Tesla's electric cars to be competitive around the world, where gasoline prices were stable or even declining. Economies of scale would help as production volumes increase, but further advances in engineering also would be essential. With the initial engineering specification, Tesla has designed the powerpacks and their associated circuitry, each of which contains up to 7,000 standard lithium-ion cells of the sort found in laptops. The firm is said to buy more of these sorts of cell than all the world's computer-makers combined.

[3]"Elon Musk's Tesla Picks Nevada to Host Battery Gigafactory," *Scientific American*, September 5, 2014. This article presents various economic and financial issues associated with locating the battery plant in Nevada. Some of the performance is from Tesla Motors Corporation.

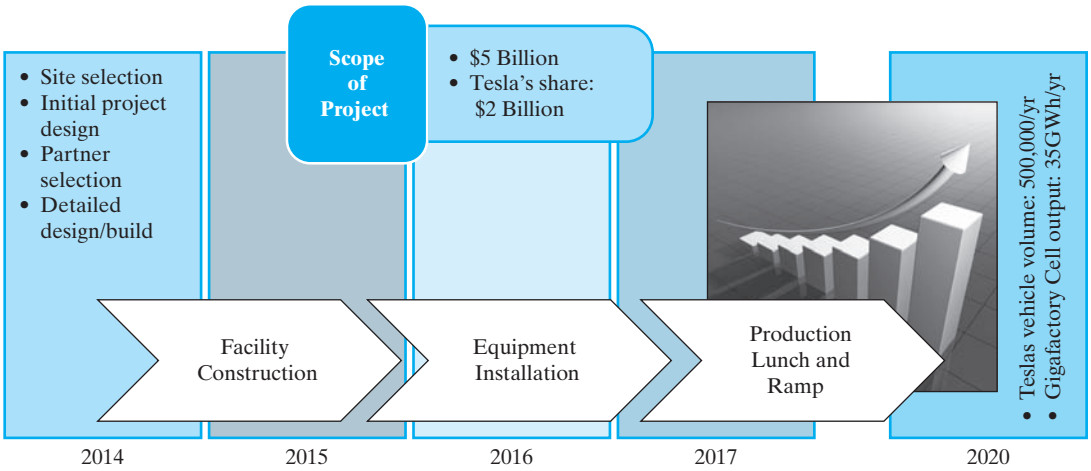


Figure 1.2 Projected Timeline of Tesla's Gigafactory.
Source: "Assault on Batteries," *The Economist*, June 14, 2014.

Tesla argues that its battery packs, including their power-management and cooling systems, currently cost less than $300 a kilowatt-hour (kWh) of storage capacity: about half the costs of its rivals.

The gigafactory, which will eventually turn out batteries for 500,000 vehicles, should cut their costs by another 30%; two-thirds of that saving will come from scale alone with the rest due to improved manufacturing technology. When costs drop below $200 a kWh, battery-powered cars start to become competitive with conventional ones without government subsidies. The gigafactory could bring Tesla close to that.

What is the Business Risk?

Although engineers at Tesla claim that they would be able to cut its current battery costs drastically, many financial analysts are skeptical as raw materials account for 70% of the price of a lithium battery. This would make the scope for savings limited, and even if the factory does turn out many cheap battery cells, that may not be enough. Technically, the key to increasing range and performance is to improve the efficiency, size, and price of the electronics that manage the power, along with overall vehicle weight. Tesla does not have the same advantages in these areas as it has with its batteries.

At a cost of $5 billion, which Tesla will share with Panasonic of Japan, its current battery supplier, and other partners, the gigafactory is a big gamble. Also, if electric-car demand stalls, the question is what we do with the huge output of cheap batteries. There is a lot of cost that can be removed at larger scales of battery manufacturing, but it's all about the capacity utilization. A battery plant that is not running will cost Tesla a fortune.

Despite Tesla management's decision to build the giant battery factory, the financial analysts were still uncertain whether there would be enough demand. Furthermore, competitors, including U.S. automakers, just did not see how Tesla could achieve the economies of scale needed to produce electric cars at a profit. The primary advantage of the design, however, is that the electric vehicle could cut auto pollution to a zero level. This is a feature that could be very appealing at a time when government air-quality standards are becoming more rigorous and consumer interest in the environment is getting strong.

However, in the case of the Tesla products, if a significant reduction in production cost never materializes, demand might remain insufficient to justify the investment in the battery factory.

1.3.2 Impact of Engineering Projects on Financial Statements

Engineers must understand the business environment in which a company's major business decisions are made. It is important for an engineering project to generate profits, but it also must strengthen the firm's overall financial position. How do we measure Tesla's success in the giant battery factory project? Will enough electric car models be sold, for example, to keep the green-engineering business as Tesla's major source of profits? While the giant battery project would provide revolutionary energy storage system for the company's customers, the bottom line is its financial performance over the long run.

Regardless of a business' form, each company has to produce basic financial statements at the end of each operating cycle (typically a year). These financial statements provide the basis for future investment analysis. In practice, we seldom make investment decisions solely on the basis of an estimate of a project's profitability, because we must also consider the overall impact of the investment on the financial strength and position of the company.

Suppose that you were the president of the Tesla Corporation. Suppose further that you even hold some shares in the company, making you one of the company's many owners. What objectives would you set for the company? While all firms are in business in hopes of making a profit, what determines the market value of a company are not profits per se, but cash flow. It is, after all, available cash that determines the future investments and growth of the firm. Therefore, one of your objectives should be to increase the company's value to its owners (including yourself) as much as possible. To some extent, the market price of your company's stock represents the value of your company.

Many factors affect your company's market value: present and expected future earnings, the timing and duration of those earnings, and the risks associated with them. Certainly, any successful investment decision will increase a company's market value. Stock price can be a good indicator of your company's financial health, and may also reflect the market's attitude about how well your company is managed for the benefit of its owners.

Any successful investment decision on the giant battery factory's scale will tend to increase a firm's stock prices in the marketplace and promote long-term success. Thus, in making a large-scale engineering project decision, we must consider its possible effect on the firm's market value. (In Chapter 2, we discuss the financial statements in detail and show how to use them in our investment decision making.)

1.4 Common Types of Strategic Engineering Economic Decisions

The story of how the Tesla Corporation successfully introduced a new product and became the market leader in the advanced electric car market is typical: Someone had a good idea, executed it well, and obtained good results. Project ideas such as the giant

battery factory can originate from many different levels in an organization. Since some ideas will be good, while others will not, we need to establish procedures for screening projects.

Many large companies have a specialized project analysis division that actively searches for new ideas, projects, and ventures. Once project ideas are identified, they are typically classified as (1) equipment or process selection, (2) equipment replacement, (3) new product or product expansion, (4) cost reduction, or (5) improvement in service or quality. This classification scheme allows management to address key questions: Can the existing plant, for example, be used to attain the new production levels? Does the firm have the knowledge and skill to undertake the new investment? Does the new proposal warrant the recruitment of new technical personnel? The answers to these questions help firms screen out proposals that are not feasible, given a company's resources.

The giant battery project represents a fairly complex engineering decision that required the approval of top executives and the board of directors. Virtually all big businesses face investment decisions of this magnitude at some time. In general, the larger the investment, the more detailed is the analysis required to support the expenditure. For example, expenditures aimed at increasing the output of existing products or at manufacturing a new product would invariably require a very detailed economic justification. Final decisions on new products, as well as marketing decisions, are generally made at a high level within the company. By contrast, a decision to repair damaged equipment can be made at a lower level. The five classifications of project ideas are as follows.

1.4.1 Equipment or Process Selection

This class of engineering decision problems involves selecting the best course of action out of several that meet a project's requirements. For example, which of several proposed items of equipment shall we purchase for a given purpose? The choice often hinges on which item is expected to generate the largest savings (or the largest return on the investment). For example, the choice of material will dictate the manufacturing process for the body panels in the automobile. Many factors will affect the ultimate choice of the material, and engineers should consider all major cost elements, such as the cost of machinery and equipment, tooling, labor, and material. Other factors may include press and assembly, production and engineered scrap, the number of dies and tools, and the cycle times for various processes.

1.4.2 Equipment Replacement

This category of investment decisions involves considering the expenditure necessary to replace worn-out or obsolete equipment. For example, a company may purchase 10 large presses, expecting them to produce stamped metal parts for 10 years. After five years, however, it may become necessary to produce the parts in plastic, which would require retiring the presses early and purchasing plastic molding machines. Similarly, a company may find that, for competitive reasons, larger and more accurate parts are required, making the purchased machines become obsolete earlier than expected.

Suppose, for example, that a firm is using a lathe that was purchased 12 years ago to produce pump shafts. As the production engineer in charge of this product, you expect demand to continue into the foreseeable future. However, the lathe has begun to show its age: It has broken frequently during the last two years and has finally stopped operating altogether. Now you have to decide whether to replace or repair it. If you expect a more efficient lathe to be available in the next one or two years, you might repair the old lathe instead of replacing it. The major issue is whether you should make the considerable investment in a new lathe now or later. As an added complication, if demand for your product begins to decline, you may have to conduct an economic analysis to determine whether declining profits from the project offset the cost of a new lathe.

1.4.3 New Product or Product Expansion

Investments in this category increase company revenues if output is increased. One common type of expansion decision includes decisions about expenditures aimed at increasing the output of existing production or distribution facilities. In these situations, we are basically asking, "Shall we build or otherwise acquire a new facility?" The expected future cash inflows in this investment category are the profits from the goods and services produced in the new facility. A second type of expenditure decision includes considering expenditures necessary to produce a new product or to expand into a new geographic area. These projects normally require large sums of money over long periods.

1.4.4 Cost Reduction

A cost-reduction project is a project that attempts to lower a firm's operating costs. Typically, we need to consider whether a company should buy equipment to perform an operation currently done manually or spend money now in order to save more money later. The expected future cash inflows on this investment are savings resulting from lower operating costs.

1.4.5 Improvement in Service or Quality

Most of the examples in the previous sections were related to economic decisions in the manufacturing sector. The decision techniques we develop in this book are also applicable to various economic decisions related to improving services or quality of product. We will provide several economic decision problems from the service sector throughout the text.

1.5 Fundamental Principles of Engineering Economics

This book is focused on the principles and procedures engineers use to make sound economic decisions. To the first-time student of engineering economics, anything related to money matters may seem quite strange when compared to other engineering subjects. However, the decision logic involved in solving problems in this domain is quite similar to that employed in any other engineering subject. There are fundamental principles to follow in engineering economics that unite the concepts and techniques presented in this text, thereby allowing us to focus on the logic underlying the practice of engineering economics.

- **Principle 1: A dollar earned today is worth more than a dollar earned in the future.** A fundamental concept in engineering economics is that money has a time value associated with it (Figure 1.3). Because we can earn interest on money received today, it is better to receive money earlier than later. This concept will be the basic foundation for all engineering project evaluation.

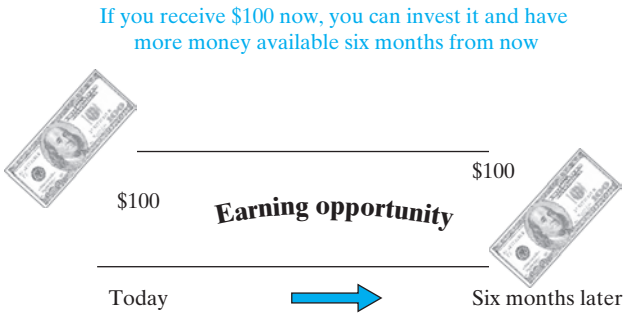


Figure 1.3 Time value of money.

- **Principle 2: All that counts are the differences among alternatives.** An economic decision should be based on the *differences* among the alternatives considered (Figure 1.4). All that is common is irrelevant to the decision. Certainly, any economic decision is no better than the alternatives being considered. Thus, an economic decision should be based on the objective of making the best use of limited resources. Whenever a choice is made, something is given up. The opportunity cost of a choice is the value of the best alternative given up.

Comparing Buy versus Lease

Whatever you decide, you need to spend the same amount of money on fuel and maintenance

Option	Monthly Fuel Cost	Monthly Maintenance	Cash Outlay at Signing	Monthly Payment	Salvage Value at End of Year 3
Buy	$960	$550	$6,500	$350	$9,000
Lease	$960	$550	$2,400	$550	0

Irrelevant items in decision making

Figure 1.4 Differential analysis.

- **Principle 3: Marginal revenue must exceed marginal cost.** Effective decision making requires comparing the additional costs of alternatives with the additional benefits (Figure 1.5). Each decision alternative must be justified on its own economic merits before being compared with other alternatives. Any increased economic activity must be justified on the basis of the fundamental economic principle that marginal

revenue must exceed marginal cost. Here, *marginal revenue* means the additional revenue made possible by increasing the activity by one unit (or small unit). *Marginal cost* has an analogous definition. Productive resources—the natural resources, human resources, and capital goods available to make goods and services—are limited. Therefore, people cannot have all the goods and services they want; as a result, they must choose some things and give up others.

To justify your action, marginal revenue must exceed marginal cost

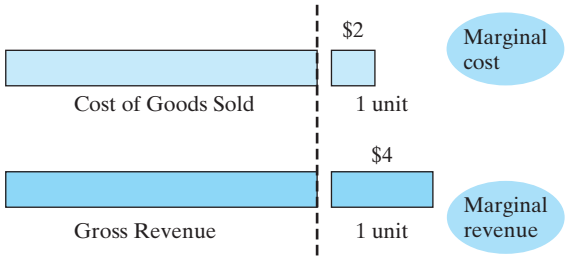


Figure 1.5 Marginal analysis.

- **Principle 4: Additional risk is not taken without the expected additional return.** For delaying consumption, investors demand a minimum return that must be greater than the anticipated rate of inflation or any perceived risk (Figure 1.6). If they didn't receive enough to compensate for anticipated inflation and the perceived investment risk, investors would purchase whatever goods they desired ahead of time or invest in assets that would provide a sufficient return to compensate for any loss from inflation or potential risk. The preceding four principles are as much statements of common sense as they are theoretical precepts. These principles provide the logic behind what is to follow. We build on them and attempt to draw out their implications for decision-making. As we continue, keep in mind that, while the topics being treated may change from chapter to chapter, the logic driving our treatment of them is constant and rooted in the four fundamental principles.

Expected returns from bonds and stocks are normally higher than the expected return from a savings account

Investment Class	Potential Risk	Expected Return
Savings account (cash)	Low/None	1.5%
Bond (debt)	Moderate	4.8%
Stock (equity)	High	11.5%

Figure 1.6 Risk and return trade off.

SUMMARY

- This chapter has given us an overview of a variety of engineering economic problems that commonly are found in the business world. We examined the role and the increasing importance of engineers in the firm, as evidenced by the development of innovative electric vehicles at Tesla. Commonly, engineers are called upon to participate in a variety of strategic business decisions ranging from product design to marketing.
- The term **engineering economic decision** refers to any investment decision related to an engineering project. The facet of an economic decision that is of most interest from an engineer's point of view is the evaluation of costs and benefits associated with making a capital investment.
- The five main types of engineering economic decisions are (1) equipment or process selection, (2) equipment replacement, (3) new product or product expansion, (4) cost reduction, and (5) improvement in service or quality.
- The factors of **time** and **uncertainty** are the defining aspects of any investment project.
- The four fundamental principles that must be applied in all engineering economic decisions are (1) the time value of money, (2) differential (incremental) cost and revenue, (3) marginal cost and revenue, and (4) the trade-off between risk and reward.

Short Case Studies

ST1.1 Review the contents of *The Wall Street Journal* for the past three months. Then, identify and categorize the types of investment decisions appearing in the journal according to the types of strategic economics decisions discussed in the text.

ST1.2 Work in small groups and brainstorm ideas about how a common appliance, device, or tool could be redesigned to improve it in some way. Identify the steps involved and the economic factors that you would need to consider prior to making a decision to manufacture the redesigned product. A detailed design and actual cost estimates are not required. Some items which could be considered for this redesign exercise are a shopping cart, telephone, can opener, screwdriver, etc.

ST1.3 Many oil price forecasts in the early 2000s indicated that the price of oil in the year 2007 would not exceed $50 per barrel. What is the price of oil today? Why are these prices so difficult to predict? Imagine what the consequences would be if you used these optimistic estimates in your economic analysis in your early project undertaking. What would be some practical ways to consider this type of variation in economic analysis?

