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# FINANCIAL MANAGEMENT
## FOR SMALL BUSINESSES

### Financial Statements & Present Value Models

2021
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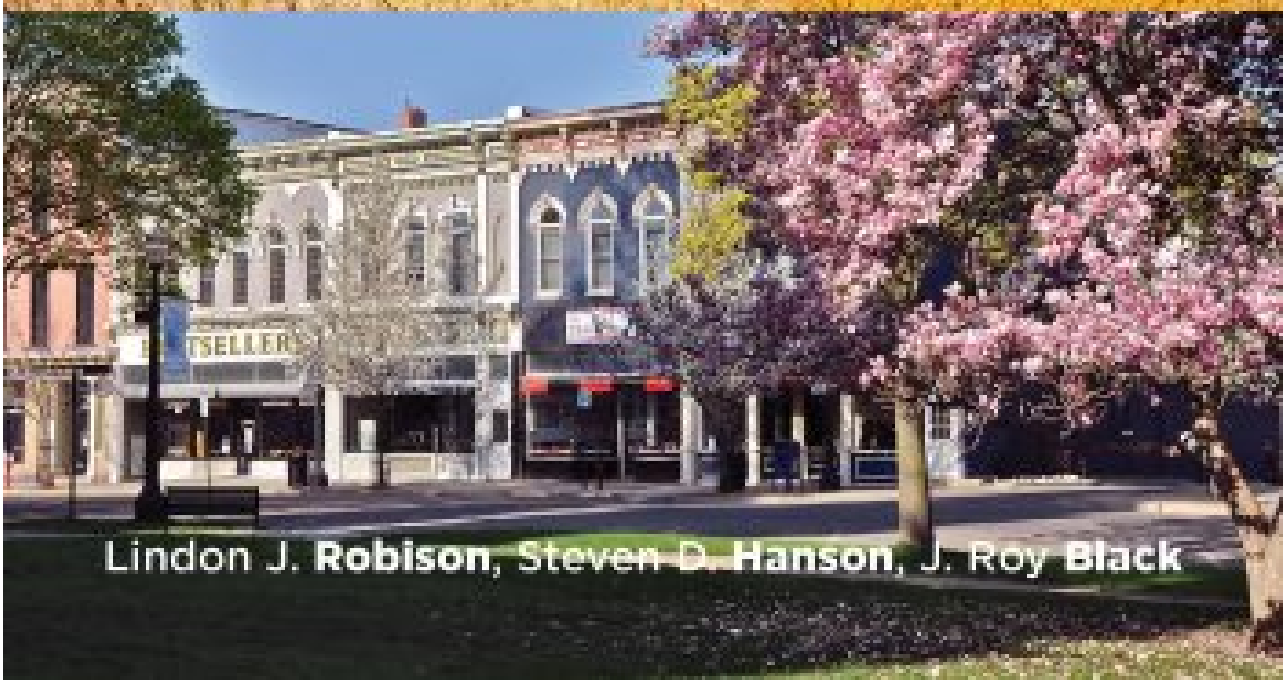

Lindon J. **Robison**, Steven D. **Hanson**, J. Roy **Black**

# Financial Management for Small Businesses, 2nd OER Edition

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## Financial Statements & Present Value Models

Second Open Edition

Lindon J. Robison

Steven D. Hanson

J. Roy Black

2021
East Lansing, MI

# Dedication

*We dedicate this book to all the students of Agribusiness Management ABM 435 at Michigan State University who over the years have challenged us to increase our understanding of and to improve the presentation of financial management concepts.*

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LINDON ROBISON

FINANCIAL MANAGEMENT FOR SMALL BUSINESSES:
Financial Statements & Present Value Models
Second Open Edition

Written by:
Lindon J. Robison
Steven D. Hanson
J. Roy Black

Agricultural, Food and Resource Economics
Michigan State University
East Lansing, Michigan
United States of America



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# List of Abbreviations

## Abbreviations & Variables

A: constant loan payment

AE: annuity equivalent

AIS: accrual income statement

AL: accrued liabilities

AP: accounts payable

APR: annual percentage rate

AR: accounts receivable

ATCF: after-tax cash flow

AVG: attachment value goods

CA: current assets

CE: cash expenses

CFS: coordinated financial statements

CL: current liabilities

COGS: cost of goods sold

CPI: consumer price index

CR: cash receipts

d: geometric decay

D: debt

Dep: depreciation

E: equity

EBIT: earnings before interest and taxes

EBT: earnings before taxes

EV: expected value-variance

FTC: Federal Trade Commission

FV: future values

g: nominal growth rate

$g^*$: real growth rate

GAAP: generally accepted accounting practices

i: average interest rate

i (superscript): investment identifier

INV: inventories

IRR: internal rate of return

$IRR^A$: internal rate of return on Assets

$IRR^E$: internal rate of return on Equity

IRS: Internal Revenue Service

L: loan amount

LLC: Limited Liability Company

m: profit margin

MACRS: modified accelerated cost recovery system

MIRR: modified IRR

mn: term

MNPV: modified NPV

NIAT: net income after taxes

NPC: net present cost

NPV: net present value

$NPV^A$: NPV for asset earnings

$NPV^E$: NPV for equity earnings

NWC: net working capital

OE: overhead expense

p: percent of loan to be paid as a refinance cost

PV: present value

QTM: quantity theory of money

r: nominal discount rate

$r^f$: APR

rm: market rate of interest

$r^*$: real discount rate

R: constant value of net cash flow

constant value of cash deposits

$R_t^i$: cash flow earned by investment i in the $t^{th}$ period

**R** (bold): vector of cash flow values $R_t^i$ earned by $V_0^i$

RCG: Realized Capital Gains

ROA: return on assets

ROE: return on equity

ROI: return on investment

S: units sold, liquidation value, sum of compounded periodic cash flows, standard deviation from a sample distribution

SCF: statement of cash flow

SEC: Securities and Exchange Commission

SEG: socio-emotional goods

T: tax

t (subscript): time period

TI: total interest

$V_0$: initial value

W: firm's wealth value

w: outcome variable

WCC: Weighted Cost of Capital

y: outcome variable

## Excel Functions

FV: future value

IPMT: interest payment

IRR: internal rate of return

NPER: number of periods

NPV: net present value

PMT: period payment

PV: present value

RATE: rate

## Functions

Cov(): covariance

E(): expected value operator

Pr(): probability

$(r, R_t^i)$: Sum of periodic cash flows

$US_0(r^f/m, mn)$: uniform series of $1 payments discounted at the actuarial rate for (mn) periods

## Greek Characters

α (alpha): endogenous projection constant; tax adjustment rate for capital gains (losses)

β (beta): coefficient multiplying an exogenous variable

$\gamma$ (gamma): scaling factor; rate of technological change; financed proportion of the purchase price; percentage between 0 and 100; change in $L_0$; % of the investment's value allowed to be deducted in a given year

$\Delta$ (Delta): difference / change

$\delta$ (delta): compounding / discounting factor; percent compensation for lost revenues

$\epsilon_t$ (epsilon): average error in the $t^{th}$ period

$\epsilon$ (epsilon): random variable component of a risky event

$\eta$ (eta): capital gains (loss) rate

$\theta$ (theta): average tax adjustment coefficient

$\lambda$ (lambda): average risk aversion coefficient

$\mu$ (mu): the expected value of a probability density function

$\pi$ (pi): insurance premium paid to exchange a risky distribution with a sure value

$\rho$ (rho): correlation coefficient between two random variables

$\sigma$ (sigma): variance of a probability density function

## Ratios

ATO: asset turnover ratio

ATOT: asset turnover time ratio

C: coverage ratio

CT: current ratio

CTR: current-to-total returns ratio

DE: debt-to-equity ratio

DS: debt-to-service ratio

EM: equity multiplier ratio

ITO: inventory turnover ratio

ITOT: inventory turnover time ratio

PE: price-to-earnings ratio

PTO: payable turnover ratio

PTOT: payable turnover time ratio

QK: quick ratio

RTO: receivable turnover ratio

RTOT: receivable turnover time ratio

SPELL: solvency, profitability, efficiency, liquidity, leverage

TIE: times interest earned ratio

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# Preface

LINDON ROBISON

This book intends to help students and others learn how to successfully manage the finances of small to medium-size firms. The underlying assumption of this book is that successful financial managers need to master the construction and analysis of financial statements and present value models. Learning how to construct and analyze financial statements and present value models is the focus of this book that is divided into five parts.

## Part I: Management

The chapters in Part I introduce management. Chapter 1 describes the firm management process—a process that includes identifying the firm's mission statement and strategic (long term) goals and tactical (short term) objectives; identifying the firm's strengths, weaknesses, opportunities, and threats; identifying and evaluating alternative strategies; and finally implementing and evaluating the preferred strategy. Chapter 1 notes that the management process has wide application including managing the financial resources of the small to medium-size firm.

The firm's opportunities and threats are most often nested in factors outside the firm's control. For example, different ways to organize the firm (Chapter 2) and the tax environment facing the firm (Chapter 3) are factors external to the firm. They are important to discuss, though, because the firm can adopt different responses to the legal and tax environment in which it operates.

We live in and make financial decisions in a world of risk and uncertainty. So how do we make choices when we can't be certain what the outcomes will be? Formal insurance programs are one way of addressing the risk firms face. However, there are other risk responses the firm can employ. Learning about risk and applying this knowledge to the purchase of insurance and adopting other risk management alternatives is the focus of Chapter 4. Some of the concepts covered in Chapter 4 are essential statistical tools needed to plan and make important decisions in a risky and uncertain world.

## Part II: Strengths, Weaknesses, Opportunities, and Threats

Chapters in Part II focus on the internal financial strengths and weaknesses of the firm and its ability to respond to external opportunities and threats. Chapter 5 focuses on the construction, analysis, and interpretation of coordinated financial statements (CFS). CFS are the primary tools for answering the

question: what is the financial condition of the firm and what are its financial strengths and weaknesses?

An important consideration, especially when the focus is on small to medium-sized firms, is how to construct financial statements when the firm has incomplete records. While the data used in the financial management process and the construction of financial statements are most often assumed to be obtainable and accurate, the reality may be quite different. Small to medium-sized firms often lack the financial records required to conduct the analyses described in Part II of this book. Acquiring and sometimes guesstimating the missing data is almost an art form—a process that forms the nexus between theory and practice.

An important lesson to be learned about financial statements—even when we can construct them accurately—is that financial statements alone do not completely reveal the financial strengths and weaknesses of the firm. A more complete view of the firm's strengths and weaknesses requires ratios be constructed using data included in the firm's CFS (Chapter 6). Ratios constructed using the firm's CFS can be compared with similar firms, and significant deviations from the norm can be noted and given further attention. Ratios describing the firm's financial well-being can be described by the acronym SPELL: (S)olvency, (P)rofitability, (E)fficiency, (L)iquidity, and (L) everage.

Chapter 7 notes that the firm's CFS is a system. An important characteristic of an open system is that its parts are connected internally with endogenous variables and externally—to factors outside of the firm—with exogenous variables. Therefore, a change in one or more of the firm's exogenous variables can change conditions inside the firm described by its endogenous variables.

Because CFS are a system, we can analyze the firm's opportunities and threats presented by forces outside the firm. For example, we can ask: what if there is a change in the firm's exogenous variables? Then, how will the financial condition of the firm change? Or we may ask: if the firm has a financial goal, then how much must an exogenous variable change for the firm to reach its goal? Finally, we may ask: if one part of the system changes, what will be the corresponding change? One way to think of the CFS system and what if and how much analysis is to compare it to a balloon: a squeeze somewhere in the balloon will produce a bulge somewhere else.

Throughout this book, we use data from a hypothetical (but not atypical) firm, HiQuality Nursery (HQN) to help make the analysis realistic. However, the financial analysis experience becomes authentic when those practicing financial management skills construct financial statements for actual firms, including ones in which the analyst has a personal interest.

## Part III: Present Value Models

Chapters in Part III of this book introduce present value (PV) models. Chapter 8 provides the theoretical basis for PV models by demonstrating that PV models are multi-period extensions of a single period accrual income statement (AIS). To aid those preparing PV models, this chapter also introduces a gen-

eralized Excel template that can be used to solve practical PV problems. While PV models have the common feature of converting a challenger's future cash flow to its equivalent in the present, Chapter 9 introduces several different kinds of PV models distinguished by the questions they answer. Chapter 10 introduces one important distinction between PV models, whether the investment is an incremental change to an existing firm versus a stand-alone investment. Chapter 11, the last chapter in Part III of this book, describes forecasting methods useful for obtaining future cash flow estimates to populate PV models. Included in chapter 11 is a brief introduction to statistical regression methods, essential for forecasting.

## Part IV: Homogeneous Measures

Chapters in part IV provide more detailed guidelines for constructing PV models. Chapter 12 compares a challenging investment to a defending one by converting a challenger's future cash flow to its equivalent in the present by exchanging cash flow between periods at the defender's internal rate of return. Chapters 13, 14, and 15 remind those solving PV problems that comparisons between challenger(s) and defenders(s) must use homogeneous measures. Chapter 13 describes how to compare investments with different sizes. Chapter 14 describes how to compare investments with different terms. Chapter 15 describes how to introduce taxes into PV models to produce consistent comparisons between challengers and defenders. Finally, chapter 16 introduces homogeneous currency and liquidity requirements when comparing challenging and defending investments.