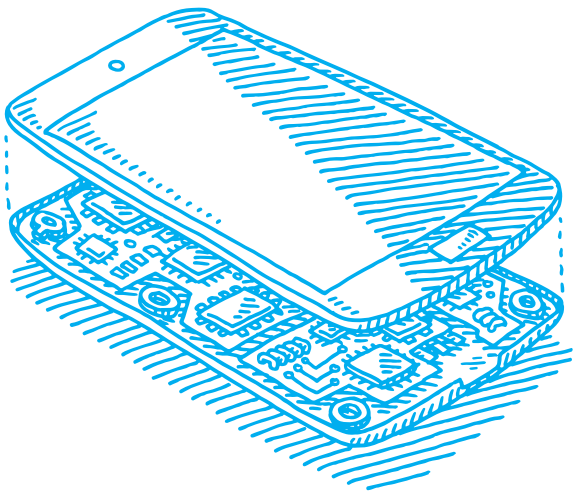
CHAPTER 2

Accounting and Financial Decision Making

Broadcom's Expansion to China Based in Irvine, CA, Broadcom is engaged in designing and marketing semiconductor components of network voice, video, and data traffic for various applications. Broadcom Corporation (BRCM) is looking to expand its sales in China by making chips that support a wider range of handsets, including those that run on the network of the world's largest telecom carrier, China Mobile Limited.

Broadcom's strategy is a bet that demand will continue to rise for low-cost smartphones that work on China Mobile's third-generation network. China Mobile's network is based on a technology rarely used outside of China. However, the company's more than 760 million subscribers have created demand for phones, and in turn chips, that support that technology. With more than 500 million smartphone users, China is the world's largest smartphone market.

Suppose you are a chief engineer who designed the chip to be used in the China's smartphone market and also participated in the Broadcom's strategic decision to expand into China. How would you determine the financial success of your project? Or, as an investor, if you want to explore investing in BRCM stock, what information would you go by? You would certainly prefer that BRCM



Source: FrankRamspott/Getty Images

have a record of accomplishment of profitable operations, earning a profit (net income) year after year. The company would need a steady stream of cash coming in and a manageable level of debt. How would you determine whether the company met these criteria? Investors commonly use the financial statements contained in the annual report as a starting point in forming expectations about future levels of earnings and about the firm's riskiness.

Before making any financial decision, it is good to understand an elementary aspect of your financial situation—one that you'll also need for retirement planning, estate planning, and, more generally, to get an answer to the question, "How am I doing?" It is called your **net worth**. If you want to invest $10,000 in BRCM stocks, how would that affect your net worth? You may need this information for your own financial planning, but it is routinely required whenever you have to borrow a large sum of money from a financial institution. For example, when you are buying a home, you need to apply for a mortgage. Invariably, the bank will ask you to submit your net-worth statement as a part of loan processing. Your net-worth statement is a snapshot of where you stand financially at a given point in time. You do that by adding your assets—such as cash, investments, and pension plans—in one column and your liabilities—or debts—in the other. Then subtract your liabilities from your assets to find your net worth. In other words, your net worth is what you would be left with if you sold everything and paid off all you owe. The bank will determine how creditworthy you are by examining your net worth. In a similar way, a corporation prepares the same kind of information for its financial planning or to report its financial health to stockholders or investors. The reporting document is known as the financial statements.

CHAPTER LEARNING OBJECTIVES

After completing this chapter, you should understand the following concepts:

- The role of accounting in economic decisions.
- Four types of financial statements prepared for investors and regulators.

- How to read the balance sheet statement.
- How to use the income statement to manage a business.
- The sources and uses of cash in business operation.
- How to conduct the ratio analysis and what the numbers really mean.

2.1 Accounting: The Basis of Decision Making

We need financial information when we are making business decisions. Virtually all businesses keep accounting records to aid in making decisions. As illustrated in Figure 2.1, accounting is the information system that measures business activities, processes the resulting information into reports, and communicates the results to decision makers. For this reason, we call accounting "the language of business." The better you understand this language, the better you can manage your financial well-being, and the better your financial decisions will be.

The uses of accounting information are many and varied.

- **Business managers** use accounting information to set goals for their organizations, to evaluate progress toward those goals, and to take corrective actions if necessary. Decisions based on accounting information may include which building or equipment to purchase, how much merchandise to keep on hand as inventory, and how much cash to borrow.
- **Investors and creditors** provide the money a business needs to begin operations. To decide whether to help start a new venture, potential investors evaluate what income they can expect on their investment. Such an evaluation involves analyzing the financial statements of the business. Before making a loan, banks determine the borrower's

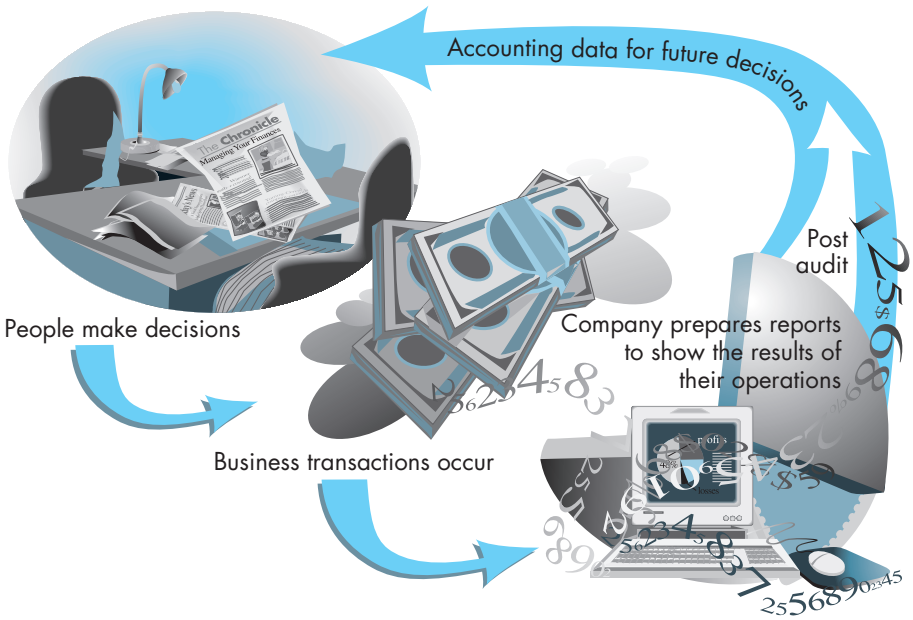


Figure 2.1 The accounting system, which illustrates the flow of information.

ability to meet scheduled payments. This kind of evaluation includes a projection of future operations and revenue based on accounting information.

An essential product of an accounting information system is a series of financial statements that allows people to make informed decisions. For business use, financial statements are the documents that report financial information about a business entity to decision makers. They tell us how a business is performing and where it stands financially. Our purpose is not to present the bookkeeping aspects of accounting, but to acquaint you with financial statements and to give you the basic information you need to make sound engineering economic decisions through the remainder of the text.

2.2 Financial Status for Businesses

Of the various reports corporations issue to their stockholders, the annual report is by far the most important, containing basic financial statements as well as management's opinion of the past year's operations and the firm's future prospects. What would managers and investors want to know about a company at the end of the fiscal year? The following are four basic questions that managers or investors are likely to ask:

- What is the company's financial position at the end of the fiscal period?
- How well did the company operate during the fiscal period?
- On what did the company decide to use its profits?
- How much cash did the company generate and spend during the fiscal period?

As illustrated in Figure 2.2, the answer to each of these questions is provided by one of the following financial statements: the balance sheet statement, the income statement, the statement of retained earnings, and the cash flow statement. The fiscal year (or operating cycle) can be any 12-month term but is usually January 1 through December 31 of a calendar year.

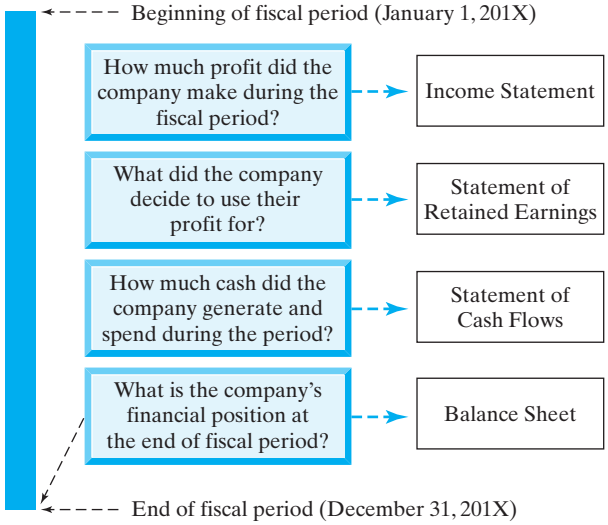


Figure 2.2 Information reported on the financial statements.

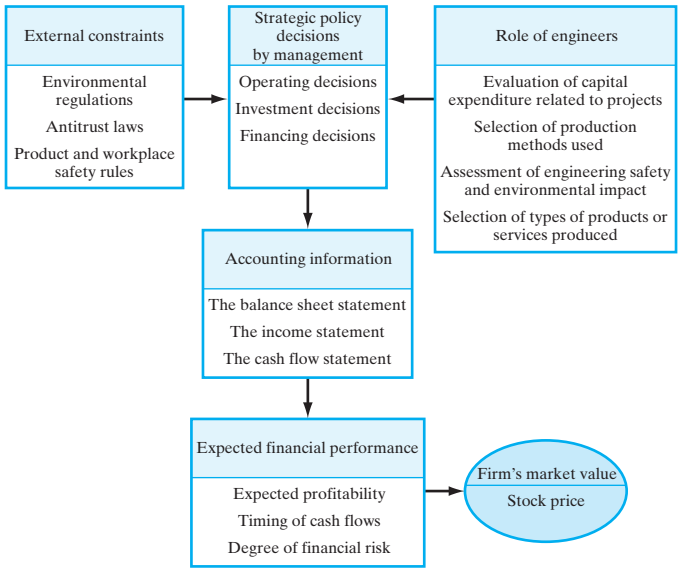


Figure 2.3 Summary of major factors affecting stock prices.

As mentioned in Section 1.1.2, one of the primary responsibilities of engineers in business is to plan for the acquisition of equipment (capital expenditure) that will enable the firm to design and produce products economically. This type of planning will require an estimation of the savings and costs associated with the acquisition of equipment and the degree of risk associated with execution of the project. Such estimation will affect the business's **bottom line** (profitability), which will eventually affect the firm's stock price in the marketplace. Therefore, engineers should understand the various financial statements in order to communicate with upper management regarding the status of a project's profitability. The situation is summarized in Figure 2.3.

Broadcom Corporation

For illustration purposes, we use data taken from Broadcom Corporation (BRCM),[1] a leading designer, manufacturer, and marketer of innovative wired and wireless communications. Broadcom (BRCM) was founded in 1991 by engineers and managed by experienced industry leaders. Based in Irvine, California, the company estimates that 99.98% of Internet traffic crosses at least one Broadcom chip—in the home, in the hand, and across the network.

The company's revenue in 2013 totaled approximately $8.305 billion. During fiscal 2013, BRCM maintained its position as one of the world's largest fabless semiconductor companies,[2] with a performance that continued to outpace the industry. In the company's 2013 annual report, management painted an even more optimistic picture for the future, stating that BRCM will continue to invest in information systems, research, development, and engineering activities to support its growth and to provide for new competitive products.

[1]Corporate Profile, BRCM, http://www.broadcom.com.

[2]Fabless manufacturing refers to the business methodology of outsourcing the manufacturing of silicon wafers.

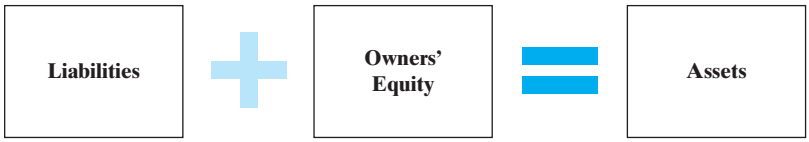


Figure 2.4 Accounting equation.

What can individual investors make of all this from the financial information contained in the annual report? Actually, they can make quite a bit. As you will see, investors use the information contained in an annual report to form expectations about future earnings and dividends. Therefore, the annual report is certainly of great interest to investors.

2.2.1 The Balance Sheet

What is the company's financial position at the end of the reporting period? We find the answer to this question in the company's **balance sheet statement**. A company's balance sheet, sometimes called its **statement of financial position**, reports three main categories of items: assets, liabilities, and stockholders' equity. This statement is based on the most fundamental tool of accounting: the accounting equation.

Accounting Equation

The **accounting equation** shows the relationship among assets, liabilities, and owners' equity, as in Figure 2.4. Every business transaction, no matter how simple or complex, can be expressed in terms of its effect on the accounting equation. Regardless of whether a business grows or contracts, the equality between the assets and the claims against the assets is always maintained. In other words, any change in the amount of total assets is necessarily accompanied by an equal change on the other side of the equation—that is, by an increase or decrease in either the liabilities or the owners' equity.

The general format used in reporting a typical balance sheet statement is shown in Figure 2.5. The dollar amount shown in the assets portion of the balance sheet represents how much the company owns at the time it issues the report. Assets are arranged in order of liquidity. Current assets are so critical that they are separately broken out and totaled. They are what will hold the business afloat for the next year. The claims against assets are of two types: liabilities and stockholders' equity. The liabilities of a company indicate where the company obtained the funds to acquire its assets and to operate the business.

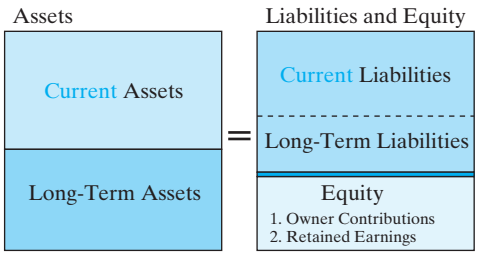


Figure 2.5 Using the four quadrants of the balance sheet.

Liability is money the company owes. Stockholders' equity is that portion of the assets of a company that is provided by the investors (owners). Therefore, stockholders' equity is the liability of a company to its owners.

Assets

The asset items are listed in the order of their "liquidity" or the length of time it takes to convert them to cash. The most liquid assets appear at the top of the list; the least liquid assets appear at the bottom. Because cash is the most liquid of all assets, it is always listed first.

- **Current assets** can be converted to cash or its equivalent in less than one year. Current assets generally include three major accounts.
  1. The first is *cash*. A firm typically has a cash account at a bank to provide for the funds needed to conduct day-to-day business. Although assets are always stated in terms of dollars, only cash represents actual money. Cash-equivalent items are also listed and include marketable securities and short-term investments.
  2. The second account is *accounts receivable*—money that is owed the firm but that has not yet been received. For example, when a company receives an order from a smartphone manufacturer, the company will send an invoice along with the shipment to the manufacturer. Then the unpaid bill immediately falls into the accounts receivable category. When the bill is paid, it will be deducted from the accounts receivable account and placed into the cash category. A typical firm will have a 30- to 45-day accounts receivable, depending on the frequency of its bills and the payment terms for customers.
  3. The third account is *inventories*, which show the dollar amount that a company has invested in raw materials, work in process, and finished goods available for sale.
- **Long-term (fixed) assets** are relatively permanent and take time to convert into cash. Fixed assets reflect the amount of money a company paid for its plant and equipment when it acquired those assets. The most common fixed asset is the physical investment in the business, such as land, buildings,[3] factory machinery, office equipment, and automobiles. With the exception of land, most fixed assets have a limited useful life. For example, buildings and equipment are used up over a period of years. Each year, a portion of the usefulness of these assets expires, and a portion of their total cost should be recognized as a depreciation expense. The term *depreciation* denotes the accounting process for this gradual conversion of fixed assets into expenses. *Property, plant and equipment*, and *net* thus represent the current book value of these assets after deducting depreciation expenses.
- Finally, **other assets** include investments made in other companies and intangible assets such as goodwill, copyrights, franchises, and so forth. Goodwill appears on the balance sheet only when an operating business is purchased in its entirety. Goodwill indicates any additional amount paid for the business above the fair market value of the business. (Here, the fair market value is defined as the price that a buyer is willing to pay when the business is offered for sale.)

[3]Land and buildings are commonly called **real assets** to distinguish them from equipment and machinery.

Liabilities

Liabilities are arranged in order of payment, the most pressing at the top of the list, the least pressing at the bottom. Like current assets, current liabilities are so critical that they are separately broken out and totaled. They are what will be paid out during the next year.

- **Current liabilities** are those debts that must be paid in the near future (normally, within one year). The major current liabilities include *accounts and notes payable* within a year. Also included are accrued expenses (wages, salaries, interest, rent, taxes, etc., which are owed but not yet due for payment) and advance payments and deposits from customers.
- **Long-term and other liabilities** include *long-term liabilities*, such as bonds, mortgages, and long-term notes that are due and payable more than one year in the future.