## Part V: Present Value Model Applications

Armed with a knowledge of PV model building principles and tools, the analyst is prepared to construct PV models for specific investments. Chapters in Part V note that specific investments, while similar, may have some distinct characteristics, depending on the type of investment activity under examination. Chapter 17 considers taking out and repaying loans, emphasizing that loan analysis is essentially a present value problem. Chapter 18 considers purchasing, using, or selling land. An important feature of land purchases and sales is transaction costs, which are included in the land models. Chapter 19 recognizes that the control and use of investments can be acquired through leases as well as through purchases. So, in this chapter, models are constructed that can be used to find the present values of leases. Chapter 20 reviews financial investments, a separate class of investments, especially relevant for personal financial management decisions. Chapter 21 prepares students to observe financial opportunities and threats using the term structure of interest rates, an important financial tool. Finally, Chapter 22 reminds readers that "money can't buy love" nor most other relational goods. Thus, Chapter 22 enlarges the management process to include relational goods as well as commodities.

## Appendices

To solve many of the problems in this text, we employ Excel spreadsheets that are now generally available and which have become the "industry standard" for solving financial management problems. Excel spreadsheets enable the analyst to solve complicated financial problems and examine the robustness of a solution under different possible scenarios. Although students are expected to come to this class with Excel experience, we include in this book an Appendix that provides a brief review of Excel methods employed in this text. Chapter 7 includes an appendix to explain the HQN Coordinated Financial Statement Excel template. Chapter 8 includes an appendix to explain the Green & White Services PV Excel template. Chapter 11 includes an appendix showing how to manage Excel add-ons to access the Data Analysis option.

## Shaded Notes

Finally, throughout this text we identify paragraphs that summarize key concepts explained in the preceding material. These key paragraphs are shaded to suggest that the reader pay them particular attention.

# Acknowledgements

**LINDON ROBISON**

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Some of the chapters in this book were adapted from published articles and books written by the authors of this text and co-authors. We acknowledge these contributions in footnotes in the chapters in which their contributions appear.

PART I

# PART I: MANAGEMENT

# 1. Financial Management and the Firm

**LINDON ROBISON**

*Learning goals.* After completing this chapter, you should be able to: (1) recognize the six steps included in the management process; (2) apply the management process to better manage the financial resources of the small to medium-size firm; and (3) apply the management process to other activities such as being a successful student.

*Learning objectives.* To achieve your learning goals, you should complete the following objectives:

- Understand the need for a concise firm mission statement.
- Learn how to distinguish between the firm's strategic (long-term) goals and its tactical (short-term) objectives.
- Learn how to choose goals and objectives that will successfully guide financial managers in the financial management process.
- Learn how to identify a firm's (internal) strengths and weaknesses.
- Learn how to identify a firm's (external) opportunities and threats.
- Learn how to develop a strategy to reach the firm's goals and objectives that take advantage of the firm's strengths and opportunities and minimize the limitations of its weaknesses and threats.
- Learn how to implement and evaluate outcomes of the firm's strategy for achieving its goals and objectives.
- Learn how to apply the management process to one's own efforts to succeed in this class.

## Introduction to Management

Financial management is about, above all else, management. The verb manage comes from an Italian verb meaning "to handle" as in how a rider handles a horse. The management process can be applied to a wide variety of organizations and resources. In this book, we apply the management process to managing the financial resources of the small business as opposed to larger corporations.

### The Management Process

The management process includes six steps: 1) develop the firm's mission statement; 2) choose the firm's strategic (long-term) goals and tactical (short-term) objectives; 3) identify the firm's strengths, weaknesses, opportunities, and threats; 4) develop the firm's strategy for accomplishing its strategic goals and tactical objectives; 5) implement the firm's strategy; and 6) evaluate the firm's performance.

These six steps are illustrated in Figure 1.1 followed by narrative that describes them in more detail. Note that as one moves from one management step to the other, one moves toward the center of the circle in Figure 1.1. And as one moves toward the center of the circle, each activity is constrained by previous management choices.


*Figure 1.1. The Managerial Process in Six Steps*

So, what have we learned? We learned that the management process includes six steps: 1) develop a mission statement; 2) choose strategic goals and tactical objectives; 3) identify the firm's strengths, weaknesses, opportunities, and threats; 4) identify strategies, 5) implement strategies; and 6) evaluate performance.

## Develop the Firm's Mission Statement

The management process begins with a mission statement. The firm's mission statement explains why the firm exists and what it values. The mission statement may also establish criteria for selecting activities in which the firm will participate. Mission statements might also describe the firm's customers, the markets in which it will participate, and the firm's social responsibilities. Mission statements are often succinct, short, easy to express and remember, clear, and flexible enough to describe the entire range of the firm's activities. For example, a mission for a vegetable farm may be: "our mission is to provide wholesome and safe vegetables grown in an environmentally healthy and worker-friendly environment."

Motives play a critical role in the formulation of the firm's mission statement. Motives spring from physical and socio-emotional needs and the relative importance of these motives will determine how the firm manages its resources to satisfy its needs. Therefore, the relative importance of the financial manager's motives should be reflected in the mission statement. To illustrate, motives may reflect the need to increase one's own consumption, to act in accordance with one's internalized set of values, to earn the good will of others, to increase one's sense of belonging in one's community or other organizations, and to improve the well-being of a disadvantaged group. The mission statement needs to guide the firm's efforts to manage its resources depending on the relative importance of these competing motives.

One word sometimes associated with management is the word "vision." Vision is the ability to imagine or picture, in one's mind, something that has not yet been created physically. Therefore, vision is a necessary condition for any kind of physical creation because we must create an event, outcome, or thing in our mind before we can create it physically. An architect must imagine a building and reflect that vision in plans which the builders will follow to create a building. A football coach imagines an offensive play and reflects it in a drawing before it can be executed in a game. A financial manager must imagine a project that will produce valued outcomes before committing time, energy, and other resources to the project. A vision of what the manager wants the firm to achieve is reflected in the firm's mission statement. A biblical expression highlights the importance of vision: "where there is no vision, the people perish…" (Proverbs 29:18).

> So, what have we learned? We learned that the management process begins with a vision that describes what the firm wants to do and become. Without a vision, the firm is unlikely to succeed.

## Choose the Firm's Strategic Goals and Tactical Objectives

Strategic goals set the long-term direction of the firm. Strategic goals are consistent with the firm's mission statement—what it values, why it exists, and what is its purpose. Strategic goals direct the firm's efforts toward achieving its mission over the long run. Strategic goals also call for tactical objectives, specific actions needed to achieve strategic goals. For example, a strategic goal may be to increase the firm's revenues by 10%. The objectives consistent with this goal may be to develop new products, to focus on a marketing strategy, or to increase the firm's sales force. The firm's objectives transform the firm's strategic goals into an action plan. Tactical objectives describe what short term actions are required if the firm is to reach its long-term goals.

### *The importance of goals and objectives*

There are at least four reasons management requires the firm to choose goals and objectives:

1. Firm goals and objectives express what the firm believes is possible and desirable to achieve. By choosing the firm's goals and objectives, the manager is expressing confidence in what the firm can achieve. By declaring the firm's goals and objectives, the manager is also declaring its commitment of time, energy, and resources to achieve a desired end. Declaring the firm's confidence and commitments in the form of its goals and objectives is the first reason for setting strategic goals and tactical objectives.
2. As the firm works to achieve its goals and objectives, it faces a multitude of choices, including how best to allocate its limited resources. Goals and objectives guide the firm in its allocation decisions by asking: what choices and resource allocations will best enable the firm to reach its goals and objectives? Therefore, firm goals and objectives provide criteria for making choices, the second reason for setting goals and objectives.
3. Most firms include multiple actors with diverse assignments. Goals and objectives provide a means for rallying firm members to support a common cause. Goals and objectives provide a means for seeing one's individual efforts as part of and consistent with the firm's overall goals and objectives and to identify opportunities for synergism within the firm. Ideally, the firm's goals and objectives represent a consensus of firm members' beliefs in what is possible and desirable and how to best achieve them so that all parts of the firm work cooperatively and enthusiastically together. Providing a framework for firm members to work synergistically is the third reason for setting goals and objectives.
4. Finally, goals and objectives provide a measure against which the firm can evaluate its performance. It allows the firm to ask and answer questions such as: Where are we? How are we doing? Can we get where we want to be from here? Are we closer to reaching our goals than before? Measuring one's efforts against a standard is the fourth reason for setting goals and objectives.

## The characteristics of good goals and objectives.

Some goals are better than others. The four reasons why we choose goals and objectives help us define the characteristics of good goals and objectives.

1. Good goals and objectives are realistic. They identify outcomes that are feasible for the firm to achieve given its environment and resources. It is not helpful to set unrealistic goals and objectives, even if they impress others. Unrealistic goals and objectives may create unrealistic expectations and lead to frustration later because they cannot be achieved. Good goals and objectives can be achieved with the wise use of resources available to the firm and the environment in which it exists.
2. Good goals and objectives answer the question: "What must the firm do to achieve its mission?" Goals and objectives that are consistent with the firm's mission statement provide the criteria for the management of the firm's energy and resources. If the firm goals and objectives fail to provide such criteria, then other goals and objectives should be selected.
3. Good goals and objectives reflect a consensus among those tasked with achieving them. People work hard for money. But they work harder when they feel they are part of a team—that their contributions are valued. Thus, good goals and objectives are the product of serious discussions intended to produce a consensus among those involved in reaching them. Therefore, at the end of the day, good goals and objectives provide a focus for synergistic efforts.
4. Finally, progress toward the achievement of good goals and objectives can be measured. Thomas S. Monson (1970) taught, "when progress is measured, progress improves. And when progress is measured and reported, the rate of improvement increases." Measuring the firm's progress helps guide the firm's future. If the measures signal that the firm is making adequate progress, then the firm is supported in its efforts to keep doing what it has been doing. If the measures signal that the firm is not making adequate progress, then the firm is supported in its efforts to change directions.

So, what have we learned? We learned that to realize the firm's vision we must choose goals that are realistic, describe what needs to be done, reflect a consensus, and can be measured. We need goals because they reflect what we believe is possible, they provide criteria for choosing between alternatives, they provide a rallying point for firm members to work together, and they provide measures against which performance can be evaluated.

## Identify the Firm's Strengths, Weaknesses, Opportunities, and Threats.

Before developing strategies to accomplish the firm's goals and objectives, a manager needs to identify and evaluate the internal strengths and weaknesses of the firm. This evaluation should include an assessment of the firm's ability to survive financially in both the long run and the short run (solvency and liquidity); its profitability; its efficient management of its resources on which its profitability depends; and the risk inherent in its current financial state. External opportunities and threats that impact the firm's ability to accomplish its objectives also need to be considered. An external opportunity and threat analysis might include evaluating the behavior of close competitors or assessing the condition of the economy and business climate, or the impacts of the business cycle on clients' incomes and the resulting product demand.

> So, what have we learned? We learned that strengths, weaknesses, opportunities and threats analysis helps the firm understand the current constraints placed on it by both internal and external forces and enables the firm to take corrective action, when possible, to better position itself to accomplish its mission.

## Develop and Evaluate the Firm's Strategy.

The firm's strategy is a plan that describes how it intends to achieve its strategic goals and its tactical objectives. Some have claimed that a goal or objective without a plan is only a wish. The firm's strategy is a plan of action that describes who will do what, when, and how. For each goal or objective, the firm must develop the corresponding strategy to accomplish it. The strategy development process includes collecting data and information about possible choices and likelihoods of possible events. Then, the information must be analyzed to determine the impact of a strategy on the firm's goals and objectives. Based on these analyses, management must select the proper strategy.

> So, what have we learned? We learned that unless we create a plan to achieve our goals and objectives consistent with our vision statement we have likely engaged only in wishful thinking. Planning who will do what, when, and how moves us in the direction of realizing our mission, goals, and objectives.

## Implement the Firm's Strategy.

Once a strategy is selected, it must be administered throughout the firm. All relevant parts of the business (accounting, purchasing, manufacturing, processing, shipping, sales, administration) must support and take an active role implementing the strategy. There may be changes in the business that are necessary to implement the strategy such as changes in personnel, technology, or financial structure. Implementing the firm's strategy will require a carefully coordinated effort if the firm's strategy leads to the firm achieving its goals and objectives.

> So, what have we learned? We learned that there is often more said than done and more planned than executed. Implementing one's strategy is the sine qua non—unless the strategy is implemented, nothing else matters.

## Evaluate the Firm's Performance.

Firm managers must continually evaluate the strategies they implemented to reach the firm's objectives and goals. They must determine if what the firm has achieved is consistent with its mission statement, goals, and objectives within an environment described by the firm's strengths, weakness, opportunities, and threats. Firm managers must also be prepared to alter strategies in response to changes in technologies, laws, market conditions, and personnel. These changes will make it necessary for the firm to continually reevaluate and adjust.

Evaluating the firm's performance must also include a review of its mission statement, goals, objectives, efforts to implement its strategies, and its strengths, weaknesses, opportunities and threats. Since the firm's mission statement and strategic goals are oriented toward the long term, they change infrequently. However, the firm's strategies may change as frequently as its internal strengths and weaknesses and external opportunities and threats change.

> So, what have we learned? We learned that life is like driving a car. Most of the time we look forward to where we are going. On occasion, however, it is important to look in our rear-view mirror to see where we have been and to learn from our journey.