Stockholders' Equity (Owners' Net Worth)

Stockholders' equity represents the amount that is available to the owners after all other debts have been paid. Generally, stockholders' equity consists of preferred and common stock, treasury stock, capital surplus, and retained earnings. Preferred stock is a hybrid between common stock and debt. In case the company goes bankrupt, it must pay its preferred stockholders after its debtors, but before its common stockholders. Preferred dividend is fixed, so preferred stockholders do not benefit if the company's earnings grow. In fact, many firms do not use preferred stock. The common stockholders' equity is a residual.

- **Common (capital) stock** is the aggregate par value of the company's stock issued. Companies rarely issue stocks at a discount (i.e., at an amount below the stated par). Normally, corporations set the par value sufficiently low enough so that, in practice, stock is usually sold at a premium.
- **Paid-in capital** (capital surplus) is the amount of money received from the sale of stock that is over and above the par value of the stock. Outstanding stock is the number of shares issued that actually are held by the public.
- **Treasury stock** is often created when shares of a company are initially issued. In this case, not all shares are issued to the public, as some are kept in the company's treasury to be used to create extra cash should it be needed. If the corporation buys back part of its own issued stock on the open market, that stock is also listed as *treasury stock* on the balance sheet.
- **Retained earnings** represent the cumulative net income of the firm since its inception, less the total dividends that have been paid to stockholders. In other words, retained earnings indicate the amount of assets that have been financed by plowing profits back into the business. Therefore, retained earnings belong to the stockholders.

What to Read from BRCM's Balance Sheet Statement

As shown in Table 2.1, the first half of BRCM's year-end 2013 and 2012 balance sheets lists the firm's assets, while the remainder shows the liabilities and equity or claims against those assets. Note that all figures are in millions.

- BRCM had total assets of $3,915 and obtained the bulk of the funds it used to buy these assets:
  1. by buying on credit from its suppliers (accounts payable);
  2. by borrowing from financial institutions (notes payable and long-term bonds);

TABLE 2.1 **Consolidated Statements of Financial Position for BRCM, Ltd.**

	2013	2012	
Period End Date	**12/31/2013**	**12/31/2012**	**Changes in Account**
Assets			
Cash and Cash Equivalent	$ 1,657.0	$ 1,617.0	+40
Short-term Marketable Securities	775.0	757.0	+18
Account Receivables	795.0	740.0	+55
Inventories	525.0	527.0	−2
Prepaid Assets and Others	163.0	140.0	+23
Total Current Assets	**$ 3,915.0**	**$ 3,781.0**	**+134**
Property, Plant, and Equipment, net	593.0	485.0	+108
Goodwill and Other Intangible Assets	4,937.0	5,512.0	−575
Long-term Investments	1,939.0	1,348.0	+591
Other Non-Current Assets	111.0	82.0	+29
Total Non-Current Assets	**$ 7,580.0**	**$ 7,427.0**	**+153**
Total Assets	**$11,495.0**	**$11,208.0**	**+287**
Liabilities and Shareholders' Equity			
Account Payables	1,475.0	1,360.0	+115
Current Portion of Long-term Debt	0.0	300.0	−300
Deferred Revenue	21.0	22.0	−1
Total Current Liabilities	**$ 1,496.0**	**$ 1,682.0**	**−186**
Long-term Debt	1,394.0	1,393.0	+1
Other Long-Term Liabilities	234.0	294.0	−60
Total Non-Current Liabilities	**$ 1,628.0**	**$ 1,687.0**	**−59**
Total Liabilities	**$ 3,124.0**	**$ 3,369.0**	**−245**
Common (Capital) Stock	0.0	0.0	0
Retained Earnings	−4,107.0	−4,531.0	+424
Additional Paid in Capital	12,475.0	12,403.0	+72
Other Equity	3.0	−33.0	+36
Total Equity	**$ 8,371.0**	**$ 7,839.0**	**+532**
Total Liabilities and Equity	**$11,495.0**	**$11,208.0**	**+287**

Source: Data from BRMC 2013 Annual Report

3. by issuing common stock to investors;

4. by plowing earnings into the business, as reflected in the retained earnings entry.

- BRCM had a very strong cash position in the amount of $1,657, which is sufficient amount to cover all current liabilities if they are due on the same date.
- BRCM had the total current assets of $3,915 and the total current liabilities of $1,496. The difference is known as the **working capital**.

$$\text{Working capital} = \text{Current assets} - \text{Current liabilities}$$

The working capital indicates whether a company has enough short-term assets to cover its short-term debt.

- BRCM had a total long-term debt of $1,394 at the end of the fiscal year, consisting of several bonds issued in previous years. According to BRCM's 2013 Annual Report, BRCM repaid its outstanding long-term debt of $300 in 2013 and interest expense on long-term debt for the year was $30.
- BRCM issued about 581 million shares of common stock with a par value of $0.0001, so the book value of common stock is about $58,100, or $0.0058 million. Since it is such small number, it is shown as "−" in the balance sheet.
- BRCM had 581 shares of common stock outstanding. Investors actually provided the company with a total capital of $11,495. However, BRCM has retained the current as well as previous earnings of $4,107 since it was incorporated. BRCM also held $12,475 worth of paid-in-capital, which was raised through the current as well as previous stock offerings. The company did not issue any preferred stock. The combined net stockholders' equity was $8,371, and these equities belong to BRCM's common stockholders.

$$\text{Assets} - \text{Liabilities} - \text{Preferred stock} = \text{Common stockholders' equity}$$
$$\$11{,}495 - \$3{,}124 - \$0 = \$8{,}371$$

- On the average, stockholders have a total investment of $14.41 per share ($8,371/581 shares) in the company. The $14.41 figure is known as the stock's *book value*. In December of 2013, the stock traded in the general range from $26 to $29 per share. Note that this market price is quite different from the stock's book value. Many factors affect the market price, the most important one being how investors expect the company to perform in the future. Certainly, the company's innovative chip products have had a major influence on the market value of its stock.
- Repurchasing its own stock is equivalent to investing the firm's idle cash from operation in the stock market. BRCM could have bought another company's stock, such as IBM or Microsoft stock, with the money, but if BRCM bought their own stock, it means that BRCM liked its own stock better than any other stocks on the market.
- BRCM had negative retained earnings for two years in a row. When a company records a loss, this too is recorded in retained earnings. If the amount of the loss exceeds the amount of profit previously recorded in the retained earnings account, then a company is said to have *negative retained earnings*.

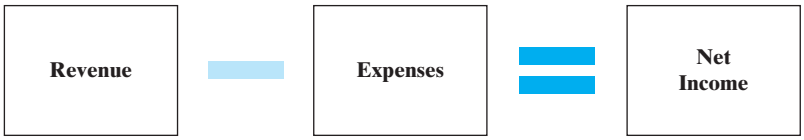


Figure 2.6 Net income-accounting profit.

2.2.2 The Income Statement

The second financial report is the **income statement**, which indicates whether the company is making or losing money during a stated *period*, usually a year. Most businesses prepare quarterly and monthly income statements as well. The company's accounting period refers to the period covered by an income statement.

Reporting Format

Just like the accounting equation, Figure 2.6 shows a simple net income equation. Typical items that are itemized in the income statement are as follows:

- **Revenue** is the income from goods sold and services rendered during a given accounting period.
- **Net revenue** represents gross sales, less any sales return and allowances.
- Shown on the next several lines are the expenses and costs of doing business as deductions from revenue. The largest expense for a typical manufacturing firm is the expense it incurs in making a product (such as labor, materials, and overhead), called the **cost of revenue** (Cost of sales or cost of goods sold).
- Net revenue less the cost of revenue gives the **gross margin**.
- Next, we subtract any other operating expenses from the gross margin. These other operating expenses are expenses associated with paying interest, leasing machinery or equipment, sales, marketing, and administration. This results in the operating income, or **operating margin**.
- Finally, we determine the **net income** (or net profit) by subtracting the income taxes from the taxable income. Net income is also commonly known as *accounting income*, or **net margin**.

Earnings per Share

Another important piece of financial information provided in the income statement is the **earnings per share** (EPS).[4] In simple situations, we compute the EPS by dividing the available earnings to common stockholders by the number of shares of common stock outstanding. Stockholders and potential investors want to know what their share of profits is, not just the total dollar amount. The presentation of profits on a per share basis allows the stockholders to relate earnings to what they paid for a share of stock. Naturally, companies want to report a higher EPS to their investors as a means of summarizing how well they managed their businesses for the benefits of the owners.

[4]In reporting EPS, the firm is required to distinguish between "basic EPS" and "diluted EPS." Basic EPS is the net income of the firm divided by the number of shares of common stock outstanding. By contrast, the diluted EPS includes all common stock equivalents (convertible bonds, preferred stock, warrants, and rights) along with common stock. Therefore, diluted EPS will usually be less than basic EPS.

Retained Earnings

As a supplement to the income statement, many corporations also report their retained earnings during the accounting period. When a corporation makes some profits, it has to decide what to do with those profits. The corporation may decide to pay out some of the profits as dividends to its stockholders. Alternatively, it may retain the remaining profits in the business in order to finance expansion or support other business activities.

When the corporation declares dividends, preferred stock has priority over common stock. Preferred stock pays a stated dividend, much like the interest payment on bonds. The dividend is not a legal liability until the board of directors has declared it. However, many corporations view the dividend payments to preferred stockholders as a liability. Therefore, "available for common stockholders" reflects the net earnings of the corporation, less the preferred stock dividends. When preferred and common stock dividends are subtracted from net income, the remainder is retained earnings (profits) for the year. As mentioned previously, these retained earnings are reinvested into the business.

What to Read from the BRCM Income Statement

For BRCM, the accounting period begins on January 1 and ends on December 31 of the following year. Table 2.2 gives the 2013 and 2012 income statements for BRCM. Clearly, it was not a good year as it had to report the declining net income even though it was still a profitable year.

BRCM's net revenue was $8,305 in 2013, compared with $8,006 in 2012, a gain of 3.74%. However, profits from operations (operating income) decreased 30.18% to $472, and net income was down 41.02% to $424.

BRCM issued no preferred stock, so there is no required cash dividend. Therefore, the entire net income of $424 could be available as cash dividends to the common stockholders. Normally, BRCM could pay it out as dividends from these earnings to the common stockholders. Instead, BRCM retained this income fully to reduce the accrued losses and decided to pay out cash dividends of $0.44 per share ($254) from their cash reserve. As shown in Table 2.1, the beginning balance of the retained earnings was −$4,531. Therefore, the total loss of retained earnings reduced to −$4,107.

Earnings per common share dropped at a faster pace in 2013, to $0.74, a decrease of 42.63% over 2012 (Table 2.2), but it also paid a larger amount of cash dividends ($0.44 per share in 2013, and $0.40 per share in 2012). Probably, BRCM's management thought their worst years were behind and needed to make the investors happy by paying cash dividends out of their current cash reserve.

2.2.3 The Cash Flow Statement

The income statement explained in the previous section indicates only whether the company was making or losing money during the reporting period. Therefore, the emphasis was on determining the net income (profits) of the firm for supporting its operating activities. However, the income statement ignores two other important business activities for the period: financing and investing activities. Therefore, we need another financial statement—the cash flow statement, which details how the company generated the cash it received and how the company used that cash during the reporting period.

TABLE 2.2 **Consolidated Statements of Income (in millions, except per share amounts) for BRCM, Ltd.**

	2013	2012
Period End Date	**12/31/2013**	**12/31/2012**
Total Revenue	**$ 8,305.0**	**$ 8,006.0**
Cost of Revenue	4,088.0	4,027.0
Gross Profit	**$ 4,217.0**	**$ 3,979.0**
Selling, General and Administrative	706.0	696.0
Research and Development	2,486.0	2,318.0
Depreciation, Amortization and Depletion	57.0	113.0
Special Income/Charges	471.0	176.0
Operating Expenses	**$ 3,745.0**	**$ 3,303.0**
Operating Income	**$ 472.0**	**$ 676.0**
Net Interest Income	−30.0	−30.0
Other Income/Expense, Net	3.0	10.0
Income before Income Taxes	**$ 445.0**	**$ 656.0**
Provision for Income Tax	21.0	−63.0
Net Income	**$ 424.0**	**$ 719.0**
Dividend Per Share	0.44	0.40
Tax Rate	0.047191	0.096037
Basic earnings per share	$ 0.74	$ 1.29
Diluted earnings per share	$ 0.73	$ 1.25
Ordinary shares outstanding	581	569

Source: Data from BRMC 2013 Annual Report

Sources and Uses of Cash

The difference between the sources (inflows) and uses (outflows) of cash represents the net cash flow during the reporting period. This is a very important piece of information, because investors determine the value of an asset (or, indeed, of a whole firm) by the cash flows it generates. Certainly, a firm's net income is important, but cash flows are even more important, particularly because the company needs cash to pay dividends and to purchase the assets required to continue its operations. As mentioned in the previous section, the goal of the firm should be to maximize the market value of the firm (or stock price). Since the value of any asset depends on the cash flows produced by the asset, managers want to maximize the cash flows available to investors over the long run. Therefore, we should make investment decisions on the basis of cash flows rather than profits. For such investment decisions, it is necessary to convert profits (as determined in the income statement) to cash flows. Here are the guidelines for distinguishing between a source and a use of cash:

- A company generates cash by reducing an asset or by increasing a liability.
- A company also uses cash to increase an asset account or to reduce a liability account.
- The net cash flow is the difference between the sources and uses of cash.

Reporting Format

In preparing the cash flow statement, many companies identify the sources and uses of cash according to the types of business activities. Basically a cash flow statement simply expands and rearranges the sources and uses statement, placing each source or use into one of three broad categories: (1) cash flows from operating activities, (2) cash flows from investing activities, and (3) cash flows from financing activities.

1. **Cash Flow from Operating Activities.** We start with the net change in operating cash flows from the income statement. Here, operating cash flows represent those cash flows related to production and the sales of goods or services. First, we add all noncash charges, such as depreciation, amortization, and deferred charges, back to net income. Although we may charge these items against current income as expenses, they do not involve an actual cash outflow. Then we add the changes in current assets and liabilities to net income, recognizing that some sales did not increase cash because customers had not yet paid. Also changes in other current assets and liabilities, such as inventories and prepaid expenses, appear here because the accountant, following the matching principle, ignored these cash flows when calculating net income for that operating period. We can lump together all these changes in current assets and current liabilities under the heading of "Changes in **working capital**.[5]

$$\text{Cash flow from operating activities} = \text{Net income} + \text{Noncash items} + \text{Changes in working capital.}$$

2. **Cash Flow from Investing Activities.** Once we determine the operating cash flows, we consider any cash flow transactions related to investment activities, which include purchasing new fixed assets (cash outflow), reselling old equipment (cash inflow), and buying and selling financial assets.
3. **Cash Flow from Financing Activities.** Finally, we detail cash transactions related to financing any capital used in business. For example, the company could borrow more money or sell more stock, resulting in cash inflows. Paying off existing debt will result in cash outflows.

By summarizing cash inflows and outflows from three activities for a given accounting period, we obtain the net change in the cash flow position of the company.

What to Read from BRCM's Cash Flow Statement

Table 2.3 is BRCM's statement of cash flows, as it would appear in the company's annual report. Note that all figures are in millions.

The cash flow categories and their values for BRCM in 2013 are as follows:

1. Cash flows from operating activities: $1,785 (source).
2. Cash flows from investing activities: −$996 (use).
3. Cash flows from financing activities: −$749 (use).

And the net cash generated during the reporting period is $40. BCRM's operating activities provided $1,785 in cash. This was primarily the result of net income of $424 and

[5]The difference between the change in current assets (excluding the cash and cash equivalents) and the change in current liabilities is the **net change in net working capital**. If this change is positive, then additional financing is needed to fund the increase in current assets. This will further reduce the cash flow from the operating activities.

TABLE 2.3 **Consolidated Statements of Cash Flows (in millions) for BRCM, Ltd.**

	2013	2012
Period End Date	**12/31/2013**	**12/31/2012**
Operating Activities:		
Net Income	$ 424.0	$ 719.0
Depreciation and Amortization	401.0	445.0
Other Non-cash Items	$ 1,027.0	$ 615.0
Changes in Working Capital	−67.0	152.0
Cash Flow from Operating Activities	**$ 1,785.0**	**$ 1,931.0**
Investing Activities:		
Purchase/Sale of Property, Plant, Equip: Net	−228.0	−244.0
Purchase/Sale of Business, Net	−142.0	−3,582.0
Purchase/Sale of Investments, Net	−626.0	−970.0
Cash Flow from Investing Activities	**$ −996.0**	**$ −4,796.0**
Financing Activities:		
Issuance/Payments of Debt, Net	−300.0	492.0
Issuance/Payments of Common Stock, Net	−65.0	278.0
Cash Dividends Paid	−254.0	−224.0
Other Financing Changes, Net	−130.0	−210.0
Cash Flow from Financing Activities	**$ −749.0**	**$ 336.0**
Cash, Equivalents, Start of Period	1,617.0	4,146.0
Cash, Equivalents, End of Period	1,657.0	1,617.0
Change in Cash	**$ 40.0**	**$ −2,529.0**

Source: Data from BRMC 2013 Annual Report

net non-cash operating expenses of $1,428, offset in part by changes in current assets and liabilities of $67. Clearly, the net cash generated from the operating activities ($1,785) is quite different from the net income earned ($424) for the same period. Why is the cash position so different from the net income earned? The main reason for the difference lies in the accrual-basis accounting principle used by the BRCM Corporation. In **accrual-basis accounting**, an accountant recognizes the impact of a business event as it occurs. When the business performs a service, makes a sale, or incurs an expense, the accountant enters the transaction into the books, regardless of whether cash has or has not been received or paid. For example, an increase in account receivables of $795 − $740 = $55 during 2013 represents the amount of total sales on credit (Table 2.1). Since the $55 figure was included in the total sales in determining the net income, we need to subtract it to determine the company's true cash position. After making similar adjustments to all other current assets and current liabilities, BRCM reported the net changes under the name of "Changes in Working Capital" in the amount of $67. Factoring in non-cash outlay items, the net cash provided from operating activities is $1,785.

- With regards to investment activities, BRCM used $996 in cash in 2013, which was primarily the result of $611 in net purchases of marketable securities, $228 of capital equipment purchases mostly to support the company's research and development efforts, $142 in net cash paid for the business acquisition, and $15 of purchases of strategic investments which is listed under "Purchase/Sale of Investment."
- Financing activities used $749 in cash; $65 of which was primarily the result of $597 in repurchases of the firm's Class A common stock, offset in part by $532 in proceeds received from issuances of common stock, the repayment of long-term debt of $300, dividend paid of $254, and $130 in other business transactions, Normally most firms would pay cash dividends out of earnings but BRCM paid out of the proceeds from stock sales.
- Together, the three types of activities generated a total cash inflow of $40. With the initial cash balance of $1,617, the ending cash balance thus increased to $1,785. This same amount denotes the change in BRCM's cash position, as shown in the cash accounts in the balance sheet in Table 2.1.

EXAMPLE 2.1 Estimating Cash Flows from Operations

A comparative balance sheet for J&M, Inc. containing data for the two reporting periods is given in Table 2.4, and the reported income statement during 2015 is also shown in Table 2.5. All figures (except the tax rate) are in thousands. The following additional information is available about the company's activities during 2015, the current year.

- Cash dividends declared and paid to the preferred stockholders totaled $600.
- Cash dividends paid to the common shareholders totaled $9,400.
- J&M purchased $9,000 worth of equipment.
- J&M paid off $2,000 long-term debt.
- The number of outstanding preferred and common stockholders was 100 and 10,000 respectively.
- The effective tax rate is 28.77%.

TABLE 2.4 Comparative Balance Sheet for J&M, Inc.

J&M, Inc. Comparative Balance Sheet Statement December 31, 2015, and 2014			
	2015	**2014**	**Changes**
Assets			
Current assets:			
Cash and cash equivalents	$ 8,500	$ 6,100	2,400
Short-term marketable securities	3,000	5,000	(2,000)

TABLE 2.4 (*continued*)

J&M, Inc. Comparative Balance Sheet Statement December 31, 2015, and 2014			
	2015	**2014**	**Changes**
Accounts receivable	23,700	19,500	4,200
Inventory	37,700	39,800	(2,100)
Prepaid expenses	2,000	1,500	500
Deferred charges	2,500	3,000	(500)
Total current assets	**77,400**	**74,900**	2,500
Long-term Assets:			–
Property and equipment	154,000	145,000	9,000
Less accumulated depreciation	(70,000)	(50,000)	(20,000)
Total assets	**161,400**	**169,900**	(8,500)
Liabilities and Shareholders' Equity			
Current liabilities:			
Accounts payable	10,000	26,000	(16,000)
Wages payable	16,000	15,000	1,000
Accrued taxes	2,000	3,500	(1,500)
Total current liabilities	**28,000**	**44,500**	(16,500)
Other liabilities			
Long-term debt	30,000	32,000	(2,000)
Total liabilities	**58,000**	**76,500**	(18,500)
Shareholders' equity			
Preferred stock	10,000	10,000	
Common stock	40,000	40,000	
Additional paid-in capital	11,000	11,000	
Retained earnings	42,400	32,400	10,000
Total owners' equity	**103,400**	**93,400**	10,000
Total liabilities and equity	**161,400**	**169,900**	(8,500)

TABLE 2.5 The Income Statement for J&M, Inc.

J&M, Inc. The Income Statement (For Year Ended December 31, 2015)	
Total revenue	$ 300,000
Cost of revenue	188,000
Gross profit	112,000
Selling, general and administrative	44,720
Depreciation	20,000
Lease payment	14,000
Operating income	33,280
Interest expense, net	(5,200)
Income before income taxes	28,080
Provision for income taxes	(8,080)
Net income	$ 20,000

Based on the information provided, estimate the cash flows from three activities in 2015.

SOLUTION

Given: Financial data as given in Tables 2.4 and 2.5

Find: (a) cash flows from operating activities, (b) cash flows from investing activities, and (c) cash flows from financing activities.

(a) Cash flows from operating activities: Note that we can estimate the cash flows from operating activities with the following equation:

$$\text{Cash flow from operating activities} = \text{Net income} + \text{Noncash items (Depreciation)} + \text{Changes in working capital.}$$

	Source/Use		Cash Flow
Net income			$ 20,000
Adjustments to net income			
Depreciation			20,000
Changes in current assets and liabilities:			
Decrease in short-term marketable securities	Source	2,000	
Increase in accounts receivables	Use	(4,200)	
Decrease in inventory	Source	2,100	

(*continued*)

	Source/Use			Cash Flow
increase in prepaid expenses	Use	(500)		
Decrease in deferred charges	Source	500		
Net changes in current assets	**Use**		(100)	
Decrease in accounts payable	Use	(16,000)		
Increase in wages payable	Source	1,000		
Decrease in accrued taxes	Use	(1,500)		
Net changes in current liabilities	**Use**		(16,500)	
Changes in working capital				(16,600)
Cash flows from operating activities				**$ 23,400**

(b) Cash flows from investing activities:

Purchased equipment: $9,000 (use)

(c) Cash flows from financing activities:

Reduction in long-term debt: $2,000 (use)
Cash dividends: $10,000 (use)

Net cash flows in 2015 = $23,400 − $9,000 − $2,000 − $10,000 = **$2,400**

COMMENTS: This cash amount is exactly the same as the increase of $2,400 in the cash account reported in the J&M's balance sheet.

2.3 Using Ratios to Make Business Decisions

As we have seen in BRCM's financial statements, the purpose of accounting is to provide information for decision-making. Accounting information tells what happened at a particular point in time. In that sense, financial statements are essentially historical documents. However, most users of financial statements are concerned about what will happen in the future. For example:

- Stockholders are concerned with future earnings and dividends.
- Creditors are concerned with the company's ability to repay its debts.
- Managers are concerned with the company's ability to finance future expansion.
- Engineers are concerned with planning actions that will influence the future course of business events.

Although financial statements are historical documents, they can still provide valuable information bearing on all of these concerns. An important part of financial analysis is the calculation and interpretation of various financial ratios. In this section, we consider some of the ratios that analysts typically use in attempting to predict the future course of events in business organizations. We may group these ratios into five categories (debt management, liquidity, asset management, profitability, and market trend) as outlined in Figure 2.7. In all financial ratio calculations, we will use the 2013 financial statements for BRCM.

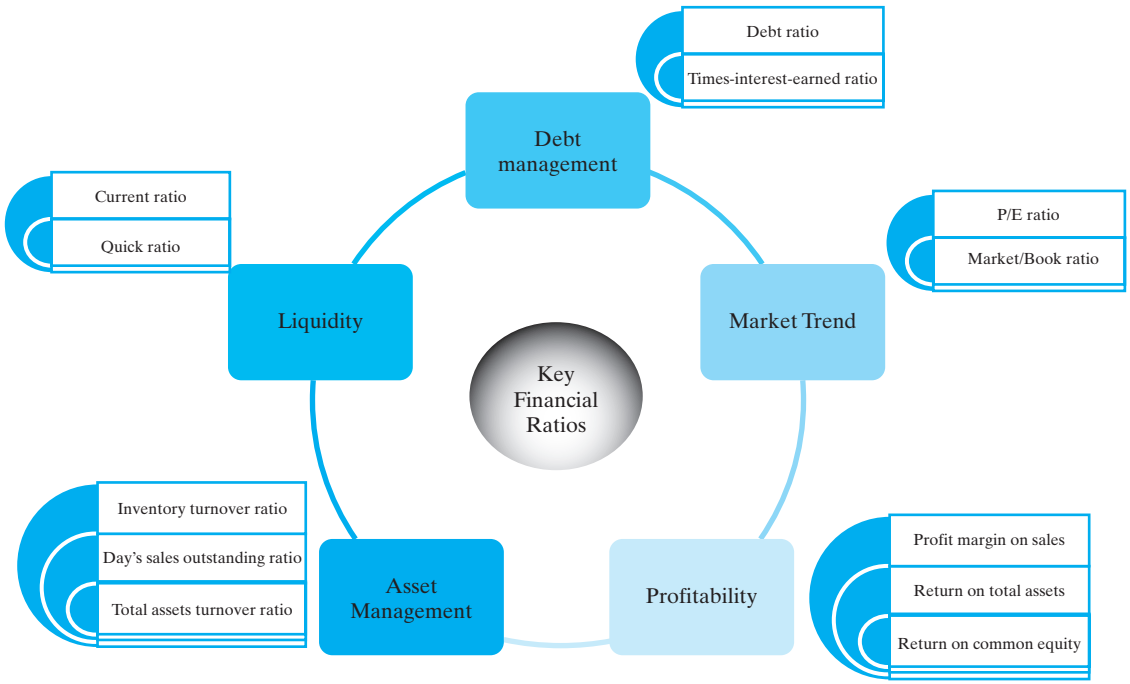


Figure 2.7 Types of financial ratios used in evaluating a firm's financial health.

2.3.1 Debt Management Analysis

All businesses need assets to operate. To acquire assets, the firm must raise capital. When the firm finances its long-term needs externally, it may obtain funds from the capital markets. Capital comes in two forms: **debt** and **equity**. Debt capital is capital borrowed from financial institutions. Equity capital is capital obtained from the owners of the company.

The basic methods of financing a company's debt are through bank loans and the sale of bonds. For example, suppose a firm needs $10,000 to purchase a computer. In this situation, the firm would borrow money from a bank and repay the loan, together with the interest specified, in a few years. This kind of financing is known as *short-term debt financing*. Now suppose that the firm needs $100 million for a new product development project. Normally, it would be very expensive (or require a substantial mortgage) to borrow the money directly from a bank. In this situation, the company would go public to borrow money on a long-term basis. When investors lend capital to a company and the company consents to repay the loan at an agreed-upon interest rate, the investor is the creditor of the corporation. The document that records the nature of the arrangement between the issuing company and the investor is called a **bond**. Raising capital by issuing a bond is called *long-term debt financing*.

Similarly, there are different types of equity capital. For example, the equity of a proprietorship represents the money provided by the owner. For a corporation, equity capital comes in two forms: *preferred stock* and *common stock*. Investors provide capital to a corporation, and the company agrees to endow the investor with fractional ownership

in the corporation. Preferred stock pays a stated *dividend*, much like the interest payment on bonds. However, the dividend is not a legal liability until the company declares it. Preferred stockholders have preference over common stockholders as regards the receipt of dividends if the company has to liquidate its assets. We can examine the extent to which a company uses debt financing (or financial leverage) in the operation of its business if we:

- Check the balance sheet to determine the extent to which borrowed funds have been used to finance assets; and
- Review the income statement to see the extent to which fixed charges (interests) are covered by operating profits.

Two essential indicators of a business's ability to pay its long-term liabilities are the *debt ratio* and the *times-interest-earned ratio*, as shown in Figure 2.8.

Debt Ratio

The relationship between total liabilities and total assets, generally called the **debt ratio**, tells us the proportion of the company's assets that it has financed with debt:

$$\text{Debt ratio} = \frac{\text{Total debt}}{\text{Total assets}}$$

$$= \frac{\$3{,}124}{\$11{,}495} = 27.17\%$$

Total debt includes both current liabilities and long-term debt. If the debt ratio is unity, then the company has used debt to finance all of its assets. As of December 31, 2013, BRCM's debt ratio was 27.17%; this means that its creditors have supplied close to 28% of the firm's total financing. Certainly, most creditors prefer low debt ratios, because the lower the ratio, the greater is the cushion against creditors' losses in case of liquidation. If a company seeking financing already has large liabilities, then additional debt payments may be too much for the business to handle. For such a highly leveraged company, creditors generally charge higher interest rates on new borrowing to help protect themselves.

Times-Interest-Earned Ratio

The most common measure of the ability of a company's operations to provide protection to the long-term creditor is the times-interest-earned ratio. We find this ratio by dividing earnings before interest and income taxes (EBIT) by the yearly interest charges that must

Figure 2.8 Debt management ratios.

be met. BRCM issued $1,394 worth of senior notes and long-term bonds. This results in $30 in interest expenses[6] in 2013:

$$\text{Times-interest-earned ratio} = \frac{\text{EBIT}}{\text{Interest expense}}$$

$$= \frac{\$445 + \$30}{\$30} = 15.83 \text{ times}$$

The times-interest-earned ratio measures the extent to which operating income can decline before the firm is unable to meet its annual interest costs. Failure to meet this obligation can bring legal action by the firm's creditors, possibly resulting in the company's bankruptcy. Note that we use the earnings before interest and income taxes, rather than net income, in the numerator. Because BRCM must pay interest with pretax dollars, BRCM's ability to pay current interest is not affected by income taxes. Only those earnings remaining after all interest charges are subject to income taxes. For BRCM, the times-interest-earned ratio for 2013 would be 15.83 times. This ratio is relatively low compared with the rest of the industry's 54.91 times during the same operating period.

2.3.2 Liquidity Analysis

If you were one of the many suppliers to BRCM, your primary concern would be whether BRCM will be able to pay off its debts as they come due over the next year or so. Short-term creditors want to be repaid on time; therefore they focus on BRCM's cash flows and on its working capital, as these are the company's primary sources of cash in the near future. The excess of current assets over current liabilities is known as **working capital**, a figure that indicates the extent to which current assets can be converted to cash to meet current obligations. Therefore, we view a firm's net working capital as a measure of its *liquidity* position. In general, the larger the working capital, the better able the business is to pay its debt. As shown in Figure 2.9, two ratios are related to liquidity analysis.

Liquidity Analysis

Ratios that show the relationship of a firm's cash and other assets to its current liabilities

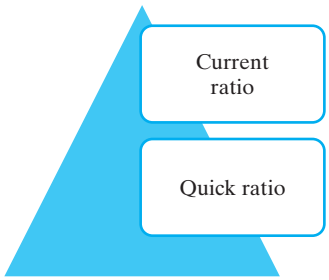


Figure 2.9 Ratios related to liquidity analysis.

[6]Unless the interest expenses are itemized in the income statement, you will find them in the firm's annual report.

Current Ratio

We calculate the **current ratio** by dividing current assets by current liabilities:

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

$$= \frac{\$3{,}915}{\$1{,}496} = 2.62 \text{ times}$$

If a company is getting into financial difficulty, it begins paying its bills (accounts payable) more slowly, borrowing from its bank, and so on. If current liabilities are rising faster than current assets, the current ratio will fall, and that could spell trouble. What is an acceptable current ratio? The answer depends on the nature of the industry. The general rule of thumb calls for a current ratio of 2 to 1. This rule, of course, is subject to many exceptions, depending heavily on the composition of the assets involved.