## The Firm Financial Management Process

The firm's financial management process involves the acquisition and use of funds to accomplish its financial goals and objectives consistent with its financial mission statement. The firm's financial management process essentially employs the same six management steps described earlier. The six steps of financial management include: 1) develop the financial mission of the firm; 2) choose the financial goals and objectives of the firm; 3) identify and evaluate the firm's financial strengths, weaknesses, opportunities and threats; 4) develop financial strategies including evaluating and ranking investment opportunities to achieve financial goals and objectives consistent with the firm's mission; 5) implement investment strategies by matching the liquidity of funding sources with cash flow generated from investments, by forecasting future funding needs, and by assessing the risk facing the firm; and, 6) evaluate the firm's financial performance relative to the goals and objectives of the firm. These six steps are described next in more detail.

### (1) Develop the Firm's (Financial) Mission Statement.

While financial management usually plays a role in developing the firm's overall mission statement, there are other considerations shaping the firm's mission. As a result, the financial mission of the firm is usually nested within the more general mission of the firm. One financial mission of the firm may be to reach certain financial conditions that allow the firm's owners to pursue other goals and provide firm owners resources in the future. The firm's mission statement may lead naturally to important financial goals such as to maximize profit, reduce costs and increase efficiency, manage or increase the firm's market share, limit the firm's risk, or maximize the owner's equity in the firm. However, there may be a distinction between a firm's financial mission and the firm's overall mission. In other words, the firm's financial mission included in the strategic financial management process may be an objective in the firm's overall strategic management process.

### (2) Choose the Firm's (Financial) Strategic Goals and Tactical Objectives.

The part of the firm's mission related to financial management must lead to the firm selecting financial goals consistent with the firm's mission statement and objectives likely to lead to the successful achievement of its strategic goals. The financial objectives may direct how the firm organizes itself, how it manages its tax obligations, and how it responds to risk—subjects discussed in Chapters 2, 3, and 4.

## (3) Identify (Financial) Strengths, Weaknesses, Opportunities and Threats.

The use of coordinated financial statements (CFS) discussed in Chapter 5 can be used to evaluate the firm's internal strengths and weaknesses. We may need to look outside of the firm to identify external opportunities and threats facing the firm. Financial statements are used to formulate ratios that can be compared to other firms to determine how the firm's financial condition compares to normal—or average—firms, the subject of Chapter 6. Chapter 7 uses financial statements and ratios to demonstrate that the firm is a system with interconnected parts. As a result, each financial measure (e.g. solvency, profitability, efficiency, liquidity, and leverage) are connected to each other, and a change in one measure will change all the others.

## (4) Develop and Evaluate the Firm's (Financial) Strategy.

Financial managers face an almost limitless set of investment opportunities with a wide variety of characteristics. Some investments will be liquid and easily converted to cash, such as inventories or time deposits. Other investments, such as real estate or production facilities, cannot be easily converted to cash and are considered illiquid. There are investments that provide fairly certain, low risk returns while others will provide uncertain, high risk returns. Some investments are depreciable while others increase in value over time. Firm budget resources for capital or long-term investments and evaluate them using present value (PV) tools. Many of the chapters that follow focus on PV models. Indeed, it may be correct to say that the focus of much of this book is on how to use PV models to evaluate a firm's financial strategy.

- PV models are similar in construction to accrual income statements (Chapter 8);
- PV models are distinguished by the questions they can answer (Chapter 9);
- PV models often evaluate incremental changes in a firm's portfolio of investments (Chapter 10)
- PV models project the future values of exogenous variables (Chapter 11)
- PV models need to be consistent, must be investments of homogeneous rates of return, size, term, tax treatment, and liquidity—requiring that we compare apples to apples and oranges to oranges (Chapters 12, 13, 14, 15, and 16);

Equipped with PV models and knowledge of how to conduct proper comparisons of investments using consistent measures, we are prepared to apply our tools to a wide range of investment problems that employ a variety of PV models. Included is a discussion of loan analysis in Chapter 17, land investments in Chapter 18, leasing options in Chapter 19, and investment in financial assets in Chapter 20. Then Chapter 21 introduces yield curves to help us identify outside-of-the-firm external threats and opportunities. Finally, the last chapter in this book, Chapter 22, ends with a cautionary note—there are relational goods that may be more important than money and should not be ignored.

## (5) Implement the Firm's (Financial) Strategy.

Financial managers often play an important role in managing the implementation of an investment strategy. The implementation stage of financial management may include interacting with capital markets to raise funds required to support a strategy. Managers decide whether to acquire funds internally or borrow from other investors, commercial banks, the Farm Credit System, life insurance companies, or, depending on how the firm is organized, by issuing stocks or bonds.

In the process of obtaining and allocating funds, financial managers interact directly or indirectly with financial markets. This interaction could be simply obtaining a savings or checking account at your local bank. Or it could involve more sophisticated interactions such as raising funds by issuing ownership (equity) claims in your firm in the form of shares of stock.

Another part of implementing the financial strategy of the firm is to interact with various parts of the business and the household. For example, setting inventory policy is both a financial and business management decision and requires input from the production and sales departments of the firm as well as the firm's financial managers. In addition, financial managers must make trade-offs between risks and expected returns. One tool that can be used to evaluate future returns and risk is the term structure of interest rates, the subject of Chapter 21. There are other kinds of trade-offs as well. One important trade-ff is between commodities and relational goods. We will need both because they each satisfy different needs. This book is mostly about managing commodities, but Chapter 22 reminds us that "money can't buy love" or relational goods. Therefore, one more thing about management is to account for and manage relational goods.

## (6) Evaluate the Firm's (Financial) Performance.

Finally, financial concepts and information are often used to evaluate a strategy's performance and to signal investment changes the firm needs to adopt in the future. In this effort, PV models will prove to be particularly helpful.

The relative importance of the six steps included in the management process will differ depending on what is being managed. In the case of financial management, the financial goals, the objectives, the strengths, weaknesses, opportunities, and threats analysis, and the strategies adopted and evaluated will differ from personnel management, for example. Like both financial management and other management efforts is their shared responsibility for the firm. What follows is strategic firm management applied to the financial resources available to the firm.

Our focus on firm financial management. While all six firm financial management processes are important and discussed in this book, we focus on two:

1. Assessing the firm's internal strengths and weakness through the use of coordinated financial statements, ratio analysis, and comparisons with 'average' firms; and

2. Developing strategies described by after-tax cash flow and evaluating them using PV models.

Of course the other parts of the management process are important, especially implementing strategic financial investment plans and evaluating the firm's performance. However, a thorough treatment of these topics which should be pursed in other venues.

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## Trade-offs between Financial Goals and Objectives

The firm's financial goals and objectives guide the financial manager. There are, of course, a wide range of possible tactical objectives that a firm may adopt to achieve its strategic goals and its mission. However, one maxim should guide the manager's choice of objectives: "There is no such thing as a free lunch!" Interpreted, this adage reminds us that nearly always, every objective comes at the cost of another objective

For example, consider the objective of maximizing the firm's profits. Increases in short-term profits may often reduce long-term profits. If the firm desires to reduce its risk, this may require that the firm reduce its profits by investing in less risky–but lower return–investments.

One often-stated firm financial management objective is to maximize the profits of the firm. However, the measure of profits can differ drastically across different accounting practices. For example, cash versus accrual accounting, different depreciation methods, and different inventory accounting methods all lead to different measures of profit. Maximizing profits using one accounting method may not maximize profits using another accounting practice. Furthermore, profits may be difficult to measure when the firm employs unpaid family labor. The real problem is that profits don't reflect the actual cash flow of the firm.

In addition, the traditional notion of profit ignores the timing of the cash flow received by a firm. Suppose you are given the choice of receiving $1,000 either today or one year from today. Which would you choose? Naturally, you would choose to get the money today because you could invest the money

for some positive rate of return and earn more than $1,000 by the end of one year. For instance, suppose you could invest the money in the bank and earn a 5 percent return during the year. At the end of the year you would get back your $1,000 plus $1,000 x (.05) = $50 interest or a total of $1,050. Clearly, the $1,000 today is worth more than the $1,000 one year from today. The notion that dollars at different points in time are not worth the same amounts at a single point in time is known as the time value of money concept. Moreover, it underlies one of the most important financial trade-offs: present profits versus the present value of discounted future after-tax cash flow.

Another trade-off involving the maximize profit objective is that it ignores liquidity. Liquidity can be defined as a firm's ability to meet unexpected cash demands. These cash demands might be unexpected cash expenses for such things as repairs and overhead expenses, new investment opportunities, or unexpected reductions in revenue. The concept of liquidity is closely related to risk. Liquidity needs are usually met by holding salable assets and/or maintaining the capacity to borrow additional funds. Serious risks may reduce the value of some assets and make liquidation of the assets difficult. Likewise, serious risk may also make it difficult to borrow additional funds.

If you were a firm manager, would your objective be to maximize profits or would some other objective be preferable? In this class, we will argue that traditional profit maximization is not a very desirable objective for a financial manager. We will argue that in most cases, financial decisions should be made so they maximize the value of the firm, which turns out to be the same thing as maximizing the present value of all the future cash generated by the firm. Once again, it is important to note that "cash flow" is much different than "profit."

This concept of maximizing firm value is easy to defend in large firms where firm ownership is often separate from management. Owners of these firms generally want management to operate the firm in a way that maximizes the value of their investment; however, in smaller firms and households the value maximization principal is often constrained by other considerations such as concerns about quality of life. For example, you would likely be able to increase your personal wealth over time by driving a Chevrolet instead of a Cadillac (you could invest the cost savings), but you may gain enough satisfaction from driving a Cadillac (or a tractor with green paint) that you are willing to accept the lower wealth level. Nevertheless, for most of this course we will assume that financial decisions are made in a manner that is consistent with maximizing value. In cases where a firm does not maximize present value, it is still useful to estimate the present value maximizing decisions as a benchmark in order to understand the cost of alternative decision in terms of wealth loss.

## Summary and Conclusions

Like it or not, we are all managers—if not managers of a firm then we are personal managers. We have important management responsibilities for our lives and resources. The management process is a universal process requiring that we first determine our mission and what goals and objectives are consistent with our mission? The goals and objectives we choose must declare what it is that we believe

we can and should accomplish and the level of our commitment to reaching our goals and objectives. Finally, we cannot avoid setting goals and objectives because having no goal or objective is a goal or objective—to reach nowhere in particular.

Choosing our goals and objectives is crucial in the management process. We cannot achieve our mission without properly formulated goals and objectives. Goals and objectives lead us to conduct an honest evaluation of our internal strengths and weakness and external threats and opportunities, a process that identifies the resources and constraints likely to contribute to achieving our mission. After formulating our goals and objectives, and after conducting an honest evaluation of our strengths, weaknesses, opportunities and threats, we next decide on a strategy, a plan to follow that will enable us to accomplish our mission. Strategic management requires that we implement our plan, that we take specific actions to ensure we achieve our goal by implementing our strategies. And finally, we evaluate and, if necessary, modify our goals, objectives, and our understanding of our strengths, weaknesses, threats, and opportunities. Then, when we have completed the management process, we repeat it all over again, continually, and not necessarily following the steps in the management process in the same order. We end this chapter by emphasizing this truism: we are all managers, all the time.

## References

Monson, T.M. (1970). "Thou Art a Teacher Come From God," Conference Report, Oct. 1970, 107.

## Questions

1. What does the word management mean?
2. Discuss the six steps included in the management process. Should these steps be practiced sequentially? In any order? Or does it depend on the management problem? Defend your answer.
3. What features differentiate management and firm financial management?
4. Consider mission statements and strategic goals and tactical objectives. Is the following statement: "I want to obtain a college degree." a mission statement, a goal, or an objective? If it is a tactical objective, what strategic goals and mission statement are consistent with this tactical objective? If it is a strategic goal, what mission statement and tactical objectives are consistent with this strategic goal? Finally, if it is a mission statement, what strategic goals and tactical objectives are consistent with this mission statement?
5. Mission statements, strategic goals, and tactical objectives reflect motives. Several motives may explain one's desire to achieve a college degree. One motive for obtaining a college degree is to increase one's lifetime earnings. But there are other motives. To help you connect motives to your personal mission statement, goal, or objective to obtain a college degree, identify the relative importance of the five motives described below. To complete the questionnaire below, assume

you have 10 weights (e.g. pennies) to allocate among the five motives for attending the university. Distribute the 10 weights (pennies) according to the relative importance of each motive. Write your answer in the blank next to each question. There is no right or wrong allocation of weights among the motives except that the sum must add to 10. Each motive reflects the relative importance of one's need to increase one's own consumption, to earn internal/external validation, and to have a sense of belonging.

a. I want a college degree so I can increase my lifetime earnings and get a better job.
b. I want a college degree so important people in my life will be pleased with my achievements.
c. I want a college degree to live up to the expectations I have for myself.
d. I want a college degree so I will feel part of groups to which I want to belong.
e. I want a college degree so that in the future, I will be better able to help others.

6. Develop a management plan for this class, this semester. This should include a brief discussion of each of the six steps in the strategic planning process including a mission statement, strategic goals and objectives, your strengths, weaknesses, opportunities, and threats, your strategies, your plan to implement your strategies, and, lastly, your evaluation process. Discuss what role financial management will play in your strategic planning process.
7. Imagine yourself as the financial manager of a small firm. Write a mission statement focused on profit maximization. What other considerations may be ignored if profit maximization were your primary mission? Suppose your mission statement was to "aid the disadvantaged"? Would profit or value maximization be part of your firm's goals and objectives? Please explain.

# 2. Alternative Forms of Business Organizations

LINDON ROBISON

*Learning goals.* After completing this chapter, you should be able to: (1) know the different forms of business organizations; (2) compare the advantages and disadvantages of alternative business organizations; and (3) identify how alternative business organizations can influence a firm's ability to achieve its financial goals and objectives.

*Learning objectives.* To achieve your learning goals, you should complete the following objectives:

- Learn about the advantages and disadvantages of a sole proprietorship.
- Study the characteristics of firms ideally organized as sole proprietorships.
- Learn about the advantages and disadvantages of partnerships.
- Study the characteristics of firms ideally organized as partnerships.
- Learn about the advantages and disadvantages of C corporations and S corporations.
- Study the characteristics of firms ideally organized as C corporations and S corporations.
- Learn about the advantages and disadvantages of a Limited Liability Company (LLC).
- Study the characteristics of firms ideally organized as LLCs.
- Learn about the advantages and disadvantages of a cooperative.
- Study the characteristics of firms ideally organized as cooperatives.
- Learn about the advantages and disadvantages of a trust.
- Study the characteristics of firms ideally organized as trusts.

## Introduction

The way a business is organized influences its ability to reach its goals and objectives. This chapter focuses on legal forms of business organizations that are widely used in the U.S. These include sole proprietorships, general and limited partnerships, limited liability corporations (LLCs), S corporations, and C corporations. Partnerships, LLCs, and C corporations are found across a wide spectrum of business types and sizes. LLCs are becoming increasingly important in the production agricultural sector, particularly with multi-generation family businesses. In family businesses, legal business structures which facilitate intergenerational transfer of assets has become particularly important.

Characteristics of businesses organizations that influence the ability of a firm to reach its goals and achieve its mission include: 1) who makes the management decisions; 2) how much flexibility does it have in its production, marketing, consumption, and financing activities; 3) its liability exposure; 4) its opportunities for acquiring capital; 5) how the life of the business is defined; 6) how the death of its

owners affects the firm; 7) methods available for transferring the current owners' interest to others; and 8) Internal Revenue Service definitions of business profits and their taxation. Thus, the way a firm is legally organized provides the framework for making financial management decisions.

## Sole Proprietorship

The sole proprietorship is a common organization form especially used by small businesses. A sole proprietorship is a business that is owned and operated by a single individual. Most sole proprietorships are family-owned businesses. The advantages of a sole proprietorship business include:

1. It is easy and inexpensive to form and operate administratively (simplicity);
2. It offers the maximum managerial control; and
3. Business income is taxed as ordinary (personal) income to the owner.

The disadvantages of the sole proprietorship include:

1. It is difficult to raise large amounts of capital;
2. There is unlimited liability;
3. It is difficult to transfer ownership; and
4. The company's life is determined by the life of the owner.

*Sole proprietorships* are typically organized informally and require relatively little paperwork to begin operations. It is the most simple among the alternative business organizations to understand and use. To begin operation, the individual declares himself/herself to be a business. In many cases, a license will be required to operate the business, but often the business begins simply by "opening its door." The day-to-day operations of the firm are also organized informally and may be administered as the owner desires, subject to legal and tax restrictions. For example, certain taxes must be paid by specific dates. The vast majority of regulations small businesses face are independent of the legal form of the business. Metrics such as business size, number of employees, and location often determine which regulations businesses face.

Since sole proprietorships are owned by a single individual, this form of business organization offers the maximum management control. In small firms, the owner of the business is often involved in all aspects of the business: purchasing, inventory control, production, sales, accounting, personnel and customer relations, as well as financial and general management. While the large amount of owner control can be a strength in small firms, it often turns out to be a disadvantage as firms begin to grow and the owner is no longer able to manage all aspects of the business. The owner must then hire competent staff to manage specific aspects of the business.

Sole proprietor business resources equal those available to the owner. This can restrict the startup of the business as well as its growth over time. In many cases, substantial cash outlays are required to

make the capital purchases (land, facilities, equipment, cars, offices) to start the business and to provide initial overhead expenses (salaries, wages, supplies) until the business gets going. Further, it frequently takes two or three years before the business begins to show a profit. The owner of the business has to obtain these funds using their own equity (funds owned by the individual) and/or by borrowing funds, and borrowing requires collateral in the form of owner equity The amount that can be borrowed depends on the equity as well as the projected cash flow generated by the business. The lack of available financial capital for starting and expanding the business is a major drawback of the sole proprietorship. The profits from the business are taxed as personal income to the owner.

Sole proprietorships are subject to unlimited liability which means that the liability for business debts extends beyond the owner's investment in the firm. For example, if the sole proprietorship is unable to cover its debts and obligations, creditors have the right to collect the personal assets that are not part of the business or other businesses of the owner. The owner may be forced to liquidate assets, such as a personal savings account, a vacation home, or other personal assets just to cover the firm's obligations.

Another disadvantage of a sole proprietorship is that it has a limited life that corresponds to life of the owner. The owner may sell assets from the business to another sole proprietorship or business. However, if the business is not terminated prior to the death of the owner, then after the proprietor's death, the assets remaining in the firm will be distributed according to the owner's will or comparable instrument. When the owner dies, the business is terminated.

## Partnerships

A *general partnership* is a business that is owned and operated by two or more individuals. The partners contribute to the business, share in management, and divide any profit. Partnerships are usually created by written contract among the partners, but they can be legally recognized even without a written agreement. If the partnership owns real property, the partnership agreement should be filed in the county where the property is located.

Advantages of partnerships include:

1. They are easy and inexpensive to form and operate administratively;
2. They have the potential for large managerial control;
3. Business income is taxed as ordinary (personal) income to the owner; and
4. A partnership may be able to raise larger amounts of capital than a sole proprietorship.

The disadvantages of a general partnership include:

1. Raising capital can still be a constraint;
2. There is unlimited liability;
3. It is difficult to transfer ownership; and

4. The company has limited life.

The advantages and disadvantages of a general partnership are similar to the sole proprietorship. Partnerships are generally easy and inexpensive to set up and operate administratively. Partnership operating agreements are critical. Like sole proprietorships, profit allocated to the partners is based upon their share in the business.

*Managerial control* resides with the partners. This feature can be an advantage or disadvantage depending on how well the partners work together and the level of trust in each other. Control by any one partner is naturally diluted as the number of partners increases. Partnerships are separate legal entities that can contract in their own name and hold title to assets

The challenge to partnerships extends beyond possible conflicts with the partners. Divorce and other disputes may threaten the survival of the partnership when a claimant to a portion of the business's assets demands his/her equity.

*Unlimited liability* remains a strong disadvantage for a general partnership. All partners are liable for the debts of the firm. Due to this unlimited liability, the risks of the business may be spread according to the owners' equity rather than according to their interests in the business. This risk becomes an actual obligation whenever the partners are unable to satisfy their shares of the business's obligations.

Increasing the number of partners can increase the amount of capital that can be accessed by the firm. More partners tends to mean more financial resources and this can be an advantage of a partnership compared to a sole proprietorship. Still, it is generally difficult for partnerships to raise large amounts of capital—particularly when liability is not limited.

*Ownership transfer* and limited life continues to be a problem for partnerships; however, it may be possible to build provisions into the partnership that will allow it to continue operating if one partner leaves or dies. In some cases, parent-child partnerships can ease the difficulties of ownership transfer.

A *limited partnership* is another way businesses can organize. Limited partnerships have some partners (limited partners) who possess limited liability; limited partners do not participate in management of the firm. There must be at least one general partner (manager) who has unlimited liability. Because of the limited liability feature for limited partners, this type of business organization makes it easier to raise capital by adding limited partners. These limited partners are investors and make no management decisions in the firm.

One difficulty occurs if the limited partners wish to remove their equity from the firm. In this instance, they must find someone who is willing to buy their share of the partnership. In some cases, this may be difficult. Another difficulty is that the Internal Revenue Service (IRS) may tax the limited partnership as a corporation if it believes the characteristics of the business organization are more consistent with the corporate form of business organization.

In production agriculture, family limited partnerships serve a number of objectives. For example, parents contemplating retirement may wish to maintain their investment in a farm business but limit their liability and be free of management concerns. To reduce their liability exposure and be free of man-

agerial responsibilities, parents can be limited partners in a business where younger family members are the general partner.

The joint venture is another variation of the partnership, usually more narrow in function and duration than a partnership. The law of partnership applies to joint ventures. The primary purpose of this form or organization is to share the risks and profits of a specific business undertaking.

## Corporations

A *corporation* is a legal entity separate from the owners and managers of the firm. Three fundamental characteristics distinguish corporations from proprietorships and partnerships: (1) the way they are owned and managed, (2) their perpetual life, and (3) their legal status separate from their owners and managers.

A corporation can own property, sue and be sued, contract to buy and sell, and be fined—all in its own name. The owners usually cannot be made to pay any debts of the corporation. Their liability is limited to the amount of money they have paid or promised to pay into the corporation.

Ownership in the corporation is represented by small claims (shares) on the equity and firm's profit.

The two most common types of claims on the equity of the firm are common and preferred stock. The claims of preferred stockholders takes preference over equity claims of common stockholders in the event of the corporation's bankruptcy. Preferred stockholders must also receive dividends before other equity claims. The preferred stockholders' dividends are usually fixed amounts paid at regular intervals that rarely change. In most cases, preferred stock has an accumulated preferred feature. This means that if the firm fails to pay a dividend on preferred stock, at some point in time the corporation must make up the payment to its preferred stockholders holders before it can make payments to other equity claims.

*Common stock* equity claims are the last ones satisfied in the event of the corporation's bankruptcy. These are residual claims on the firm's earnings and assets after all other creditors and equity holders have been satisfied. Although it appears that common stock holders always get the "leftovers," the good news is that the leftovers can be substantial in some cases because of the nature of the fixed payments to creditors and other equity holders.

Large corporations are usually organized as Subchapter C corporations.

The advantages of a C corporation include:

1. There is limited liability;
2. The corporation has unlimited life;
3. Ownership is easily transferred; and
4. It may be possible to raise large amounts of capital.

The disadvantages of a C corporation include:

1. There is double taxation; and
2. It is expensive and complicated to begin operations and to administer.

## Seeing Double

Earnings from the corporation are taxed using a corporate tax rate. When earnings are distributed to the shareholders in the form of dividends, the earnings are taxed again as ordinary income to the shareholder. For example, suppose a corporation, whose ownership is divided among its 3000 shareholders, earns $1,000,000 in taxable profits for the year and is in a flat 40-percent tax bracket. Profits per share equal $1,000,000/3000—or $333.33. The corporation pays 40% of $1,000,000—or $400,000—in taxes to the government. Taxes per share equal $400,000/3000—or $133.33.

Now suppose the corporation distributes its after-tax profits to its 3,000 shares in the form of dividends. Each shareholder would receive a dividend check of $600,000/3,000 = $200. The $200 dividend income received by each shareholder would then be taxed as ordinary personal income. If all the shareholders were in the 30-percent tax bracket, then each would pay 30% of $200 or $60 in taxes, leaving each shareholder with $140 in after-tax dividend income.

So what is the total tax rate paid on corporate earnings? Dividing the taxes paid by the corporation and the shareholder by the profit per share, the total tax rate is ($133.33+$60)/$333.33 = 58%, a higher rate than would be paid on personal income of the same amount.

One of the primary strengths of the corporate form of business organization is that the most the owners of the firm (shareholders) can lose is what they have invested in the firm. This limited liability feature means that as a shareholder, one's personal assets beyond the investment in the corporation can't be taken to satisfy the corporation's debts or obligations.

*Ownership* can easily be transferred by selling shares in the corporation. Likewise, the corporation has an unlimited life because when an owner dies, the ownership shares are passed to his/her heirs. The common separation of ownership and management in large corporations helps to ease the ownership transfer as the firm management process never ceases.

The easy transfer of ownership, separation of management and ownership, and limited liability features of a corporation combine to create a business structure that is designed to raise large sums of

equity capital. Investors in large corporations don't have to become involved in management of the firm. Their risk is limited to the amount of funds invested in the firm, and their ownership interest can be transferred by selling their shares in the firm.

*Corporations are more expensive and complicated to set up and administer* than sole proprietorships or partnerships. Corporations require a charter, must be governed by a board of directors, pay legal fees, and meet certain accounting requirements. Despite the relatively high setup cost, the primary disadvantage of the corporate form of business is that income generated by the corporation is subject to double taxation.

However, there is a limit on corporate earnings that are double-taxed. The corporation may pay reasonable salaries, and these are deducted from the corporation's profits. Therefore, salaries paid to corporate workers and operators are not taxed at the corporate level. In some cases, the corporation's entire net profit may be offset by salaries to the owners so that no corporate income tax is due. On the other hand, if the corporation pays dividends to the shareholders, those payments are subject to corporate-level income tax. However, the individual does not have to pay self-employment tax on the dividends. And, qualifying dividends (and most United States Corporation dividends can fit into this definition) are taxed at capital gains rates and not the individual's top marginal tax rate. Finally, dividends paid to a shareholder that actively participates in the business are not subject to either the 0.9 percent Medicare surtax on earnings or the 3.8 percent tax on net investment income that are levied on higher-income taxpayers.

Another disadvantage of corporations has to do with the fact that the managers do not own the firm. Managers, who control the resources of the firm, may use them for their own benefit. For example, top management may build extravagantly large headquarters and buy fleets of jets and limousines for transportation. If less were spent on perquisites, then the income of the corporation would be higher. Higher income allows higher dividends to be paid to the owners (shareholder).