Quick (Acid-Test) Ratio

The quick ratio tells us whether a company could pay all of its current liabilities if they came due immediately. We calculate the quick ratio by deducting inventories from current assets and then dividing the remainder by current liabilities:

$$\text{Quick ratio} = \frac{\text{Current assets} - \text{Inventories}}{\text{Current liabilities}}$$

$$= \frac{\$3{,}915 - \$525}{\$1{,}496} = 2.27 \text{ times}$$

The quick ratio measures how well a company can meet its obligations without having to liquidate or depend too heavily on its inventory. Inventories are typically the least liquid of a firm's current assets; hence, they are the assets on which losses are most likely to occur in the case of liquidation. These ratios indicate that BRCM's liquidity position is relatively strong, as it has carried very little inventory in its current assets (only $525 out of $3,915 of current assets, or 13.41%). We often compare against industry average figures and should note at this point that an industry average is not an absolute number that all firms should strive to maintain. In fact, some very well managed firms will be above the average, while other good firms will be below it. However, if we find that a firm's ratios are quite different from the average for its industry, we should examine the reason for the difference.

2.3.3 Asset Management Analysis

The ability to sell inventory and collect accounts receivables is fundamental to business success. Therefore, the third group of ratios measures how effectively the firm is managing its assets. As shown in Figure 2.10, we will review three ratios related to a firm's asset management: (1) the inventory turnover ratio, (2) the day's sales outstanding ratio, and (3) the total asset turnover ratio. The purpose of these ratios is to answer this question: Does the total amount of each type of asset, as reported on the balance sheet, seem reasonable in view of current and projected sales levels? The acquisition of any asset requires the use of funds. On the one hand, if a firm has too many assets, its cost of capital will be too high; hence, its profits will be depressed. On the other hand, if assets are too low, the firm is likely to lose profitable sales.

Asset Management

A set of ratios that measure how effectively a firm is managing its assets

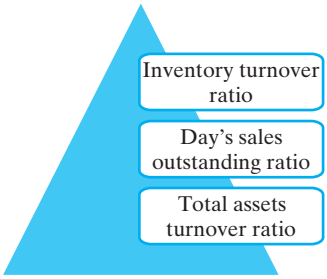


Figure 2.10 Ratios related to asset management.

Inventory Turnover

The inventory turnover ratio measures how many times the company sold and replaced its inventory over a specific period—for example, during the year. We compute the ratio by dividing sales by the average level of inventories on hand. We compute the average inventory figure by taking the average of the beginning and ending inventory figures. Since BRCM has a beginning inventory figure of $527 and an ending inventory figure of $525, its average inventory for the year would be $526, or ($527 + $525)/2. We then compute BRCM's inventory turnover for 2013 as

$$\text{Inventory turnover ratio} = \frac{\text{Sales}}{\text{Average inventory balance}}$$

$$= \frac{\$8{,}305}{\$526} = 15.79 \text{ times}$$

As a rough approximation, BRCM was able to sell and restock its inventory 15.79 times per year. BRCM's turnover of 15.79 times is much faster than its competitor QCOM (Qualcomm, Inc.) at 7.91 times during the same reporting period. This suggests that QCOM is holding excess stocks of inventory; excess stocks are, of course, unproductive, and they represent an investment with a low or zero rate of return.

Day's Sales Outstanding (Accounts Receivable Turnover)

The day's sales outstanding (DSO) is a rough measure of how many times a company's accounts (or trade) receivable have been turned into cash during the year. We determine this ratio, also called the **average collection period**, by dividing accounts receivable by average sales per day. In other words, the DSO indicates the average length of time the firm must wait after making a sale before receiving cash. For BRCM,

$$\text{DSO} = \frac{\text{Receivables}}{\text{Average sales per day}} = \frac{\text{Receivables}}{\text{Annual sales}/365}$$

$$= \frac{\$795}{\$8{,}305/365} = 34.94 \text{ days}$$

Thus, on average, it takes BRCM 34.94 days to collect on a credit sale. During the same period, QCOM's average collection period was 12.52 days. Whether the average of 34.94 days taken to collect an account is good or bad depends on the credit terms BRCM is offering its customers. If the credit terms are 30 days, we can say that BRCM's customers,

on average, are not paying their bills on time. In order to improve their working-capital position, most customers tend to withhold payment for as long as the credit terms will allow and may even go over a few days. The long collection period may signal either that customers are in financial trouble or that the company manages its credit poorly.

Total Assets Turnover

The total assets turnover ratio measures how effectively the firm uses its total assets in generating its revenues. It is the ratio of sales to all the firm's assets:

$$\text{Total assets turnover ratio} = \frac{\text{Sales}}{\text{Total assets}}$$

$$= \frac{\$8{,}305}{\$11{,}495} = 0.7225 \text{ times}$$

BRCM's ratio of 0.7225 times, compared with QCOM's 0.54, is almost 34% faster, indicating that BRCM is using its total assets about 34% more intensively than QCOM is. In fact, BRCM's total investment in plant and equipment is about 20% of QCOM's. If we view BRCM's ratio as the industry average, we can say that QCOM has too much investment in inventory, plant, and equipment compared to the size of sale.

2.3.4 Profitability Analysis

One of the most important goals for any business is to earn a profit. The ratios examined thus far provide useful clues about the effectiveness of a firm's operations, but the profitability ratios show the combined effects of liquidity, asset management, and debt on operating results. Therefore, ratios that measure profitability play a large role in decision-making. As shown in Figure 2.11, three ratios are related to profitability analysis.

Profit Margin on Sales

We calculate the profit margin on sales by dividing net income by sales. This ratio indicates the profit per dollar of sales:

$$\text{Profit margin on sales} = \frac{\text{Net income available to common stockholders}}{\text{Sales}}$$

$$= \frac{\$424}{\$8{,}305} = 5.11\%$$

Profitability Analysis

A set of ratios that show the combined effects of liquidity, asset management, and debt on operating results

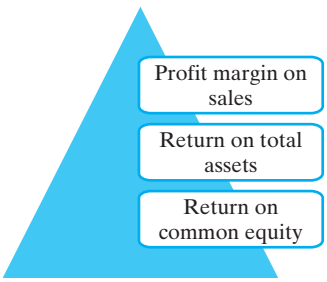


Figure 2.11 Ratios related to profitability analysis.

Thus, BRCM's profit margin is equivalent to 5.11 cents for each sales dollar generated. BRCM's profit margin is much smaller than QCOM's profit margin of 26.9%, indicating that, although QCOM's sales are about 300% more than BRCM's revenue during the same operating period, QCOM's operation is equally more efficient than BRCM's. BRCM's lower profit margin is also a result of its carrying a higher level of debt. Recall that net income is income after taxes. Therefore, if two firms have identical operations in the sense that their sales, operating costs, and earnings before income tax are the same, but if one company uses more debt than the other, it will have higher interest charges. Those interest charges will pull net income down, and since sales are constant, the result will be a relatively low profit margin.

Return on Total Assets

The return on total assets—or simply, return on assets (ROA)—measures a company's success in using its assets to earn a profit. The ratio of net income to total assets measures the return on total assets after taxes:

$$\text{Return on total assets} = \frac{\text{Net income} + \text{interest expense}\,(1 - \text{tax rate})}{\text{Average total assets}}$$

$$= \frac{\$424 + \$30(1 - 0.047191)}{(\$11{,}208 + \$11{,}495)/2} = 4\%$$

Adding interest expenses back to net income results in an adjusted earnings figure that shows what earnings would have been if the assets had been acquired solely by selling shares of stock. (Note that BRCM's effective tax rate was 4.72% in 2013.) With this adjustment, we may be able to compare the return on total assets for companies with differing amounts of debt. Again, BRCM's 4% return on assets is well below the 14.49% for QCOM. This high return for QCOM results from (1) the company's high basic earning power and (2) its low use of debt, both of which cause its net income to be relatively high.

Return on Common Equity

Another popular measure of profitability is rate of return on common equity. This ratio shows the relationship between net income and common stockholders' investment in the company—that is, how much income is earned for every $1 invested by the common stockholders. To compute the return on common equity, we first subtract preferred dividends from net income, yielding the net income available to common stockholders. With no preferred stocks for BRCM, there were no preferred cash dividends. We then divide this net income available to common stockholders by the average common stockholders' equity during the year. We compute average common equity by using the beginning and ending balances. At the beginning of fiscal year 2013, BRCM's common equity balance was $7,839; at the end of fiscal year 2013, the balance was $8,371. The average balance is then simply $8,105, and we have

$$\text{Return on common equity} = \frac{\text{Net income available to common stockholders}}{\text{Average common equity}}$$

$$= \frac{\$424}{\$8{,}105} = 5.23\%$$

The rate of return on common equity for BRCM was 5.23% during 2013. Over the same period, QCOM's return on common equity amounted to 18.23%, a better performance relative to the computer industry (14.92% in 2013) in general, but BRCM had a poor year again.

To learn more about what management can do to increase the return on common equity, or ROE, we may rewrite the ROE in terms of the following three components:

$$\text{ROE} = \frac{\text{Net income available to common stockholders}}{\text{Average stockholders' equity}}$$

$$= \frac{\text{Net income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Assets}} \times \frac{\text{Assets}}{\text{Average stockholders' equity}}$$

The three principal components can be described as the profit margin, asset turnover, and financial leverage, respectively, so that

$$\text{ROE} = (\text{Profit margin}) \times (\text{Asset turnover}) \times (\text{Financial leverage})$$

$$= (5.11\%) \times (0.7225) \times \left(\frac{\$11{,}495}{\$8{,}105}\right)$$

$$= 5.23\%$$

This expression tells us that management has only three key ratios for controlling a company's ROE: (1) the earnings from sales (the profit margin); (2) the revenue generated from each dollar of assets employed (asset turnover); and (3) the amount of equity used to finance the assets in the operation of the business (financial leverage).

2.3.5 Market Value Analysis

When you purchase a company's stock, what are your primary factors in valuing the stock? In general, investors purchase stock to earn a return on their investment. This return consists of two parts: (1) gains (or losses) from selling the stock at a price that differs from the investors' purchase price; and (2) dividends—the periodic distributions of profits to stockholders. As shown in Figure 2.12, the market value ratios, such as the price-to-earnings ratio and the market-to-book ratio, relate the firm's stock price to its earnings and book value per share, respectively. These ratios give management an indication of what investors think of the company's past performance and future prospects. If the firm's asset

Market Value Analysis

A set of ratios that relate the firm's stock price to its earnings and book value per share

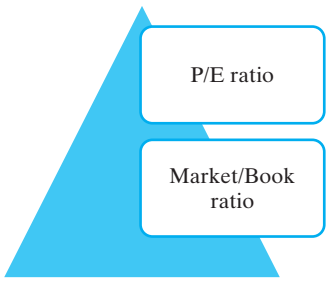


Figure 2.12 Ratios related to market value analysis.

and debt management is sound and its profit is rising, then its market value ratios will be high, and its stock price will probably be as high as can be expected.

Price-to-Earnings Ratio

The price-to-earnings (*P*/*E*) ratio shows how much investors are willing to pay per dollar of reported profits. BRCM's stock sold for $29.64 at the end of the fiscal period (December 31, 2013), so with an EPS of $0.74, its *P*/*E* ratio was 40.05:

$$P/E \text{ ratio} = \frac{\text{Price per share}}{\text{Earnings per share}}$$

$$= \frac{\$29.64}{\$0.74} = 40.05$$

That is, the stock was selling for about 40 times its current earnings per share. In general, *P*/*E* ratios are higher for firms with high growth prospects, other things held constant, but they are lower for firms with lower expected earnings. BRCM's expected annual increase in operating earnings is 14.6% over the next 3 to 5 years. Since BRCM's ratio is greater than 7.55%, the average for other computer industry firms, this suggests that investors value BRCM's stock more highly than most as having excellent growth prospects, believing that their worst years are behind. However, all stocks with high *P*/*E* ratios carry high risk whenever the expected growths fail to materialize. Any slight earnings disappointment tends to punish the market price significantly.

Book Value per Share

Another ratio frequently used in assessing the well-being of the common stockholders is the book value per share, which measures the amount that would be distributed to holders of each share of common stock if all assets were sold at their balance sheet carrying amounts and if all creditors were paid off. We compute the book value per share for BRCM's common stock as follows:

$$\text{Book value per share} = \frac{\text{Total stockholders' equity} - \text{preferred stock}}{\text{Average shares outstanding}}$$

$$= \frac{\$8{,}371 - \$0}{(569 + 581)/2} = \$14.56$$

If we compare this book value with the market price of $29.64 at the end of BRCM's fiscal period (December 31, 2013), then we may say that the stock appears to be overpriced. Once again, though, market prices reflect expectations about future earnings and dividends, whereas book value largely reflects the results of events that occurred in the past. Therefore, the market value of a stock tends to exceed its book value.

2.3.6 Limitations of Financial Ratios in Business Decisions

Business decisions are made in a world of uncertainty. As useful as ratios are, they have limitations. We can draw an analogy between their use in decision making and a physician's use of a thermometer. A reading of 102°F indicates that something is wrong with the patient, but the temperature alone does not indicate what the problem is or how to cure it. In other words, ratio analysis is useful, but analysts should be aware of ever-changing market conditions and make adjustments as necessary. It is also difficult to generalize

about whether a particular ratio is "good" or "bad." For example, a high current ratio may indicate a strong liquidity position, which is good, but holding too much cash in a bank account (which will increase the current ratio) may not be the best utilization of funds. Ratio analysis based on any one year may not represent the true business condition. It is important to analyze trends in various financial ratios, as well as their absolute levels, for trends give clues as to whether the financial situation is likely to improve or deteriorate. To do a **trend analysis**, one simply plots a ratio over time. As a typical engineering student, your judgment in interpreting a set of financial ratios is understandably weak at this point, but it will improve as you encounter many facets of business decisions in the real world. Again, accounting is a language of business, and as you speak it more often, it can provide useful insights into a firm's operations.

EXAMPLE 2.2 Ratio Analysis for J&M, Inc.

Reconsider the J&M's financial statements given in Tables 2.4 and 2.5 and other data given in Example 2.1. Compute the following values for 2015.

(a) The amount of working capital.
(b) The debt to equity ratio.
(c) The time-interest-earned ratio.
(d) The current ratio.
(e) The quick ratio.
(f) The inventory-turnover ratio.
(g) The days-sales-outstanding ratio.
(h) The total asset turnover ratio.
(i) The profit margin.
(j) The return on total assets.
(k) The return on common equity.

SOLUTION

Given: Financial statements given in Tables 2.4 and 2.5, and other financial data provided in Example 2.1, tax rate = 28.77%.

Find: Compute the financial ratios.

(a) The amount of working capital:

$$\begin{aligned}\text{Working capital} &= \text{Current assets} - \text{Current liabilities}\\ &= \$77{,}400 - \$28{,}000\\ &= \$49{,}400\end{aligned}$$

(b) The debt ratio:

$$\text{Debt ratio} = \frac{\text{Total debt}}{\text{Total assets}} = \frac{\$58{,}000}{\$161{,}400} = 35.94\%$$

(c) The time-interest-earned ratio:

$$\text{Times-interest-earned ratio} = \frac{\text{EBIT}}{\text{Interest expense}} = \frac{\$33{,}280}{\$5{,}200} = 6.40 \text{ times}$$

(d) The current ratio:

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current labilities}} = \frac{\$77{,}400}{\$28{,}000} = 2.76 \text{ times}$$

(e) The quick ratio:

$$\text{Quick ratio} = \frac{\text{Current assets} - \text{Inventory}}{\text{Current labilities}} = \frac{\$77{,}400 - \$37{,}700}{\$28{,}000}$$

$$= 1.42 \text{ times}$$

(f) The inventory-turnover ratio:

$$\text{Inventory Turnover} = \frac{\text{Sales}}{\text{Average Inventory}} = \frac{\$300{,}000}{(\$39{,}800 + \$37{,}700)/2}$$

$$= 7.74 \text{ times}$$

The typical item sits in inventory almost 1.55 months (12 months/7.74) or 46.51 days before being sold.