The (potential) self-serving behavior by management running contrary to the interests of stockholders is an example of a principal-agent problem. Methods of dealing with the principal-agent exist. One way is to hire auditors to monitor the use of firm resources. Further, a corporation has a board of directors responsible for hiring, evaluating, and removing top management. Boards are often ineffective because they meet infrequently and may not have access to the information necessary to fulfill their responsibilities. Additional problems exist if management personnel also sit on the board of directors.

Another way to deal with the principal-agent problem in corporations is to align the interests of management with those of shareholders. This is accomplished by basing the compensation of management on the value of the firm's stock. A chief executive officer could receive stock options as a part of his/her compensation package. If the stock price rises, the value of the options increase, which benefits the manager financially. The shareholders also benefit when the stock price increases. Such an arrangement may reduce the principal-agent problem. However, very high executive compensation can often trigger criticism from external groups such as consumer or labor activists.

Limitations of linking management's compensation to the value of its stock have been illustrated by Enron and Tyco corporations. These corporations inflated the value of their stocks and eventually

bankrupted themselves and lost the investments of their employees. It seems there is still a lot to be learned about aligning the interests of corporate managers and shareholders.

Many small businesses, including farms, use the C corporation structure and operate much like partnership. This is frequently done for reasons of expensing and intergenerational transfer.

The corporation will need to be "capitalized" by some level of equity funds from the shareholders. It is common practice among lenders to require personal guarantees by the owners of small corporations before providing funds to the business. This essentially eliminates the limited liability features for those shareholders. As one might expect, due to these difficulties, many small corporations are not able to generate large amounts of capital by simply selling ownership shares. As a result, many small corporations do not really receive the full benefits of corporate organization but are still subject to the disadvantages, namely double taxation.

*C corporations and S corporations.* Any corporation is first formed under the laws of a particular state. From the standpoint of state business law, a corporation is a corporation. However, there are two types of for-profit corporations for federal tax law purposes:

- C corporations: What we normally consider "regular" corporations that are subject to the corporate income tax
- S corporations: Corporations that have filed a special election with the IRS. They are not subject to corporate income tax. Instead, they are treated similarly (but not identically) to partnerships for tax purposes.

There is an alternative form of corporate business organization that is often more desirable from a small business perspective. Subchapter S Corporations have limited liability protection, but the income for the business is only taxed once as ordinary income to the individual (Wolters Kluwer. n.d.).

*Subchapter S Corporations* are sometimes preferred by small businesses because they provide limited liability protection. Meanwhile the income for the business is only taxed once as ordinary income to the individual. There are requirements that must be satisfied for firms to be organized as Subchapter S corporations. These requirements include: (1) it cannot have more than 100 shareholders; (2) it may have only one class of stock; (3) it cannot have partnerships or other corporations as stockholders; and (4) it may not receive more than 20 percent of its gross receipts from interest, dividends, rents, royalties, annuities, and gains from sales or exchange of securities. In agriculture, these restrictions usually mean that only family or closely-held farm businesses can achieve Subchapter S status.

Federal income tax rules for Subchapter S corporations are similar to regulations governing partnerships and sole proprietors. However, corporations may provide certain employee benefits that are tax deductible. Accident and health insurance, group life insurance, and certain expenditures for recreation facilities all qualify. However, these benefits may be taxable to the employees and subsequently to the shareholders.

There is greater continuity for businesses organized under Subchapter S than for sole proprietorships or partnerships. Upon the death of shareholders, their shares of the corporations are transferred to

the heirs and the Subchapter S election is maintained. Surveys suggest that the major reason farms incorporate is for estate planning. The corporate form allows for the transfer of shares of stock either by sale or gift. This is much easier than transferring assets by deed.

## Limited Liability Company

The *Limited Liability Company (LLC)* is a relatively new form of business organization. An LLC is a separate entity, like a corporation, that can legally conduct business and own assets. The LLC must have an operating agreement which regulates its business activities and the relationship among its owners (referred to as members). There are no restrictions on the number of members or the members' identities. LLCs are subject to disclosure, record keeping, and reporting requirements that are similar to a corporation.

The attractive feature of the LLC is that all members obtain limited liability, but the entity is taxed as a general partnership. The LLC is similar in many respects to the Subchapter S corporation. The primary differences are: 1) the LLC has less restrictive membership requirements; and 2) the LLC is dissolved in the event of transfer of interest or death unless members vote to continue the LLC. Table 2.1 summarizes the primary characteristics of the business organizations discussed so far.

**Table 2.1. Comparison of Business Organizations**

| | Organization | | | | | |
|---|---|---|---|---|---|---|
| **Characteristic** | Sole Proprietorship | Partnership | Limited Partnership | S Corporation | C Corporation | Limite Liabili Comp |
| ownership | • single<br>• individual | • two or more individuals | • two or more individuals<br>• one or more general partners | • legal person<br>• max 35 shareholders<br>• individuals | • legal person | • le pe<br>• tw m m |
| management decision | • proprietor | • partners | • general partner | • elected directors<br>• management | • elected directors<br>• management | • m<br>• m |
| life | • terminates at death | • terminates at death | • agreed term<br>• terminates at death | • perpetual or fixed<br>• transfer stock | • perpetual or fixed<br>• transfer stock | • ag te<br>• te at |
| transfer | • assets | • assets | • assets | • shares | • shares | • as |
| income tax | • individual | • individual | • individual | • individual | • corporate<br>• individual | • in |
| liability | • unlimited | • unlimited | • general partners unlimited<br>• limited partners limited | • limited | • limited | • li |
| capital | • personal<br>• loans | • personal<br>• loans | • personal<br>• loans | • shareholders<br>• bonds<br>• loans | • shareholders<br>• bonds<br>• loans | • m<br>• lo |

## Cooperative

A *cooperative* is a business that is owned and operated by member patrons. Generally, cooperatives are thought to operate at cost, with all profits going to member patrons. The profits are usually redistributed over time in the form of patronage refunds. Cooperatives often appear to operate as profit making organizations much the same as other forms of business organization. Agricultural cooperatives do not face the same anti-trust restrictions as non-cooperative businesses, and they enjoy a different federal income tax status. In most instances, the concepts and analysis techniques covered in this course will be relevant to financial management in cooperatives.

## Trusts

A *trust* transfers legal title of designated assets to a trustee, who is then responsible for managing the assets on the beneficiaries' behalf. The management objectives can be spelled out in the trust agreement. Beneficiaries retain the right to possess and control the assets of the trust and to receive the income generated by the properties owned by the trust. Beneficiaries hold the trust and personal property, rather than title to the assets. The legal status of certain types of land trusts are unclear in some states.

## Farm Business Organization Types in US Agriculture

Gross cash farm income (GCFI) includes income from commodity cash receipts, farm-related income, and government payments. Family farms (where the majority of the business is owned by the operator and individuals related to the operator) of various types together accounted for nearly 98 percent of 2.05 million U.S. farms in 2018. Small family farms (less than $350,000 in GCFI) accounted for 90 percent of all U.S. farms. Large-scale family farms ($1 million or more in GCFI) accounted for about 3 percent of farms but 46 percent of the value of production.

The USDA defines a farm as a place that generates at least $1,000 value of agricultural products per year. In 2007, farms generating between $1,000 and $10,000 of agricultural products made up 60% of the 2.2 million U.S. farms. Farms producing $500,000 or more in 2007 dollars generated 96% of the value of U.S. agricultural production.[1]

1. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/farming-and-farm-income

Table 2.2 shows the percentage of farms by organizational type and their share of aggregate agriculture product sales according to the 2007 Census of Agriculture. Sole proprietorships are the dominant form of business organization measured by farm count (86.5%) but have only 49.6% of the value of agricultural production. Partnerships and family corporations make up 20.8% of farms but have 43% of the value of agricultural production. Non-family corporations, part of the "other organization" category, accounted for 0.4% of farms and 6.5% of the value of agricultural production.

**Table 2.2. Farm Business Organization Types (USDA Census of Agriculture, 2007. Farms in US 1,925,300)**

| Business Type | % of Farms | % of Cash Receipts |
|---|---|---|
| Sole Proprietorships | 86.5% | 49.6% |
| Partnerships | 7.9% | 20.9% |
| Family Corporations[2] | 3.95 | 22.9% |
| Other[3] | 1.2% | 7.3% |

More generally, about 80 percent of all businesses (agriculture and non-agriculture) are organized as sole proprietorships while only around 10 percent of businesses are organized as corporations. Conversely, about 80 percent of business sales come from corporations while sole proprietorships account for only about 10 percent of business sales.

So, what have we learned? We learned that firms organize differently depending on the size, ability to manage, the need for internal versus external funding, and tax implications. Indeed, the need for different business organizations can be compared to the need for different kinds of transportation—it depends on where you are going.

2. More than 50% of the stock is owned by persons related by blood or marriage.
3. Nonfamily farms, estates or trusts, grazing associations, American Indian Reservations, etc.

## Summary and Conclusions

Recognizing that we cannot offer financial management tools that meet the needs of all business organizations, we purposely focus in this text on small to medium-size businesses. As a result, we focus on firms that depend on internal capital and exercise the maximum control of the firm.

## Questions

1. Describe the connection between how a business is organized and its ability to reach its goals and objectives.
2. Discuss the advantages and disadvantages of organizing a business as a sole proprietorship versus a C corporation.
3. Limited partnerships, limited liability companies, and Subchapter S corporations are alternative business organizations. Discuss the advantages and/or disadvantages these organizations offer relative to sole proprietorships, general partnerships, and C corporations.
4. Approximately 85% of all farm businesses in the US are organized as sole proprietorships. Explain why the organization form of farm businesses in the U.S. is dominated by sole proprietorships.
5. Can you explain in Table 2.2 why corporations tend to control more land than partnerships and sole proprietorships?
6. What are the advantages or disadvantages of a family corporation compared to a regular corporation?

# 3. The Federal Tax System

**LINDON ROBISON**

*Learning goals.* At the end of this chapter, you should be able to: (1) describe the major components of the federal tax system; (2) know how the different forms of business organizations are taxed; (3) recognize the difference between marginal and average tax rates; and (4) understand how depreciation, capital gains, and depreciation recapture affect the amount of taxes a firm pays.

*Learning objectives.* To achieve your learning goals, you should complete the following objectives:

- Learn to distinguish between the firm's gross income, adjusted gross income, and personal deductions.
- Learn how to calculate the firm's tax liability by finding its taxable income
- Learn how to find the firm's average tax rate and marginal tax rates.
- Learn how to find a firm's tax liabilities by using tables of Federal Income Tax Rates.
- Learn how depreciation can reduce the firm's tax liabilities.
- Learn how to find the amount of taxes paid on interest and dividend income.
- Learn how to distinguish between capital gains and losses and depreciation recapture.
- Learn how taxes are calculated on depreciation recapture and capital gains and losses.
- Learn about the different ways depreciation can be calculated and the advantages and disadvantages of each depreciation method.

## Introduction

Chapter 2 proposed that one financial management objective is to organize the firm so that its value is maximized. Of course, "the firm" could mean any business organization ranging from a large corporate firm to a small business or even an individual household. Later, we will see that the firm's value is determined by its after-tax cash flow, which can differ significantly from the firm's profits measured by its accounting income. As a result, we need to understand the differences between a firm's cash flow and its accounting income—this discussion will come later. Fortunately, for the most part, a detailed knowledge of specific accounting differences for the different types of business organizations isn't essential for our purposes. So we begin by discussing some of the major components of the federal tax system that have a bearing on a firm's after-tax cash flow.

Due to the influence of taxes on cash flow, it is important to have an understanding of how the tax system works. This chapter intends to present a few of the basic concepts related to taxes that are important from a financial management perspective. Our focus is on the federal tax code, because of its importance in determining after-tax profit and after-tax cash flow. Nevertheless, there are a number of additional taxes (e.g. state and local taxes) that can have a significant impact on a firm's earnings

and cash flow. It is important to consider the impacts of all taxes when making financial decisions. The federal tax laws are written by Congress. The Internal Revenue Service (IRS) is the agency responsible for administering the code and collecting federal income taxes. The IRS issues regulations which are its interpretation of the tax laws. The regulations are effectively the tax laws faced by businesses and individuals. One final word of caution: always remember that tax laws can and do change, and these changes are not always announced in ways that inform small businesses. Nevertheless, ignorance is not an excuse for incorrectly filing one's taxes.

## Individual Taxes

Individual (ordinary) tax liabilities are determined by subtracting certain allowable deductions from one's total income to obtain taxable income. Taxable income is then used as the basis from which the tax liability is calculated. The general procedure is:

- *Gross income – Adjustments to income = Adjusted gross income.*
- *Adjusted gross income – Personal exemptions and deductions = Taxable income.*
- *(Taxable income) x (Average tax rate) = Tax liability.*

*Gross income* consists of all income received during the tax year in the form of money, goods and services, and property. *Adjustments to income*, including some past losses, may include income that is not taxed, such as interest income generated by nontaxable municipal bonds. *Adjusted gross income* may be reduced by subtracting *personal exemptions and deductions* regardless of whether you itemize or not and includes such things as business expenses and deductions for some types of Individual Retirement Account (IRA) contributions. A personal exemption is the allowable reduction in the income based on the number of persons supported by that income. You may claim deductions for yourself, your spouse, and other dependents who meet certain criteria. As of 2018, the personal exemption amount is zero until 2025. In addition, you can reduce your taxable income by either claiming a standard deduction or itemizing allowable expenses.

The standard deduction is an amount allowed for all taxpayers who do not itemize, and represents the government's estimate of the typical tax-deductible expenses that you are likely to have. As of 2018, the standard deduction is $12,000 for single, $18,000 for head of household, and $24,000 for married filing jointly. These are adjusted annually for inflation. If your tax-deductible expenses are greater than the standard deduction, you can list them separately and deduct the total value of the itemized deductions. Itemized deductions include expenses for such things as medical expenses, certain types of taxes, mortgage interest expense, and charitable contributions. After reducing *Adjusted gross income* by subtracting *Personal exemptions and deductions*, we obtain our *Taxable income*, the amount of income that will be used to calculate your *Tax liability.*

The Federal income tax in the United States is called a *progressive* tax, meaning that the percentage tax rate increases as taxable income increases. In contrast, *regressive* taxes have their tax rate remain con-

stant or decrease as taxable income increases. State sales taxes, property taxes, social security taxes, and in some cases, state income taxes are regressive taxes because as a percentage of one's income paid as taxes they increase with a decline in one's income.

Two different tax rate measures include the Average tax rate and the Marginal tax rate defined below:

average tax rate = tax liability / taxable income

marginal tax rate = tax rate on the next dollar of taxable income.

The average tax rate represents the "average" tax rate that is paid on each dollar of taxable income. The marginal tax rate is the tax rate that is paid on the next dollar of taxable income. In a progressive tax system, the marginal tax rate will always be equal to or greater than the average tax rate.

The federal tax rate schedule for 2018 taxable income is shown in Table 3.1.

**Table 3.1. Federal Income Tax Rates in 2018**

| Tax Bracket | Married Filing Jointly | Single |
|---|---|---|
| 10% Bracket | $0 – $19,050 | $0 – $9,525 |
| 12% Bracket | $19,050 – $77,400 | $9,525 – $38,700 |
| 22% Bracket | $77,400 – $165,000 | $38,700 – $82,500 |
| 24% Bracket | $165,000 – $315,000 | $82,500 – $157,500 |
| 32% Bracket | $315,000 – $400,000 | $157,500 – $200,000 |
| 35% Bracket | $400,000 – $600,000 | $200,000 – $500,000 |
| 37% Bracket | Over $600,000 | Over $500,000 |

Due to the progressive nature of the tax, the marginal tax rate increases as your income increases. The first $19,050 of taxable income for married couples filing a joint return are taxed at a rate of 10%, the next $58,350 ($77,400 – $19,050) of taxable income are taxed at a rate of 12%, and so on. Suppose a married couple had $120,000 of taxable income in 2018.

Their Federal tax liability would be calculated on each increment of income as follows: The average tax rate paid equals Total tax liability/taxable income = $18,279/$120,000 = 15.2% and the marginal tax rate paid on the last dollar earned would be 22%.

10% tax on first $19,050 ($19,050 – $0) = 10% x $19,050 = $1,905.00
12% tax on next $58,350 ($77,400 – $19,050) = 12% x $58,350 =$7,002.00
22% tax on next $42,600 ($120,000 – $77,400) = 25% x $44,700 = $9,372.00
**Total Tax Liability on $120,000 = $18,279.00**

It is important to distinguish between the marginal and average tax rate. The average tax rate is useful because it allows us, with a single number, to characterize the proportion of our total income that is taxed. In many cases, however, we are interested in the amount of tax that will be paid on any additional income that is earned, perhaps as a result of profitable investment. In these situations, the mar-

ginal tax rate is the appropriate rate to use. For example, suppose your average tax rate is 18.4 percent and you are in the 22 percent tax bracket, and you receive a $1,000 raise. The additional income you earn will be taxed at the marginal tax rate of 22 percent, regardless of the average tax rate, so that your increase in after-tax income is only $1,000(1 – .22) = $780. The marginal tax rate is also significant when considering the impact of tax deductions. Suppose you are in the 22 percent tax bracket and you contribute $2,000 to your favorite charity. This reduces your taxable income by $2,000, saving you $440 in taxes (22% times $2,000) so that your after-tax cost of your contribution is only $2,000(1 – .22) = $1,560.

## Total Marginal Tax Rates

As we pointed out earlier, because of the progressive nature of the federal tax code, the effective marginal rate that individuals pay is nearly always greater than the federal marginal tax rate. However, there are more levels of government collecting tax revenues than just the federal government. In addition to the federal tax, most personal income is also subject to state taxes, Social Security taxes, Medicare taxes, and perhaps city taxes. State taxes vary but often run in the 4 – 6 percent range. Social Security (6.2 percent) and Medicare (1.45 percent) taxes are split between employer and employee, and the rate for most employees is 7.65 percent (self-employed pay both the employer and employee half, usually 15.3 percent). In 2018, the social security tax is imposed only on individual income up to $128,400. There is no maximum income limit on the Medicare tax. City taxes can run 3 – 4 percent. Therefore, the effective marginal tax rate for someone in the 24 percent federal tax bracket who pays social security tax will generally be over 37 percent. If the same person were self-employed they would be subject to an additional 7.65 percent, and a marginal tax rate that could exceed 50 percent of taxable income in some cases. It should be noted that one-half of "self-employment tax" is deductible from income subject to federal tax, so the effective marginal tax rate increases by only 7.65(1 – .24) = 5.81 percent for someone in the 24 percent tax bracket. As you can see, it is extremely important to understand what the effective marginal tax rate is when making financial management decisions.

## Bracket Creep

Progressive tax systems are subject to an undesirable feature, often termed "bracket creep." *Bracket creep* is an inflation-induced increase in taxes that results in a loss in purchasing power in a progressive tax system. The idea is that inflation increases tend to cause roughly equal increases in both nominal income and the prices of goods and services. Inflation induced increases in income push taxpayers into higher marginal tax brackets, which reduces real after tax income. Consider an example of how inflation reduces real after-tax income and therefore purchasing power.

For the couple in our previous example with a taxable income of $120,000, their real after-tax income, their purchasing power in today's dollars, is equal to their *Gross income less* any *Tax liabilities* which in

their case is: $120,000 – $18,279 = $101,721. Another way to calculate their purchasing power is to multiply (1 – average tax rate T) times their gross income: (1 – 15.2325%)$120,000 = $101,721.

Inflation is a general increase in price. Suppose that, as a result of inflation, that next year inflation will increase your salary 10%. However, suppose that inflation will also increase the cost of things you buy by 10%. As a result, to purchase the same amount of goods next year that were purchased this year will require a 10% increase in this year's expenditures. For the couple described in our earlier example, this will require expenditures of $101,721 times 110% = $111,893.10.

Now let's see what happens to our couple's after-tax income. A 10% increase in taxable income means they will have $120,000 times 110% = $132,000 in taxable income next year. Recalculating the couple's tax liabilities on their new income of $130,000:

The average tax rate paid equals Total tax liability/taxable income = $20,919/$132,000 = 15.85% while the marginal tax rate paid on the last dollar earned would be 22%. Subtracting couple's tax liabilities from their income leaves them $111,051, less than $111,893.10 which is the amount required to maintain the same purchasing power before inflation. In other words, as a result of the combination of inflation and bracket creep with increases on the average tax rate, the couple's purchasing power is reduced

The IRS recognizes the impacts of bracket creep, and periodically adjusts the tax schedules and/or deductions in an attempt to smooth or eliminate purchasing power losses due to bracket creep.

10% tax on first $19,050 ($19,050 – $0) = 10% x $19,050 = $1,905.00
12% tax on next $58,350 ($77,400 – $19,050) = 12% x $58,350 = $7,002.00
22% tax on next $54,600 ($132,000 – $77,400) = 25% x $54,700 = $12,012.00
**Total Tax Liability on $132,000 = $20,919.00**

## Interest and Dividend Income

Interest and ordinary dividends earned by individuals are generally taxed as ordinary income. One exception is interest income earned on municipal bonds issued by state and local governments (bonds are promissory notes issued by a business or government when it borrows money). Municipal bonds are exempt from federal taxes, which makes them attractive to investors in high marginal tax brackets.

Suppose you are in a 25% marginal tax bracket and are considering investing $1,000 in either a corporate bond that yields 10% per year, (yield means the rate of return the investment provides) or a municipal bond yielding 8% each year. You can calculate your after-tax cash flow from each investment by subtracting the tax liability from the before-tax cash flow from each investment.

The corporate bond provides a $100 cash flow before taxes but only $75 is left after paying taxes. Meanwhile, the municipal bond is exempt from federal taxes and provides an $80 before and after-tax cash flow. This example illustrates the importance of considering after-tax cash flow as opposed to before-tax cash flow when considering investment opportunities.

| Asset | Before-tax cash flow return | – Taxes | = After-tax cash flow |
|---|---|---|---|
| Corporate bond | $1,000(.10) = $100 | $100(25%) | $75.00 |
| Municipal bond | $1,000(.08) = $80 | $0 | $80.00 |

We can also measure an investment's return using percentages. Percentage measures standardize return measures so investments of different sizes can be compared. We calculate the percentage return during a period as the cash flow received during the period divided by the total amount invested. For example, the percentage rate of return on the corporate bond was $75/$1000=7.5%, while the percentage rate of return on the municipal bond was $80/$1000=8.0%.

When the returns on the bonds are expressed as rates of return, it is clear that the municipal bond is the preferred investment.

Suppose you wanted to find the before-tax rate of return on a corporate bond (*r*cb), a pre-tax equivalent rate of return that would provide the same after-tax rate of return as a tax free municipal bond (*r*mb ). To find *r*cb , equate the after-tax rates of returns on the corporate and municipal bonds, *r*cb (1 – T ) = *r*mb , and solve for the following:

$$r^{cb} = \frac{r^{mb}}{(1-T)} \tag{3.1}$$

In our example municipal bond rate is 8% so that for an investor in the 25% marginal tax bracket, the pre-tax equivalent rate of return is:

$$r^{cb} = \frac{8\%}{(1-0.25)} = 10.67\% \tag{3.2}$$

In other words, a corporate bond yielding 10.67% would produce the same after-tax return as the municipal bond yielding 8% for an investor in the 25% tax bracket.

## Interest Paid by Individuals

Interest paid by individuals is generally not tax deductible for personal expenditures, such as interest on a loan for a car used solely for personal travel. One primary, and important, exception to this is that interest on a home mortgage is usually deductible from taxable income if filing using itemized deductions. There is also a limited deduction available for student loan interest payments.

# Capital Gains and Losses

From an accounting standpoint, we define *book value* (or basis) as acquisition cost less accumulated depreciation, which is determined by tax codes. (Book value may also be altered by improvements to depreciable assets.) For a variety of reasons, an asset's market value is usually different from its book value. When an asset is liquidated at a market value greater than its book value we say it has appreciated in value. If the appreciation is equal to or less than its original acquisition cost, we refer to the appreciation value as *depreciation recapture*. Appreciated value in excess of its acquisition value is referred to as *capital gains*.

Likewise, when an asset's liquidation value is less than its book value, we say that the asset has experienced *capital losses* and define: capital losses = book value – market value (if book value > market value). The tax rate for individuals on "long-term capital gains", which are gains on assets that have been held for over one year before being sold, depends on the ordinary income tax bracket. For taxpayers in the 10% or 15% bracket, the rate is 0%. For taxpayers in the 22%, 24%, 32%, or 35% bracket, it is 15%. For those in the 37% bracket, the rate is 20%. Other rates also exist under certain situations. The tax rate paid on depreciation recapture is the taxpayer's income tax rate since depreciation was used to shield income from income tax payments.

Suppose you are in the 24% tax bracket. You have just sold some land (a non-depreciable asset) for $50,000. The land was purchased 5 years ago for $30,000. Since you sold the land for more than its book value (the purchase price in this case) you will realize a capital gain of $50,000 – $30,000 = $20,000. Your tax liability on the sale will then be the capital gain times the capital gains tax rate or in this case $20,000(15%) = $3,000.

Capital losses must first be used to offset any capital gains realized that year; however, if you have any capital losses remaining after offsetting capital gains, you may offset ordinary income. If you still have capital losses remaining, you may carry the losses forward to offset future capital gains and income. This can be a powerful tool. Suppose the land in the above example brought a selling price of $20,000. Now you have realized a capital loss of $30,000 – $20,000 = $10,000. If you have not realized capital gains for the year, you can use the loss to offset your ordinary income, which in this example is being taxed at 24%. Your tax savings from the capital loss would be $10,000(24%) = $2,400. In other words, you can use the loss to reduce the level of taxable income by $10,000, which saves you $2,400 in taxes you would have been required to pay without the loss. If you had realized at least $10,000 in capital gains on assets held over 12 months during the year, your capital loss would have only saved you $10,000(.15%) = $1,500. It is clear that the current capital laws require some careful planning to capture the full benefits. (Note: some capital losses are limited to $3,000 per year to be taken against regular income. Anything left over can be carried forward to future years.)

## Tax Credits

Tax deductions are subtracted from Adjusted Gross income and reduce the level of Taxable income. This results in a tax savings that is equal to the marginal tax rate for each dollar of allowable deduction. Tax credits, on the other hand, are direct deductions from one's Tax liability. Tax credits, therefore, result in a tax savings of one dollar for each dollar of tax credit. For example, consider the tax savings of a $1,000 deduction versus a $1,000 tax credit for an individual facing a 24% marginal percent tax rate:

tax deduction: tax savings = $1,000(24%) = $240; and
tax credit: tax savings = $1,000(100%) = $1,000.

Clearly, you would prefer one dollar of tax credits more than one dollar of tax-deductible expense. Tax credits come and go sporadically in the tax laws. They have been used in the past to stimulate investment in some types of assets. There are still some tax credits available today. For example, certain college tuition and child care expenses may be eligible for tax credits. Also, for each dependent child under age 17, up to $2,000 credit may be available.