(g) The days-sales-outstanding ratio:

$$\text{DSO} = \frac{\text{A/R}}{\text{Average sales per day}} = \frac{\$23{,}700}{\$300{,}000/365} = 28.84 \text{ days}$$

(h) The total asset turnover ratio:

$$\text{Total Asset Turnover} = \frac{\text{Sales}}{\text{Total Assets}} = \frac{\$300{,}000}{\$161{,}400} = 1.86 \text{ times}$$

(i) The net profit margin:

$$\text{Net Margin Ratio} = \frac{\text{Net Income (\$)}}{\text{Net Sales}} = \frac{\$20{,}000}{\$300{,}000} = 6.67\%$$

(j) The return on total assets:

$$\text{Return on Total Assets} = \frac{\text{Net Income} + \text{interest expenses } (1 - \text{tax rate})}{\text{Average total assets}}$$

$$= \frac{\$20{,}000 + \$5{,}200\,(1 - 0.2877)}{(\$161{,}400 + \$169{,}900)/2}$$

$$= 14.31\%$$

(k) The return on common equity.

$$\text{Return on Equity} = \frac{\text{Net Income} - \text{Cash Dividend to Preferred Stockholders}}{\text{Average Common Equity}}$$

$$= \frac{\$20{,}000 - \$600}{(\$93{,}400 + \$83{,}400)/2}$$

$$= 21.95\%$$

SUMMARY

The primary purposes of this chapter were to (1) describe the basic financial statements, (2) present some background information on cash flows and corporate profitability, and (3) discuss techniques used by investors and managers to analyze financial statements. The following are some concepts we covered.

- Before making any major financial decisions, it is important to understand their impact on your net worth. Your net-worth statement is a snapshot of where you stand financially at a given point in time.
- The three basic financial statements contained in the annual report are the balance sheet, the income statement, and the statement of cash flows. Investors use the information provided in these statements to form expectations about future levels of earnings and dividends and about the firm's risk-taking behavior.
- A firm's balance sheet shows a snapshot of a firm's financial position at a particular point in time through three categories: (1) assets the firm owns, (2) liabilities the firm owes, and (3) owners' equity (assets less liabilities).
- A firm's income statement reports the results of operations over a period of time and shows earnings per share as its "bottom line." The main items are (1) revenues and gains, (2) expenses and losses, and (3) net income or net loss (revenue less expenses).
- A firm's statement of cash flows reports the impact of operating, investing, and financing activities on cash flows over an accounting period.
- The purpose of calculating a set of financial ratios is twofold: (1) to examine the relative strengths and weaknesses of a company compared with those of other companies in the same industry; and (2) to learn whether the company's position has been improving or deteriorating over time.
- Liquidity ratios show the relationship of a firm's current assets to its current liabilities and thus its ability to meet maturing debts. Two commonly used liquidity ratios are the current ratio and the quick (acid-test) ratio.
- Asset management ratios measure how effectively a firm is managing its assets. Some of the major ratios are inventory turnover, fixed assets turnover, and total assets turnover.
- Debt management ratios reveal (1) the extent to which a firm is financed with debt and (2) the firm's likelihood of defaulting on its debt obligations. In this category are the debt ratio and the times-interest-earned ratio.
- Profitability ratios show the combined effects of liquidity, asset management, and debt management policies on operating results. Profitability ratios include the profit margin on sales, the return on total assets, and the return on common equity.
- Market value ratios relate the firm's stock price to its earnings and book value per share, and they give management an indication of what investors think of the company's past performance and future prospects. Market value ratios include the price-to-earnings ratio and the book value per share.
- Trend analysis, in which one plots a ratio over time, is important, because it reveals whether the firm's ratios are improving or deteriorating over time.

PROBLEMS

Financial Statements

2.1 Consider the balance-sheet entries for War Eagle Corporation in Table P2.1.

(a) Compute the firm's

Current assets: $_____

Current liabilities: $_____

Working capital: $_____

Shareholders' equity: $_____

TABLE P2.1 Balance Sheet Statement as of December 31, 2015

Assets		
Cash		$ 150,000
Marketable securities		200,000
Accounts receivable		150,000
Inventories		50,000
Prepaid taxes and insurance		30,000
Manufacturing plant at cost	$ 600,000	
Less accumulated depreciation	100,000	
Net fixed assets		500,000
Goodwill		20,000
Liabilities and Shareholders' Equity		
Notes payable		50,000
Accounts payable		100,000
Income taxes payable		80,000
Long-term mortgage bonds		400,000
Preferred stock, 6%, $100 par value (1,000 shares)		100,000
Common stock, $15 par value (10,000 shares)		150,000
Capital surplus		150,000
Retained earnings		70,000

(b) If the firm had a net income of $500,000 after taxes, what are the earnings per share?

(c) When the firm issued its common stock, what was the market price of the stock per share?

2.2 A chemical processing firm is planning on adding a duplicate polyethylene plant at another location. The financial information for the first project year is shown in Table P2.2.

(a) Compute the working-capital requirement during the project period.

(b) What is the taxable income during the project period?

(c) What is the net income during the project period?

(d) Compute the net cash flow from the project during the first year.

Financial Ratio Analysis

2.3 The data in Table P2.3 are available for two companies, A and B, all stated in millions.

(a) Calculate each company's return on equity (ROE) and return on total assets (ROA).

(b) Why Company B's ROE so much higher than Company A's? Does this mean Company B is a better company? Why or why not?

(c) If Companies A and B were combined (merged), what would be the impact on the results on ROE? Under what conditions would such a combination make sense?

TABLE P2.2 Financial Information for First Project Year

Sales		$ 1,500,000
Manufacturing costs		
Direct materials	$ 150,000	
Direct labor	200,000	
Overhead	100,000	
Depreciation	200,000	
Operating expenses		150,000
Equipment purchase		400,000
Borrowing to finance equipment		200,000
Increase in inventories		100,000
Decrease in accounts receivable		20,000
Increase in wages payable		30,000
Decrease in notes payable		40,000
Income taxes		272,000
Interest payment on financing		20,000

TABLE P2.3

Description	Company A	Company B
Earnings before interest and taxes	$ 300	$ 560
Interest expenses	20	160
Earnings before tax	280	400
Taxes at 40%	112	160
Earnings after tax (Net income)	168	240
Debt	$ 200	$1,600
Equity	800	400

2.4 Table P2.4 shows financial statements for Apple Computer Corporation. The closing stock price for Apple was $68.11 on September 30, 2013. The average number of outstanding shares was 6.03 billion. On the basis of the financial data presented, compute the various financial ratios and make an informed analysis of Apple's financial health.

(a) Debt ratio
(b) Times-interest-earned ratio
(c) Current ratio
(d) Quick (acid-test) ratio
(e) Inventory-turnover ratio
(f) Day's-sales-outstanding
(g) Total-assets-turnover ratio
(h) Profit margin on sales
(i) Return on total assets
(j) Return on common equity
(k) Price/earnings ratio
(l) Book value per share

TABLE P2.4 Financial Statements for Apple Computer (All numbers in thousands)

THE BALANCE SHEET STATEMENT		
Period Ending	**Sep 28, 2013**	**Sep 29, 2012**
Cash And Cash Equivalents	$ 14,259,000	$ 10,746,000
Short Term Investments	26,287,000	18,383,000
Net Receivables	24,094,000	21,275,000
Inventory	1,764,000	791,000
Other Current Assets	6,882,000	6,458,000
Total Current Assets	**$ 73,286,000**	**$ 57,653,000**
Long Term Investments	106,215,000	92,122,000
Property Plant and Equipment	16,597,000	15,452,000
Goodwill	1,577,000	1,135,000
Intangible Assets	4,179,000	4,224,000
Other Assets	5,146,000	5,478,000
Total Assets	**$207,000,000**	**$176,064,000**
Accounts Payable	36,223,000	32,589,000
Short/Current Long Term Debt	–	–
Other Current Liabilities	7,435,000	5,953,000
Total Current Liabilities	**$ 43,658,000**	**$ 38,542,000**
Long Term Debt	16,960,000	–
Other Liabilities	20,208,000	16,664,000
Deferred Long Term Liability Charges	2,625,000	2,648,000
Total Liabilities	**$ 83,451,000**	**$ 57,854,000**
Common Stock	19,764,000	16,422,000
Retained Earnings	104,256,000	101,289,000
Treasury Stock	–	–
Capital Surplus	–	–
Other Stockholder Equity	(471,000)	499,000
Total Stockholder Equity	**$123,549,000**	**$118,210,000**
Total Liabilities and Stockholders' Equity	**$207,000,000**	**$176,064,000**
Income Statement		
Total Revenue	**$170,910,000**	**$156,508,000**
Cost of Revenue	106,606,000	87,846,000
Gross Profit	**$ 64,304,000**	**$ 68,662,000**

(*continued*)

TABLE P2.4 (*continued*)

THE BALANCE SHEET STATEMENT		
Period Ending	**Sep 28, 2013**	**Sep 29, 2012**
Research Development	4,475,000	3,381,000
Selling General and Administrative	10,830,000	10,040,000
Operating Income or Loss	**$ 48,999,000**	**$ 55,241,000**
Total Other Income/Expenses Net	1,156,000	522,000
Earnings Before Interest And Taxes	50,155,000	55,763,000
Interest Expense	–	–
Income Before Tax	50,155,000	55,763,000
Income Tax Expense	13,118,000	14,030,000
Minority Interest	–	–
Net Income From Continuing Ops	37,037,000	41,733,000
Net Income	**$ 37,037,000**	**$ 41,733,000**
Preferred Stock And Other Adjustments	–	–
Net Income Applicable To Common Shares	**$ 37,037,000**	**$ 41,733,000**

Source: Data from Apple Reports Fourth Quarter Results, Apple, October 28, 2013.

2.5 Table P2.5 on Page 54 summarizes the financial conditions for Intel Corporation (INTC), a manufacturer of various computer-processing chips for fiscal year 2013. Compute the various financial ratios and interpret the firm's financial health during fiscal year 2013. The closing stock price was $25.50 on December 31, 2013 and the average number of outstanding shares was 4.98 billion.

(a) Debt ratio
(b) Times-interest-earned ratio
(c) Current ratio
(d) Quick (acid-test) ratio
(e) Inventory-turnover ratio
(f) Days-sales-outstanding
(g) Total-assets-turnover ratio
(h) Profit margin on sales
(i) Return on total assets (with a tax rate of 40%)
(j) Return on common equity
(k) Price/earnings ratio
(l) Book value per share

2.6 R.C. had earnings per share of $12 in year 2015, and it paid a $6 dividend. Book value per share at year's end was $80. During the same period, the total retained earnings increased by $42 million. R.C. has no preferred stock, and no new common stock was issued during the year. If R.C.'s year-end debt (which equals its total liabilities) was $240 million, what was the company's year-end debt ratio?

2.7 If Company B uses more debt than Company A and both companies have identical operations in terms of sales, operating costs, etc., which of the following statements is *true*?

(a) Company A has a higher profit margin on sales than Company B.
(b) Company A has a lower profit margin on sales than Company B.
(c) Both companies have identical profit margins on sales.
(d) Company A will definitely have a higher current ratio.

TABLE P2.5 Financial Statements for Intel Co.

BALANCE SHEET		
Period Ending	**Dec 28, 2013**	**Dec 29, 2012**
Cash And Cash Equivalents	$ 5,674,000	$ 8,478,000
Short Term Investments	14,413,000	9,684,000
Net Receivables	6,176,000	5,950,000
Inventory	4,172,000	4,734,000
Other Current Assets	1,649,000	2,512,000
Total Current Assets	**$ 32,084,000**	**$ 31,358,000**
Long Term Investments	7,694,000	4,917,000
Property Plant and Equipment	31,428,000	27,983,000
Goodwill	10,513,000	9,710,000
Intangible Assets	5,150,000	6,235,000
Other Assets	5,489,000	4,148,000
Total Assets	**$ 92,358,000**	**$ 84,351,000**
Accounts Payable	11,191,000	10,654,000
Short/Current Long Term Debt	281,000	312,000
Other Current Liabilities	2,096,000	1,932,000
Total Current Liabilities	**$ 13,568,000**	**$ 12,898,000**
Long Term Debt	13,165,000	13,136,000
Other Liabilities	2,972,000	3,702,000
Deferred Long Term Liability Charges	4,397,000	3,412,000
Total Liabilities	**$ 34,102,000**	**$ 33,148,000**
Common Stock	21,536,000	19,464,000
Retained Earnings	35,477,000	32,138,000
Other Stockholder Equity	1,243,000	(399,000)
Total Stockholder Equity	**$ 58,256,000**	**$ 51,203,000**
Total Liabilities and Stockholders' Equity	**$ 92,358,000**	**$ 84,351,000**
Income Statement		
Total Revenue	**$170,910,000**	**$156,508,000**
Cost of Revenue	106,606,000	87,846,000
Gross Profit	**$ 64,304,000**	**$ 68,662,000**
Research Development	4,475,000	3,381,000
Selling General and Administrative	10,830,000	10,040,000
Operating Income or Loss	**$ 48,999,000**	**$ 55,241,000**

(*continued*)

TABLE P2.5 (*continued*)

BALANCE SHEET		
Period Ending	**Dec 28, 2013**	**Dec 29, 2012**
Total Other Income/Expenses Net	1,156,000	522,000
Earnings Before Interest And Taxes	50,155,000	55,763,000
Interest Expense	–	–
Income Before Tax	50,155,000	55,763,000
Income Tax Expense	13,118,000	14,030,000
Net Income From Continuing Ops	37,037,000	41,733,000
Net Income Applicable To Common Shares	**$ 37,037,000**	**$ 41,733,000**

Source: Data from Intel Corporation

2.8 You are trying to assess the well-being of the common stockholders of a company. Which of the following ratios would help you make such an assessment?

(a) Debt ratio
(b) Current ratio
(c) Book value per share
(d) Total asset turnover

2.9 Which of the following statements is *correct*?

(a) The quickest way to determine whether the firm has too much debt is to calculate the Times-interest-earned ratio.
(b) The best rule of thumb for determining the firm's liquidity is to calculate the current ratio.
(c) From an investor's point of view, the price-to-earnings ratio is a good indicator of whether or not a firm is generating an acceptable return to the investor.
(d) The operating margin is determined by subtracting all operating and non-operating expenses from the gross margin.

2.10 Consider the following financial data for Northgate Corporation ($ in millions):

- Cash and marketable securities, $100
- Total fixed assets, $280
- Annual sales, $1,200
- Net income, $418
- Inventory, $180
- Current liabilities, $134
- Current ratio, 3.2
- Average correction period, 45 days
- Average common equity, $550

On the basis of these financial data, determine the firm's *return on (common) equity*.

(a) 114.6%
(b) 71.6%
(c) 76%
(d) 30%

2.11 Consider B&B Company's financial data as follows: (unit: millions of dollars except ratio figures):

- Cash and marketable securities $5,000
- Fixed assets $16,500
- Sales $50,200
- Net income $4,100
- Inventory $8,750
- Current ratio 2.8
- Average collection period 73 days
- Average common equity $25,000

Fill in the blanks by calculating the appropriate accounting entries in the balance or the income statement.

Category	Financial Data
Accounts Receivable	
Current Assets	
Long-Term Debt	
Total Asset Turnover	

2.12 The following table summarizes some of key financial data for Copeland Corporation (unit: thousand dollars except ratio figures):

Item	Value
Cash and marketable securities	$10,000
Fixed assets	$90,000
Sales	$200,000
Net income	$15,000
Inventory	$150,000
Current ratio	4.20
Average collection period	91.25 days
Long-term debt	$200,000

(a) Determine the accounts receivables.
(b) Determine the amount of current liabilities.
(c) Calculate the amount of long-term debt.
(d) Calculate the return on common equity.

2.13 Consider Fisher & Company's financial data as follows: (unit: millions of dollars except ratio figures):

Item	Value
Cash and marketable securities	$100
Fixed assets	$280
Sales	$1,200
Net income	$358
Inventory	$180
Current ratio	3.2
Average collection period	45 days
Average common equity	$500

(a) Find Fisher's accounts receivable.
(b) Calculate the amount of current assets.
(c) Determine the amount of current liabilities.
(d) Determine the amount of total assets.
(e) Calculate the amount of the long-term debt.
(f) Calculate the profit margin.
(g) Calculate the Return on Common Equity

Short Case Studies

ST2.1 Consider the two companies Google and Yahoo, which compete with each other in the mobile advertising sector. Google enjoys strong relationships among businesses and has a dominant role in online search. Get these companies' most recent annual reports from their websites, and answer the following questions.

(a) On the basis of the most recent financial statements, comment on each company's financial performance in the following areas:
- Asset management
- Liquidity
- Debt management
- Profitability
- Market trend

(b) Check the current stock prices for both companies. The stock ticker symbol is GOOG for Google and YHOO for Yahoo. Based on your analysis in (a), which company would you bet your money on and why?

ST2.2 Compare Monsanto Company (MON) and E.I. du Pont de Nemours & Company (DD) using a thorough financial ratios analysis.

(a) For each company, compute all the ratios listed in Figure 2.7 (i.e., debt management, liquidity, asset management, market trend, and profitability) for the fiscal year chosen.
(b) Compare and contrast the two companies, using the ratios you calculated from part (a).
(c) Carefully read and summarize the "risk management" or "hedging" practices described in the financial statements of each company.
(d) If you were a mutual fund manager and could invest in only one of these companies, which one would you select and why? Be sure to justify your answer by using your results from parts (a), (b), and (c).

ST2.3 Read the Coca-Cola Company's Annual Report (most recent one) and calculate the various financial ratios defined in Figure 2.7. Then give your assessment of the company's general financial condition compared with the one of Pepsi Company.

CHAPTER 3

Interest Rate and Economic Equivalence

Dearborn Couple Claim Missouri's Largest Jackpot—$293.75 Million Every once in a while, a lottery jackpot becomes so large that it attracts national attention. Cindy and Mark Hill posed with an oversized check for $293,750,000 at the press conference after winning their half of the $588 million Powerball jackpot on November 28, 2012. Mark and Cindy are common people—Mark works for a meatpacking plant and Cindy is a clerical worker.

Source: Edw./Shutterstock

According to lottery officials, the odds of winning the jackpot were approximately 1 in 175 million. The winning ticket had the numbers 5–16–22–23–29 and Mega Ball number 6. According to lottery rules they could elect for the lump sum cash payment of $192.37 million (or exactly $192,373,928) immediately, or an average annuity payment of $9.79 million ($9,791,667 to be exact)—either sum would go a long way in the farming town of 500 where they live. The Hills decided to take their money in a lump sum of $192.37 million, which, after state and federal taxes, would amount to $132 million.

Now put yourself in the Hills' position. You might wonder why the value of the lump sum payment, $192.37 million paid immediately, is so much lower than the $293.75 million paid in 30 installments. Isn't receiving the $293.75 million overall a lot better than receiving $192.37 million now?

First, most people familiar with investments would tell the Hills that receiving a lump amount of $192.37 million today is likely to prove a far better deal than receiving $293.75 million for 30 years, even if they live long enough to collect the entire annual payments. This reasoning involves the principles we will discuss in this chapter, namely, the interest operation and the **time value of money**. A dollar in hand today is worth more than one that will be paid to you in the future.

In engineering economics, the principles discussed in this chapter are regarded as the underpinning for nearly all project investment analysis. This is because we always need to account for the effect of interest operating on sums of cash over time. Interest formulas allow us to place different cash flows received at different times in the same time frame and to compare them. As will become apparent, almost our entire study of engineering economics is built on the principles introduced in this chapter.

CHAPTER LEARNING OBJECTIVES

After completing this chapter, you should understand the following concepts:

- The time value of money.
- The difference between simple interest and compound interest.
- The meaning of economic equivalence and why we need it in economic analysis.
- How to compare two different money series by means of the concept of economic equivalence.
- The interest operation and the types of interest formulas used to facilitate the calculation of economic equivalence.

3.1 Interest: The Cost of Money

Most of us are familiar in a general way with the concept of interest. We know that money left in a savings account earns interest so that the balance over time is greater than the sum of the deposits. We also know that borrowing to buy a car means repaying an amount over time; that amount includes interest, and it is therefore greater than the amount borrowed. What may be unfamiliar to us is the idea that, in the financial world, money itself is a commodity and, like other goods that are bought and sold, money costs money.

The cost of money is established and measured by a **market interest rate**, a percentage that is periodically applied and added to an amount (or varying amounts) of money over a specified length of time. When money is borrowed, the interest paid is the charge to the borrower for the use of the lender's property; when money is lent or invested, the interest earned is the lender's gain from providing a service to another (Figure 3.1). **Interest**, then, may be defined as the cost of having money available for use. In this section, we examine how interest operates in a free-market economy, and we establish a basis for understanding the more complex interest relationships that follow later on in the chapter.

3.1.1 The Time Value of Money

The "time value of money" seems like a sophisticated concept, yet it is a concept that you grapple with every day. Suppose you have two options; (1) receiving $1,000 cash now, or (2) receiving $1,090 one year from now. Which option would you prefer? Here, we assume that there is no risk of not receiving the money a year from now. Ask yourself what you would do if you decide to receive $1,000 now. If you don't need money now for any other purpose, you may deposit the money in a bank. If the bank's interest rate is 10%, then your balance would grow to $1,100. Certainly waiting a year to receive $1,090 does not make sense.

Suppose that you could expect a 4% inflation during your deposit period. Inflation is simply the loss of purchasing power. That is, as prices increase, it would require more money to purchase the same amount of goods and services. (We will devote a full chapter on this topic in Chapter 11.) In the previous example, the receipt of $1,090 one year from now is only worth $1,048 (= $1,090/1.04) if you expect a 4% inflation. Conceptually, the rate at which you earn interest from your investment should be higher than the inflation rate to make any economic sense of the delayed consumption, as your purchasing power will continue to decrease over time. In order to make up this future loss in purchasing power, your earning interest rate should be sufficiently larger than the anticipated inflation rate.

Considering both Earning and Purchasing Power

What the example above illustrates is that we must connect the "earning power" and the "purchasing power" to the concept of time. After all, time, like money, is a finite resource. There are only 24 hours in a day, so time has to be budgeted, too. When we deal with large amounts of money, long periods of time, or high interest rates, the change in the value of a sum of money over time becomes extremely significant. For example, at a current annual interest rate of 10%, $1 million will earn $100,000 in interest in one year; thus, to wait one year to receive $1 million clearly involves a significant sacrifice. When deciding among

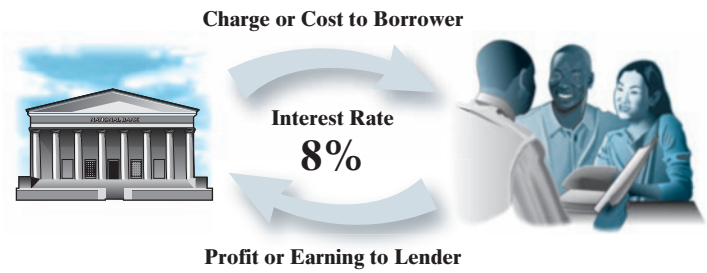


Figure 3.1 The meaning of *interest rate* to the lender (bank) and to the borrower.

alternative proposals, we must take into account the operation of interest and the time value of money in order to make valid comparisons of different amounts at various times.

The way interest operates reflects the fact that money has a time value. This is why amounts of interest depend on lengths of time; interest rates, for example, are typically given in terms of a percentage per year. We may define the principle of the time value of money as follows: The economic value of a sum depends on when it is received. Because money has both **earning power** as well as **purchasing power** over time, as shown in Figure 3.2 (it can be put to work, earning more money for its owner), a dollar received today has a greater value than a dollar received at some future time.

Market Interest Rate and Cash Flow Transactions in Actual Dollars

When lending or borrowing, interest rates are quoted by financial institutions in the marketplace; those interest rates reflect the desired amounts to be earned, as well as any protection from loss in the future purchasing power of money because of inflation. We will assume that, unless otherwise mentioned, *the interest rate used in this book reflects the market interest rate,* which takes into account the earning power as well as the effect of inflation perceived in the marketplace. We will also assume that all cash flow transactions are given in terms of **actual dollars** with the effect of inflation, if any, reflected in the amount. (If we want to know the true desired earnings in isolation from inflation, we can determine the real interest rate. We consider this issue in Chapter 11. The earning power of money and its loss of value because of inflation are calculated by different analytical techniques.)

3.1.2 Elements of Transactions Involving Interest

Many types of transactions (e.g., borrowing or investing money, or purchasing machinery on credit) involve interest, but certain elements are common to all of these types of transactions.

- An initial amount of money in transactions involving debt or investments is called the **principal**.
- The **interest rate** measures the cost or price of money and is expressed as a percentage per period of time.

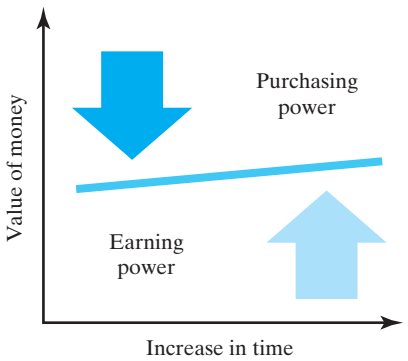


Figure 3.2 The time value of money. This is a two-edged sword whereby earning grows, but purchasing power decreases as time goes by due to inflation.

- A period of time, called the **interest period**, determines how frequently interest is calculated.
- A specified length of time marks the duration of the transaction and thereby establishes a certain **number of interest periods**.
- A **plan for receipts or disbursements** yields a particular cash flow pattern over a specified length of time. (For example, we might have a series of equal monthly payments that repay a loan.)
- A **future amount of money** results from the cumulative effects of the interest rate over a number of interest periods.

For the purposes of calculation, these elements are represented by the following variables.

A_n = A discrete payment or receipt occurring at the end of some interest period.

i = The interest rate per interest period.

N = The total number of interest periods.

P = A sum of money at a time chosen as time zero (now) for purposes of analysis; sometimes referred to as the **present value** or **present worth**.

F = A future sum of money at the end of the analysis period.

A = An end-of-period payment or receipt in a uniform series that continues for N periods. This is a special situation where $A_1 = A_2 = \cdots = A_N$.

V_n = An equivalent sum of money at the end of a specified period n that considers the effect of the time value of money. Note that $V_0 = P$ and $V_N = F$.

Because we make frequent use of these symbols in this text, it is important that you become familiar with them. Note, for example, the distinction between A, A_n and A_N. The symbol A_n refers to a specific payment or receipt, at the end of period n, in any series of payments. A_N is the final payment in such a series, because N refers to the total number of interest periods. A refers to any series of cash flows in which all payments or receipts are equal.

Example of an Interest Transaction

As an example of how the elements we have just defined are used in a particular situation, let us suppose that an electronics manufacturing company buys a machine for $25,000 and borrows $20,000 from a bank at a 9% annual interest rate. In addition, the company pays a $200 loan origination fee when the loan commences. The bank offers two repayment plans as follows:

- **Plan 1.** The principal amount P is $20,000, and the interest rate i is 9%. The interest period is one year, and the duration of the transaction is five years, which means there are five interest periods ($N = 5$). As mentioned earlier, whereas one year is a common interest period, interest is frequently calculated at other intervals: monthly, quarterly, or semiannually, for instance. For this reason, we used the term **period** rather than **year** when we defined the preceding list of variables. The receipts and disbursements planned over the duration of this transaction yield a cash flow pattern of five equal payments A of $5,141.85 each, paid at year's end during years 1 through 5. (You will have to accept these amounts on faith for now—the next section presents the formula

TABLE 3.1 **Repayment Plans for Example Given in Text (for $N = 5$ years and $i = 9\%$)**

End of Year	Receipts	Payment Plan	
		Plan 1	Plan 2
Year 0	$20,000.00	$ 200.00	$ 200.00
Year 1		5,141.85	1,800.00
Year 2		5,141.85	1,800.00
Year 3		5,141.85	1,800.00
Year 4		5,141.85	1,800.00
Year 5		5,141.85	21,800.00

Note: An origination fee is an up-front fee charged by a lender for processing a new loan. You actually borrow $19,800 with the origination fee of $200, but you pay back on the basis of $20,000.

used to arrive at the amount of these equal payments, given the other elements of the problem.)

- **Plan 2.** This plan has most of the elements of Plan 1, except that the partial payment of principal is not allowed. Instead, only interest is paid each year and the principal is paid in a lump sum when the loan matures.

These two payment plans are summarized in Table 3.1.

Cash Flow Diagrams

Problems involving the time value of money can be conveniently represented in graphic form with a cash flow diagram (Figure 3.3). **Cash flow diagrams** represent time by a horizontal line marked off with the number of interest periods specified. The cash flows over time are represented by arrows at relevant periods: Upward arrows denote positive flows

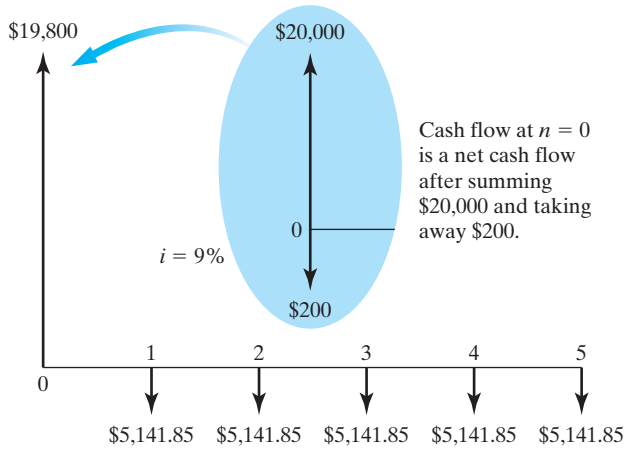


Figure 3.3 A cash flow diagram for Plan 1 of the loan repayment example summarized in Table 3.1.

(receipts) and downward arrows negative flows (disbursements). Note, too, that the arrows actually represent **net cash flows**: Two or more receipts or disbursements made at the same time are summed and shown as a single arrow. For example, $20,000 received during the same period as a $200 payment would be recorded as an upward arrow of $19,800. Also, the lengths of the arrows can suggest the relative values of particular cash flows.

Cash flow diagrams function in a manner similar to free-body diagrams or circuit diagrams, which most engineers frequently use: Cash flow diagrams give a convenient summary of all the important elements of a problem in a graphical form to determine whether the statement of the problem has been converted into its appropriate parameters. This text frequently uses this graphic tool, and you are strongly encouraged to develop the habit of using well-labeled cash flow diagrams as a means to identify and summarize pertinent information in a cash flow problem. Similarly, a table such as Table 3.1 can help you organize information in another summary format.

End-of-Period Convention

In practice, cash flows can occur at the beginning or in the middle of an interest period—or indeed, at practically any point in time. One of the simplifying assumptions we make in engineering economic analysis is the **end-of-period convention**, which is the practice of placing all cash flow transactions at the end of an interest period. (See Figure 3.4.) This assumption relieves us of the responsibility of dealing with the effects of interest within an interest period, which would greatly complicate our calculations.

Like many of the simplifying assumptions and estimates we make in modeling engineering economic problems, the end-of-period convention inevitably leads to some discrepancies between our model and real-world results. Suppose, for example, that $100,000 is deposited during the first month of the year in an account with an interest period of one year and an interest rate of 10% per year. In such a case, the difference of 1 month would cause an interest income loss of $10,000. This is because, under the end-of-period convention, the $100,000 deposit made during the interest period is viewed as if the deposit were made at the end of the year, as opposed to 11 months earlier.

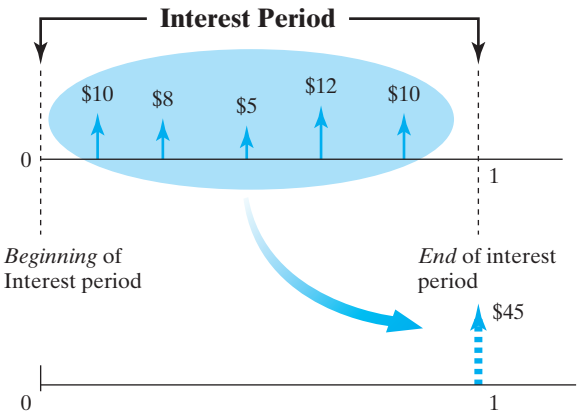


Figure 3.4 Any cash flows occurring during the interest period are summed to a single amount and placed at the end of the interest period.

This example gives you a sense of why financial institutions choose interest periods that are less than one year, even though they usually quote their rate as an annual percentage. (We will discuss this issue in Chapter 4.)

Armed with an understanding of the basic elements involved in interest problems, we can now begin to look at the details of calculating interest.

3.1.3 Methods of Calculating Interest

Money can be lent and repaid in many ways, and, equally, money can earn interest in many different ways. Usually, however, at the end of each interest period, the interest earned on the principal amount is calculated according to a specified interest rate. The two computational schemes for calculating this earned interest are said to yield either **simple interest** or **compound interest**. Engineering economic analysis uses the compound-interest scheme almost exclusively.

Simple Interest

Simple interest is interest earned on only the principal amount during each interest period. In other words, with simple interest, the interest earned during each interest period does not earn additional interest in the remaining periods, *even though you do not withdraw it*.

In general, for a deposit of P dollars at a simple interest rate of i for N periods, the total earned interest would be

$$I = (iP)N \tag{3.1}$$

The total amount available at the end of N periods thus would be

$$F = P + I = P(1 + iN) \tag{3.2}$$

Simple interest is commonly used with add-on loans or bonds, as we will see in Chapter 4.