## Business Taxation

Remember that Subchapter S corporations, partnerships, and sole proprietorships are taxed according to the individual tax rate schedule the owner faces. Many Subchapter S corporations, partnerships, and sole proprietorships may get a 20% reduction of their Qualified Business Income, which might be their net business income. C corporations, on the other hand, are taxed according to corporate income tax rates. The corporate tax ate schedule for 2018 is now 21%.

Not all the income generated by a business's operations is subject to taxes. Most expenses incurred in order to generate the business income are deductible. In addition, there are a number of other adjustments to business income which deserve mention. Also be aware that many, but not all, states impose an additional tax on corporate income.

## Depreciation

When a business purchases assets that can be used in the business for more than one year (often called capital expenditures), the business is generally not allowed to deduct the entire cost of the asset in the year in which it was purchased. *Depreciation* is an accounting expense that allocates the purchase cost of a depreciable asset over its projected economic life. This deduction acts as an expense for both accounting and tax purposes; so increases in depreciation expense result in decreased profit measures

for a business. Nevertheless, depreciation expense is a *noncash expense*; that is, you aren't sending a check to anyone for the amount of the depreciation expense. This allows depreciation expense to act as a *tax shield*, which lowers taxable income, resulting in lower tax obligations and consequently higher after-tax cash flow. Accordingly, higher depreciation expenses result in lower profits but higher after-tax cash flow.

For tax purposes, there are rules that determine how you depreciate an asset. You can only depreciate an asset that has been *placed in service*, which means that it is available for use during the accounting period. There are also conventions that determine the point in time during the accounting period you must assume the asset was placed into service. Most depreciable assets are assumed to be placed into service at the mid-point of the year, regardless of the actual date they are placed in service. This is known as the *half-year convention.* There are also rules about the *recovery period* over which an asset can be depreciated. Table 3.2. shows the allowable recovery periods for different classes of farm property.

**Table 3.2. Farm Property Recovery Periods**[1]

| Assets | Recovery Period in Years | |
|---|---|---|
| | Gen. Dep. System | Alter. Dep. System |
| Agricultural structures (single purpose) | 10 | 15 |
| Automobiles | 5 | 5 |
| Calculators and copiers | 5 | 6 |
| Cattle (dairy or breeding) | 5 | 7 |
| Communication equipment | 7 | 10 |
| Computers and peripheral equipment | 5 | 5 |
| Cotton ginning assets | | |
| Drainage facilities | 15 | 20 |
| Farm buildings | 20 | 25 |
| Farm machinery and equipment | 7 | 10 |
| Fences (agricultural) | 7 | 10 |
| Goats and sheep (breeding) | 5 | 5 |
| Grain bin | 7 | 10 |
| Hogs (breeding) | 3 | 3 |
| Horses (age when placed in service) | | |
| Breeding and working (12 yrs or less) | 7 | 10 |
| Breeding and working (more than 12 yrs) | 3 | 10 |
| Racing horses (more than 2 yrs) | 3 | 12 |
| Horticultural structures (single purpose) | 10 | 15 |
| Logging machinery and equipment | 5 | 6 |
| Nonresidential real property | 39 | 40 |
| Office furniture, fixtures and equipment (not calculators, copiers, or typewriters) | 7 | 10 |

| | | |
|---|---|---|
| Paved lots | 15 | 20 |
| Residential rental property | 27.5 | 40 |
| Tractor units (over-the-road) | 3 | 4 |
| Trees or vines bearing fruit or nuts | 10 | 20 |
| Truck (heavy duty, unloaded weight 13,000 lbs. or more) | 5 | 6 |
| Truck (weight less than 13,000 lbs.) | 5 | 5 |
| Water wells | 15 | 20 |

There are two depreciation methods that can be used for tax reporting purposes: *straight line* (SL) and *modified accelerated cost recovery system* (MACRS). Straight line allocates the depreciation expense uniformly each period. The amount of depreciation is found by multiplying the straight line recovery rate for each year times the asset's unadjusted basis (original cost). The SL recovery rate is simply the inverse of the number of years in the asset's recovery period adjusted by the required half-year placed in service convention. The straight recovery rates for 3-year, 5-year, and 7-year assets are shown in Table 3.3.

**Table 3.3. Straight Line Recovery Rates for 3, 5, 7 Year Assets**

| Year | 3-Year | 5-Year | 7-Year |
|---|---|---|---|
| 1 | 16.67% | 10% | 7.14% |
| 2 | 33.33% | 20% | 14.29% |
| 3 | 33.33% | 20% | 14.29% |
| 4 | 16.67% | 20% | 14.28% |
| 5 | | 20% | 14.29% |
| 6 | | 10% | 14.28% |
| 7 | | | 14.29% |
| 8 | | | 7.14% |

As you might guess from its name, MACRS produces larger depreciation expenses in early years than the SL method of depreciation and lower depreciation expenses in the later years than the SL method of depreciation. The federal government specifies the allowable rates of MACRS depreciation. These rates are determined by using a combination of the declining balance (either 150% or 200%) and straight-line depreciation methods. Prior to 2018, farmers were not permitted to use 200% declining balance. The MACRS depreciation expense for each year is calculated by multiplying the unadjusted

1. Most assets use the General Depreciation System for recovery periods. See IRS guidelines for more information.

basis (acquisition cost) of the asset by the appropriate recovery rate for that year. The MACRS (200% method) recovery rates for the 3-year, 5-year, and 7-year asset classes are shown in Table 3.4.

**Table 3.4. MACRS Recovery Rates for 3, 5, and 7-Year Assets**

| Year | 3-Year | 5-Year | 7-Year |
|---|---|---|---|
| 1 | 33.0% | 20.00% | 14.29% |
| 2 | 44.45% | 32.00% | 24.49% |
| 3 | 14.81% | 19.20% | 17.49% |
| 4 | 7.41% | 11.52% | 12.49% |
| 5 | | 11.52% | 8.93% |
| 6 | | 5.76% | 8.93% |
| 7 | | | 8.93% |
| 8 | | | 4.46% |

Suppose your business just purchased a $100,000 asset that has a 3-year useful life, and falls into 3-year class of assets. Using the SL method, the depreciation expense each year for the next 3 years would be:

| Year | Recovery Rate | Unadjusted Basis | Depreciation Expense | Accumulated Depreciation |
|---|---|---|---|---|
| 1 | .1667 | $100,000 | $16,670 | $16,670 |
| 2 | .3333 | $100,000 | $33,330 | $50,000 |
| 3 | .3333 | $100,000 | $33,330 | $88,330 |
| 4 | .1667 | $100,000 | $16,670 | $100,000 |

Note that the book value or basis of the asset (acquisition cost – accumulated depreciation) would be $0 after it has been fully depreciated at the end of 4 years. Because of the half-year convention, it takes 4 years to depreciate the asset, even though it falls into the 3-year classification.

Depreciation expense for the same asset using the MACRS method would be calculated as:

| Year | Recovery Rate | Unadjusted Basis | Depreciation Expense | Accumulated Depreciation |
|---|---|---|---|---|
| 1 | .3333 | $100,000 | $33,333 | $33,333 |
| 2 | .4445 | $100,000 | $44,450 | $77,780 |
| 3 | .1481 | $100,000 | $14,810 | $92,950 |
| 4 | .741 | $100,000 | $7,410 | $100,000 |

Note again that the depreciation expense using MACRS is higher in the early years and lower in later years than with the SL method and that the book value after 4 years is again zero. Businesses often use MACRS for tax purposes and SL for profit reporting. Can you think of any reasons why?

Some businesses that invest small amounts in capital assets are allowed to deduct up to $1,000,000 of the cost of acquired depreciable property as a current expenditure instead of a capital expenditure. This is known as *direct expensing*, and is available only to businesses that don't make large capital purchases each year. The allowable expensing amount is reduced by one dollar for each dollar of capital investment expenditure over $2,500,000 during the year. Other restrictions also apply.

## Bonus or Additional Depreciation

Property purchased with a recovery period of 20 years or less may be eligible for 100% additional depreciation the year it is purchased. It is required unless the taxpayer elects out of it by class or recovery period (3, 5, 7, 10, 15, 20 year classes). It can be used on either new or used property but has limitations if purchased from a relative. Passenger automobiles may be limited to an extra $8,000 additional depreciation rather than 100%. The 100% depreciation decreases to 80% in 2024 and reduces by 20% each year after that until 2028 when it disappears.

## Interest and Dividends Received

Interest and ordinary dividend income received by sole proprietorships and partnerships is taxed as ordinary income. Interest income received by corporations is taxed as corporate income. However, dividend income received by corporations is allowed eighty percent *tax exclusion* (only 20 percent is taxed) before being taxed as corporate income. The reason for the exclusion is that corporate income is already subject to double taxation, and taxing dividends as corporate income would result in triple (or more) taxation. Can you explain why?

Which is better for a corporation in a 21% marginal tax bracket: $1,000 of interest income or $1,000 of dividend income? Remember what we care about is after-tax cash flow (ATCF) so let's evaluate both investments:

| Investment Income | – Taxes | = ATCF |
|---|---|---|
| Interest income $1,000 | – $1,000(.21) | = $790 |
| Dividend income $1,000 | – $1,000(.20)(.21) | = $958 |

The ATCF from the dividends of $958 would be preferred to the $790 from the interest income. The dividends are effectively taxed at a lower rate than interest income. We can find the effective rate on each dollar of dividend income received by multiplying the two marginal tax rates by the proportion of income subject to tax: that is $1(.20)(*T*) = $1(.20)(.21) = 0.042 or 4.2%. Accordingly, the effective tax rate *T* for dividends in this case is 4.2% as opposed to 21% for interest income at this marginal tax rate. What incentives do federal tax laws give regarding the type of investments that corporate businesses make?

## Interest and Dividends Paid

Interest expenses paid by businesses are tax deductible. Dividends or withdrawals paid by businesses are not tax deductible. Consider a firm in a 21 percent tax bracket that pays $1,000 in interest expense and $1,000 in dividends or withdrawals. What is the after-tax cost of each expense?

| Expense Type | Expense | – Tax-savings | = After-tax expense |
|---|---|---|---|
| Interest expense | $1,000 | – $100(.21) | = $790 |
| Dividend expense | $1,000 | – $0 | = $1000 |

Dividends and withdrawals cost the firm $1 of after-tax income for each $1of dividend paid. Interest expense, on the other hand, costs the firm $1(1 – *T*) = $1(1 – .21) = $0.79 of after-tax income for each $1 of interest expense paid. Another way to think about it is to find out how much before-tax income it takes to pay $1 of both interest and dividend expenses. Using the formula discussed earlier:

Before-tax dividend expense = $1.00/(1 – .21) = $1.266
Before-tax interest expense = $0.79/(1 – .21) = $1.00

It takes $1.27 of before-tax income to pay $1 in dividend or withdrawal expense, while it takes only $1 in before-tax income to pay $1 in interest expense. The two ways for a firm to finance its assets are to use debt or equity financing. Which method of financing do the federal tax loans favor?

> So, what have we learned? It's not what you earn but what you get to keep that matters. And that's where tax management plays an important role. Taxes are an important difference between what you earn and what you get to keep. Thus, an important part of strategic financial management is managing one's tax obligations.

## Summary and Conclusions

The main lesson for managing taxes is to look at investments and cash flow on an after-tax basis, and this requires that all tax obligations are accounted for in the tax management process. Management of the firm's taxes also requires managers to understand how different business organizations can create different tax obligations, the difference between average and marginal tax rates, the different tax obligations associated with interest versus dividend income, capital gains and capital losses, depreciation schedules, book value and market value of assets, tax deductions, and tax credits. Understanding these and other tax-related concepts will help financial managers manage the difference between what you earn and what you get to keep.

# Questions

1. Tiptop Farms, a sole proprietorship, had a gross income of $600,000 in 2018. Tiptop Farms expenses were equal to $320,000. Tiptop had interest expenses of $80,000 and depreciation expenses of $75,000 during the year. Tiptop's owner withdrew $25,000 from the business during the year to help pay college expenses for the owners' children. The tax schedule for 2018 is:

| Income | Tax Rate |
|---|---|
| $0 – 40,000 | 15% |
| $40,001 – 100,000 | 28% |
| $100,000 – 150,000 | 31% |
| $150,001 + | 35% |

   a. What was Tiptop's taxable income during 2018?
   b. What is Tiptop's tax liability for 2018?
   c. What is Tiptop's average and marginal tax rate for the year?
   d. If Tiptop is considering the purchase of a new investment, what tax rate should they use?
2. Consider a couple filing jointly, whose taxable income last year was $130,000. Assume that state taxes on their taxable earnings were 5%. The couple pays social security at the rate of 6.2%, and Medicare taxes at the rate of 1.45%. Half of the couple's social security and Medicare taxes are paid by their employer. Also recognize that social security was only charged on the first $128,400. Find the couples tax liability, its average tax rate, and its marginal tax rate. What is higher, the couple's average tax rate or their marginal tax rate? Explain your answer.
3. Suppose that last year, inflation was 8%, meaning that the price of every- thing you buy has increased by 8%. If your before-tax income increased by 8% would you be just as well off as before? If not, how much more than 8% would you need to increase to buy as much as you did before inflation?
4. A corporate bond is providing a yield of 12% per year, while at the same time, a municipal bond (which is tax exempt) is yielding 9% per year. Each bond only pays interest each year until the bond matures, at which time the principal investment will be returned. Each bond is equally risky, and your marginal tax bracket is 30%. You have $1,000 to invest.

   a. What is the after-tax cash flow from each bond? Which bond would you invest in?
   b. What is the percentage after-tax return on each bond?
   c. What before-tax equivalent on the corporate bond would make you choose it as an investment?
   d. Suppose that you are also subject to a 5% state tax from which neither the corporate or municipal bond is tax exempt. What is the after-tax return on each bond?
5. Suppose you invest in a new tractor during the tax year that costs you $78,000, plus $2,000 for delivery and set up. Your marginal tax rate is 40%. *Note: new farm machinery has a class life of 5 years.*

a. What is the depreciation expense each year using the straight line method of depreciation?
b. What is the depreciation expense each year using the MACRS 200% declining balance method of depreciation?
c. What is the tax shield each year from each method?
d. Which method would you use for tax purposes? How about profit reporting? Explain.