Compound Interest

Under a compound-interest scheme, the interest earned in each period is calculated on the basis of the total amount at the end of the previous period. This total amount includes the original principal plus the accumulated interest that has been left in the account. In this case, you are, in effect, increasing the deposit amount by the amount of interest earned. In general, if you deposited (invested) P dollars at interest rate i, you would have $P + iP = P(1 + i)$ dollars at the end of one period. If the entire amount (principal and interest) is reinvested at the same rate i for another period, at the end of the second period you would have

$$\begin{aligned} P(1 + i) + i[P(1 + i)] &= P(1 + i)(1 + i) \\ &= P(1 + i)^2 \end{aligned}$$

Continuing, we see that the balance after the third period is

$$P(1 + i)^2 + i[P(1 + i)^2] = P(1 + i)^3$$

This interest-earning process repeats, and after N periods, the total accumulated value (balance) F will grow to

$$F = P(1 + i)^N \tag{3.3}$$

Recall that under the simple-interest scheme, you earn interest only on the principal amount at the end of each interest period. Under the compounding scheme, you earn interest on the principal, as well as interest on interest. From Eq. (3.3), the total interest earned over N periods is

$$I = F - P = P[(1 + i)^N - 1] \tag{3.4}$$

Compared with the simple-interest scheme, the additional interest earned with compound interest is

$$\Delta I = P[(1 + i)^N - 1] - (iP)N \tag{3.5}$$

$$= P[(1 + i)^N - (1 + iN)] \tag{3.6}$$

As either i or N becomes large, the difference in interest earnings also becomes large, so the effect of compounding is further pronounced. Note that when $N = 1$, compound interest is the same as simple interest. *Unless otherwise mentioned, all interest rates mentioned in this text refer to compound interest.*

To illustrate the difference between the compound interest and the simple interest, let's consider two examples. Example 3.1 illustrates the computational aspects of the interest operations. Example 3.2 illustrates the extraordinary power of compound interest.

EXAMPLE 3.1 Simple Interest versus Compound Interest

Suppose you deposit $1,000 in a bank savings account that pays interest at a rate of 10% compounded annually. Assume that you don't withdraw the interest earned at the end of each period (one year), but let it accumulate. How much would you have at the end of year 3?

SOLUTION

Given: $P = \$1{,}000$, $N = 3$ years, and $i = 10\%$ per year.

Find: F.

Applying Eq. (3.3) to our three-year, 10% case, we obtain

- Simple interest:

$$F = \$1{,}000[1 + 0.10(3)] = \$1{,}300$$

- Compound interest:

$$F = \$1{,}000(1 + 0.10)^3 = \$1{,}331$$

The total interest earned is $331, which is $31 more than was accumulated under the simple-interest method. We can keep track of the interest accrual process more precisely as follows.

Period	Amount at Beginning of Interest Period	Interest Earned for Period	Amount at End of Interest Period
1	$ 1,000	$ 1,000(0.10)	$ 1,100
2	1,100	1,100(0.10)	1,210
3	1,210	1,210(0.10)	1,331

COMMENTS: At the end of the first year, you would have $1,000, plus $100 in interest, or a total of $1,100. In effect, at the beginning of the second year, you would be depositing $1,100, rather than $1,000. Thus, at the end of the second year, the interest earned would be 0.10($1,100) = $110, and the balance would be $1,100 + $110 = $1,210. This is the amount you would be depositing at the beginning of the third year, and the interest earned for that period would be 0.10($1,210) = $121. With a beginning principal amount of $1,210 plus the $121 interest, the total balance would be $1,331 at the end of year 3. The sequence of the compounding process is illustrated in Figure 3.5.

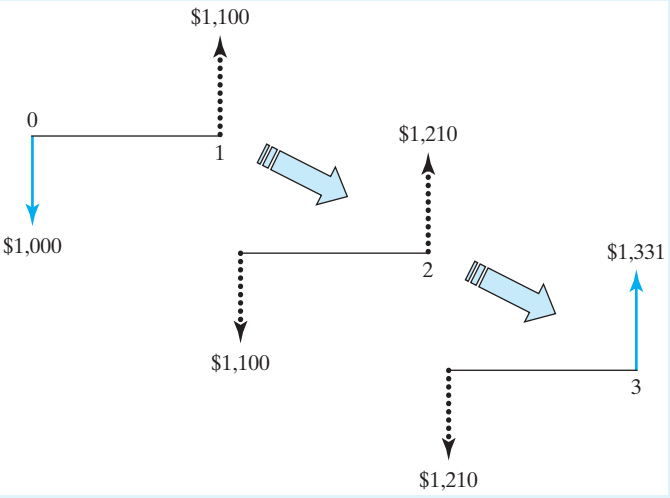


Figure 3.5 The process of computing the balance when $1,000 at 10% is deposited for three years (Example 3.1).

EXAMPLE 3.2 $24 for Manhattan a Good Deal?

Peter Minuit of the Dutch West India Company purchased the island of Manhattan from Native Americans on May 26, 1626 for goods valued at 60 Dutch guilders, which was estimated to be the equivalent of $24 (or $680 today). Instead of purchasing the island, if Minuit had invested the $24 in a savings account that earned 8% interest, how much would it be worth in 2015?

SOLUTION

Given: $P = \$24$, $i = 8\%$ per year, and $N = 389$ years.

Find: F, based on (a) 8% simple interest, and (b) 8% compound interest.

(a) With 8% simple interest,

$$F = \$24[1 + (0.08)(389)] = \$771$$

(b) With 8% compound interest,

$$F = \$24(1 + 0.08)^{389} = \$241{,}019{,}469{,}461{,}115$$

COMMENTS: The significance of compound interest is obvious in this example. Many of us can hardly comprehend the magnitude of $241 trillion. In 2015, the total population in the United States was estimated to be around 320 million. If the money were distributed equally among the population, each individual would receive $753,186. Certainly, there is no way of knowing exactly how much Manhattan Island is worth today, but most real-estate experts would agree that the value of the island is nowhere near $241 trillion. (Note that the U.S. Domestic Gross Product for 2013 was merely $15.68 trillion. The total value of all New York City property was assessed at $914.8 billion for the 2015 fiscal year.)

3.2 Economic Equivalence

The observation that money has a time value leads us to two important questions:

- How do we measure and compare various cash payments received at different points in time?
- How do we know, for example, whether we would prefer to have $20,000 today and $50,000 ten years from now or $8,000 each year for the next ten years?

In this section, we describe the basic analytical techniques for making these comparisons. Then, in Section 3.3, we will use these techniques to develop a series of formulas that can greatly simplify our calculations.

3.2.1 Definition and Simple Calculations

The central question in deciding among alternative cash flows involves comparing their economic worth. This would be a simple matter if, in the comparison, we did not need to consider the time value of money: We could simply add the individual payments within a cash flow, treating receipts as positive cash flows and payments (disbursements) as negative cash flows. The fact that money has a time value, however, makes our calculations more complicated. We need to know more than just the size of a payment in order to determine its economic effect completely. In fact, as we will see in this section, we need to know several things.

- The size of the payment.
- The type of the payment: Is it a receipt or a disbursement?
- The timing of the payment: When is it made?
- The interest rate in operation during the period under consideration.

To assess the economic value of a series of payments, we must consider the value of each payment individually.

Calculations for determining the economic effects of one or more cash flows are based on the concept of economic equivalence. **Economic equivalence** exists between cash flows that have the same economic effect and could therefore be traded for one another in the financial marketplace, which we assume to exist.

Economic equivalence refers to the fact that a cash flow—whether a single payment or a series of payments—can be converted to an *equivalent* cash flow at any point in time. For example, we could find the equivalent future value F of a present amount P at interest rate i at period n; or we could determine the equivalent present value P of N equal payments A.

We can easily extend the preceding strict concept of equivalence to include the comparison of alternatives. For example, we could compare the value of two proposals by finding the equivalent value of each at *any common point in time*. If financial proposals that appear to be quite different turn out to have the same monetary value, then we can be *economically indifferent* to choosing between them: In terms of economic effect, one would be an even exchange for the other, so no reason exists to prefer one over the other in terms of their economic value.

A way to see the concepts of equivalence and economic indifference at work in the real world is to note the variety of payment plans offered by lending institutions for consumer loans. Recall Table 3.1 where we developed two different repayment plans for a loan of $20,000 for five years at 9% interest. You will notice, perhaps to your surprise, that the two plans require significantly different repayment patterns and different total amounts of repayment. However, because money has a time value, these plans are equivalent, and economically, the bank is indifferent to a consumer's choice of plan. We will now discuss how such equivalence relationships are established.

Equivalence Calculations: A Simple Example

We can view equivalence calculations as an application of the compound-interest relationships we developed in Section 3.1. Suppose that we invest $1,000 at 12% annual interest for five years. The formula developed for calculating compound interest, $F = P(1 + i)^N$ (Eq. 3.3), expresses the equivalence between some present amount P and a future amount F, for a given interest rate i and a number of interest periods N. Therefore, at the end of the investment period, our sums grow to

$$\$1{,}000(1 + 0.12)^5 = \$1{,}762.34$$

Thus, we can say that at 12% interest, $1,000 received now is equivalent to $1,762.34 received in five years and that we could trade $1,000 now for the promise of receiving $1,762.34 in five years. Example 3.3 further demonstrates the application of this basic technique.

EXAMPLE 3.3 Equivalence

Suppose you are offered the alternative of

- Option 1: receiving $3,000 at the end of five years.
- Option 2: receiving P dollars today.

What value of P would make you indifferent to your choice between P dollars today and the promise of $3,000 at the end of five years? Here you assume that if you go with Option 2, you would deposit the money in an account that pays 8% interest because you have no current need for the money. You further assume that there is no question that the $3,000 will be paid in full (no risk).

STRATEGY: Our job is to determine the present amount that is economically equivalent to $3,000 in five years, given the earning potential of 8% per year. The "indifference" ascribed to you refers to economic indifference; that is, in a marketplace where 8% is the applicable interest rate, you could trade either cash flow for the other.

SOLUTION

Given: $F = \$3{,}000$, $N = 5$ years, and $i = 8\%$ per year.

Find: P.

Equation:

Eq. (3.3), $F = P(1 + i)^N$.

Rearranging terms to solve for P gives

$$P = \frac{F}{(1 + i)^N}$$

Substituting yields

$$P = \frac{\$3{,}000}{(1 + 0.08)^5} = \$2{,}042$$

COMMENTS: In this example, it is clear that if P is anything less than \$2,042, you would prefer the promise of \$3,000 in five years to P dollars today; if P is greater than \$2,042, you would prefer P.

3.2.2 Equivalence Calculations: General Principles

In spite of their numerical simplicity, the examples we have developed reflect several important general principles, which we will now explore.

Principle 1: Equivalence Calculations Made to Compare Alternatives Require a Common Time Basis

When we travel to foreign countries, we often need to convert U.S. dollars to equivalent local currencies via prevailing foreign exchange rates; we must also convert cash flows to a common basis to compare their value. One aspect of this basis is the choice of a single point in time at which to make our calculations. In Example 3.3, if we had been given the magnitude of each cash flow and had been asked to determine whether they were equivalent, we could have chosen any reference point and used the compound interest formula to find the value of each cash flow at that point.

When selecting a point in time at which to compare the value of alternative cash flows, we commonly use either the present time, which yields what is called the **present worth** of the cash flows, or some point in the future, which yields their **future worth**. The choice of the point in time often depends on the circumstances surrounding a particular decision, or it may be chosen for convenience. For instance, if the present worth is known for the first two of three alternatives, all three may be compared simply by calculating the present worth of the third. In Example 3.3, as you can readily see, the choice of $n = 0$ or $n = 5$ would make our problem simpler, because we need to make only one set of calculations: At 8% interest, either convert \$2,042 at time 0 to its equivalent value at time 5, or convert \$3,000 at time 5 to its equivalent value at time 0. To see how to choose a different reference point, take a look at Example 3.4.

EXAMPLE 3.4 Equivalent Cash Flows Are Equivalent at Any Common Point in Time

In Example 3.3, we determined that, given an interest rate of 8% per year, receiving $2,042 today is equivalent to receiving $3,000 in five years. Are these cash flows also equivalent at the end of year 3?

STRATEGY: This problem is summarized in Figure 3.6. The solution consists of solving two equivalence problems.

(a) What is the future value of $2,042 after three years at 8% interest?

(b) Given the sum of $3,000 after five years and an interest rate of 8%, what is the equivalent sum after three years?

SOLUTION

Given:

(a) $P = \$2{,}042$; $i = 8\%$ per year; $N = 3$ years.

(b) $F = \$3{,}000$; $i = 8\%$ per year; $N = 5 - 3 = 2$ years.

Find:

(a) V_3;

(b) V_3. Are these two values equal?

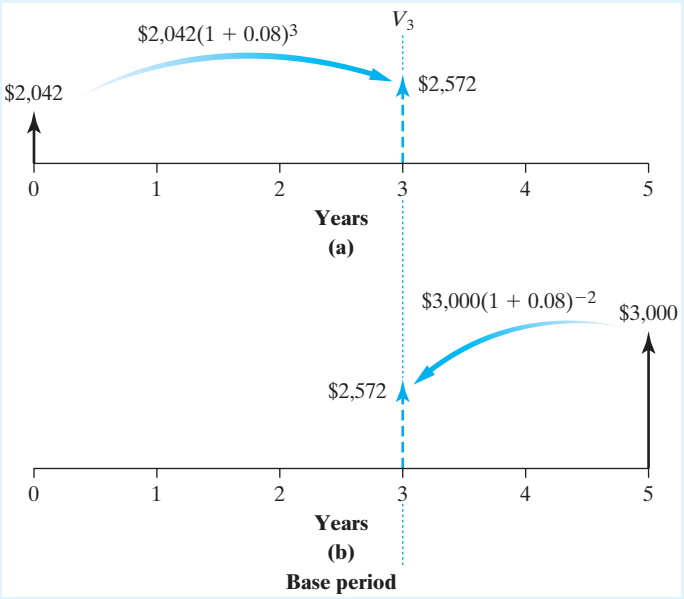


Figure 3.6 Selection of a base period for an equivalence calculation (Example 3.4).

Equation:

(a) $F = P(1 + i)^N$.

(b) $P = F(1 + i)^{-N}$.

Notation: The usual terminology of F and P is confusing in this example, since the cash flow at $n = 3$ is considered a future sum in part (a) of the solution and a past cash flow in part (b) of the solution. To simplify matters, we are free to arbitrarily designate a reference point $n = 3$ and understand that it need not be the present. Therefore, we assign the equivalent cash flow at $n = 3$ to a single variable, V_3.

(a) The equivalent worth of \$2,042 after three years is

$$\begin{aligned} V_3 &= 2{,}042(1 + 0.08)^3 \\ &= \$2{,}572 \end{aligned}$$

(b) The equivalent worth of the sum \$3,000 two years earlier is

$$\begin{aligned} V_3 &= F(1 + i)^{-N} \\ &= \$3{,}000(1 + 0.08)^{-2} \\ &= \$2{,}572 \end{aligned}$$

(Note that $N = 2$ because that is the number of periods during which discounting is calculated in order to arrive back at year 3.)

(c) While our solution doesn't strictly prove that the two cash flows are equivalent at any time, they will be equivalent at any time as long as we use an interest rate of 8%.

COMMENTS: If we were looking for an equivalent amount at $n = 2$, instead of $n = 0$, we may solve the following

$$V_2 = \frac{\$3{,}000}{(1 + 0.08)^{5-3}} = \frac{\$3{,}000}{(1 + 0.08)^2} = \$2{,}381$$

Similarly, we can calculate the equivalent values of other times as shown in Figure 3.7.

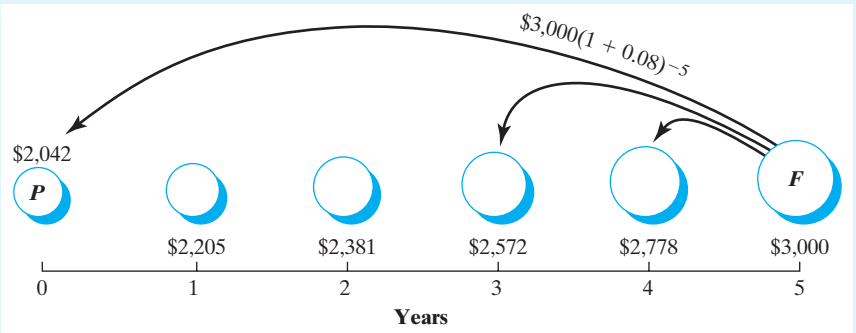


Figure 3.7 Various dollar amounts that will be economically equivalent to \$3,000 in five years, given an interest rate of 8% (Example 3.4).