6. Businesses often use MACRS for tax purposes and SL for profit reporting. Can you think of any reasons why?

# 4. Managing Risk

**LINDON ROBISON**

*Learning goals.* After completing this chapter, you should be able to: (1) define and measure risk; (2) understand how a person's risk aversion affects his/her resource allocation; (3) distinguish between direct and indirect outcome variables; and (4) evaluate alternative risk response strategies available to financial managers including sharing risky outcomes, purchasing insurance, diversifying investments, purchasing risk reducing investments, and choosing an optimal capital structure.

*Learning objectives.* To achieve your learning goals, you should complete the following objectives:

- Learn how to describe risky events by assigning a random variable to their outcomes and by assigning a probability density function (pdf) to the random variable.
- Learn how measure the variability and central tendencies of random variables using the expected values and variances of their probability density functions.
- Learn how risk premiums can be used to measure the cost of risk.
- Learn how to describe the risky choice set facing firm managers using expected value-variance (EV) efficient sets.
- Learn about the normal probability density function and understand why it is so important when describing risky events.
- Learn how sharing risk with others can be a useful response to risk.
- Learn how purchasing insurance can be a useful response to risk.
- Learn how diversification can be a useful response to risk.
- Learn how purchasing risk-reducing inputs can be a useful response to risk.
- Learn how leverage affects the level of risk facing the firm.

## Introduction

In this chapter we focus on how the firm manages risk to achieve its goals and objectives. While risk most often originates from forces outside of the firm's control, there are strategies the firm can adopt to mitigate its potential harm and put the firm in a position to benefit from its potential benefits. Before examining the possible risk strategies a firm can adopt, we must first define it, understand how to measure it, and lastly how to include it when designing firm strategies.

The adjective "uncertain" describes an event (such as a hurricane or a football game) whose outcomes are not known with certainty. An uncertain event must have at least two possible outcomes, and it usually has more. In an earlier time, a distinction was made between risky events and uncertain events based on the information available for identifying an event's possible outcomes and predicting the probabilities of those outcomes. For example, the flip of a coin is a familiar event with two outcomes:

heads (H) and tails (T). Based on past trials or logic, we can infer that the probability of a heads (tails) appearing when a fair coin is tossed is about 50 percent. Some may call this event risky because we have good information about the possible outcomes and the probability of their occurrence.

Now consider a different event: the toss of a thumbtack[1]. What is the probability that the thumbtack will land on its side versus landing on its head? Because we are not familiar with this event and cannot assign probabilities to its outcomes based on our past experience or logic, this event might be called uncertain.

For many, the distinction between risky events and uncertain events is no longer important, and most researchers assign the adjectives uncertain and risky to events interchangeably. One reason many do not distinguish between risky and uncertain events is because the assignment of probabilities to event outcomes is subjective (we never have enough information to be absolutely certain about either possible outcomes or their probabilities) and may be based on other factors besides logic and past observations including hunches, omens, experiences of others in irrelevant circumstances, and advice from unqualified persons to name a few.

A distinction between risky and uncertain events may still be useful. People appear to refer to events as uncertain when the event's outcomes are not known with certainty. It also appears popular to refer to uncertain events as risky when they are uncertain and their occurrence alters the decision maker's well-being. Thus, only risky events matter, regardless of one's confidence in the probabilities of various outcomes (e.g. the toss of a coin versus the toss of a thumbtack).

The study of risky events, of course, has application to financial management, especially when we are required to estimate future cash flow used in analyzing capital budgeting decisions.

## Statistical Concepts Useful in Describing Risky Events and Risky Outcomes

*Probability density function.* A probability density function (pdf) is a function that assigns probabilities to outcomes of risky events. For example, the toss of a fair coin is an event with outcomes showing a heads (H) or a tails (T). The pdf for this event may assign to H the probability of 50% occurrence and 50% to the occurrence of T. A pdf may be discrete or continuous. If the outcomes of an event are finite, then their likelihood of occurring is described by a discrete pdf. If the outcomes of an event are infinite, then their likelihood of occurring is described by a continuous pdf.

*Random variables.* A random variable is a numerical value assigned by a function or rule to outcomes of risky events. The probability of a particular value described by a random variable is the same as the

1. The authors thank Jack Meyer for the thumbtack example of an uncertain event.

probabilities of its underlying event outcome. For example, suppose that an event were the toss of a coin. We might assign the outcome of heads the number one, and the outcome of tails the value of zero. Then the probability of a random variable taking on the value one is the same probability as H occurring when tossing a coin.

*Expected values.* An expected value is one measure used to describe the properties of a pdf. It is sometimes called the first moment of the pdf because it measures the center of a pdf's mass (like the fulcrum of a teeter totter).

The expected value of a pdf is determined by calculating a weighted average of the possible values of the random variable values times their likelihood of occurring. To illustrate, consider two possible investments A and B. The event is the operation of the economy with three possible outcomes: a recession with 20% likelihood, a stable economy with 60% likelihood, and a growth economy with 20% likelihood. The value of the random variables describing the three outcomes for investments A and B are described in Table 4.1 and represent alternative rates of return on the investments.

**Table 4.1. pdfs and Random Variables Associated with Investments A and B**

| Economic outcomes | pdf associated with economic outcomes | Returns on investment A (a random variable) | Returns on investment B (a random variable) |
|---|---|---|---|
| Recession | 20% | -20% | -40% |
| Stable | 60% | 20% | 20% |
| Growth | 20% | 40% | 60% |
| Expected values of investments A and B | | 16% | 16% |
| Variances (standard deviations) of investments A and B | | .039 (19.6%) | .103 (32.0%) |

The expected value operator is expressed as E(). The expected value of investment A is the sum of A's random variables weighted by their respective probabilities and is written as:

$$E(\text{Investment A}) = (.2)(-.20) + (.6)(.20) + (.2)(.4) = 16\% \tag{4.1}$$

The expected value of investment B is written as:

$$E(\text{Investment B}) = (.2)(-.40) + (.6)(.20) + (.2)(.60) = 16\% \tag{4.2}$$

In general, the expected value of random variable $y_j$ which occurs with discrete probability $p_j$ with $j = 1, \ldots, n$ outcomes is expressed as:

$$E(y) = \sum_{j=1}^{n} p_j y_j \tag{4.3}$$

and where the sum of all probabilities of $y_j$ occurring equal 1:

$$\sum_{j=1}^{n} p_j = 1 \tag{4.4}$$

A special kind of expected value is the mean. A mean is calculated for n observations from an unknown pdf where every observation is equally likely. Suppose we observed five draws from an unknown distribution equal to 8, 4, 0, 2, and 6. Since we assume each observation was equally likely, $1/n$ , or 1/5, in this case the expected value is equal to the mean calculated as

$$\bar{x} = \frac{\sum x_i}{n} \tag{4.5a}$$

$$\bar{x} = \frac{8+4+0+2+6}{5} = \frac{20}{5} = 4. \tag{4.5b}$$

*Variance and standard deviation.* Even though the expected values of investments A and B described above are equal, most investors would not consider them equally attractive because of the wide differences in the variability of the values assumed by their random variables. One approach to measuring the variability of a random variable is to calculate its variance or the square root of its variance equal to its standard deviation. We can find the variance of a random variable $y_j$ with $n$ possible outcomes by summing $y_j$ minus $E(y)$ quantity squared weighted by the probability of random variable occurring. We write the variance formula for random variable $y_j$ as:

$$\text{Variance}(y) = \sigma_y^2 = \sum_{j=1}^{n} p_j [y_j - E(y)]^2 \tag{4.6}$$

We illustrate the variance formula by calculating the variances and standard deviations for investments A and B. The variance for investment A is calculated as:

$$\sigma_A^2 = .2(-.2 - .16)^2 + .6(.2 - .16)^2 + .2(.4 - .16)^2 = .039 \tag{4.7}$$

Meanwhile the standard deviation for investment A can be found by calculating the square root of the variance of investment A and is equal to:

$$\sigma_A = \sqrt{\sigma_A^2} = \sqrt{.039} = .196 \text{ or } 19.6\% \tag{4.8}$$

The variance for investment B is calculated as:

$$\sigma_B^2 = .2(-.4 - .16)^2 + .6(.2 - .16)^2 + .2(.6 - .16)^2 = .103 \tag{4.9}$$

Meanwhile the standard deviation for investment B is found to equal:

(4.10) $$\sigma_B = \sqrt{\sigma_B^2} = \sqrt{.103} = .320 \text{ or } 32\%$$

One reason for measuring the variability of the random variable by squaring its deviations from its expected value is because were we to find the average of the deviation of the random variable from their expected values, they would always sum to zero. They would sum to zero because probability weighted deviations above the expected value exactly equal probability weighted deviations below the expected value. Taking the square root of the variance of returns converts the deviation measure to units comparable with those of the original random variable. Thus, from the standard deviations calculated above, we can infer that, on average, the random variable representing investment A will deviate 19.6% from its expected value while the random variable representing investment B will deviate 32.0% from its expected value. Clearly, risky outcomes for investment B are more variable—and some would say more risky—than outcomes associated with investment A. We add to the descriptions in Table 4.1 of investments A and B their respective variances (standard deviations).

The variance of the sample is found as before by summing and squaring the deviations from the mean weighted by their probability of occurrence. However, for reasons not discussed here, the variance of the sample of observations is divided by $n$–1 instead of $n$ where $n$ is the number of observations. Thus the standard deviation from a sample distribution is denoted $S_x$ for observations on the random variable $x$. Otherwise the variance of the random variable $x$ drawn from the true population is divided by $n$. Therefore in our example, the sample standard deviation, the square root of the variance is:

(4.11a) $$S = \sqrt{\frac{(\sum x_i - \bar{x})^2}{n-1}}$$

$$S = \sqrt{\frac{(8-4)^2 + (4-4)^2 + (0-4)^2 + (2-4)^2 + (6-4)^2}{4}}$$

(4.11b) $$= \sqrt{\frac{40}{4}} = \sqrt{10}$$

*Risk premiums and certainty equivalent incomes.* While not properties of pdfs, important concepts connected to pdfs describing investments are risk premiums and certainty equivalent incomes. While these concepts are related to pdf properties, they also depend on risk preferences of individual decision makers for the variance and expected return inherent in the investment. Risk premiums, certainty equivalent incomes, and risk preferences can be easily explained.

Suppose an investor faced investment A described in Table 4.1 and had the opportunity to receive its expected value with certainty in exchange for paying a risk premium. What is the largest risk premium the investor would pay to receive the investment's expected value with certainty? The answer would

depend on the investor's risk preferences. If the investor would pay a positive risk premium to receive investment A's expected value with certainty, then the investor is risk averse. If the investor would pay nothing to receive investment A's expected value with certainty, the investor is risk neutral. If the investor would pay to keep the variability (the investor enjoys gambling), we would say the investor is risk preferring.

Once we know the investor's risk premium for a particular investment's pdf, we can find their certainty equivalent income by subtracting it from the investment's expected value. We can describe the relationship between the $i^{\text{th}}$ investor's risk premium, certainty equivalent income, risk attitudes, and the expected value and variance of the random variable in the following expression:

$$y_{CE}^{i} = E(y) - \frac{\lambda^{i}}{2}\sigma_{y}^{2} \tag{4.12}$$

In equation (4.12), the $i^{\text{th}}$ investor's certainty equivalent income $y_{\text{CE}}{}^{i}$ for an investment whose possible values are represented by the random variable $y$ is equal to the expected value of $y$ less a risk premium. In equation (4.13), we can solve for the largest insurance premium the investor would be willing to pay to receive the investment's expected value with certainty.

$$\frac{\lambda^{i}}{2}\sigma_{y}^{2} = E(y) - y_{CE}^{i} \tag{4.13}$$

The $i^{\text{th}}$'s investor's risk premium is equal to the decision maker's risk preference measure $\lambda^{i}$ divided by 2 times the variance of the random variable $y$. The investor's risk aversion coefficient $\lambda^{i} / 2$ is best understood as a slope coefficient that indicates the response on the investor's certainty equivalent income by an increase in a unit of variance of the random variable $y$.

*Expected value-variance criterion.* Suppose we had a set of pdfs each representing the likelihood of $m$ alternative random variables. Furthermore, suppose each of the $m$ investments were described using their expected values and variances. Then, assuming that all investors were risk averse and without knowing each investor's risk aversion coefficient, we know that for every two investments with equal expected values (variances) and unequal variances (expected values) the investor would prefer the investment with the smaller variance (largest expected value). On the other hand, we could not rank two investments in which one had a larger expected value and variance than the other. The set of investments and ranked preferred for risk averse decision makers is called the expected value-variance (EV) efficient set. The graph of a particular EV set follows.

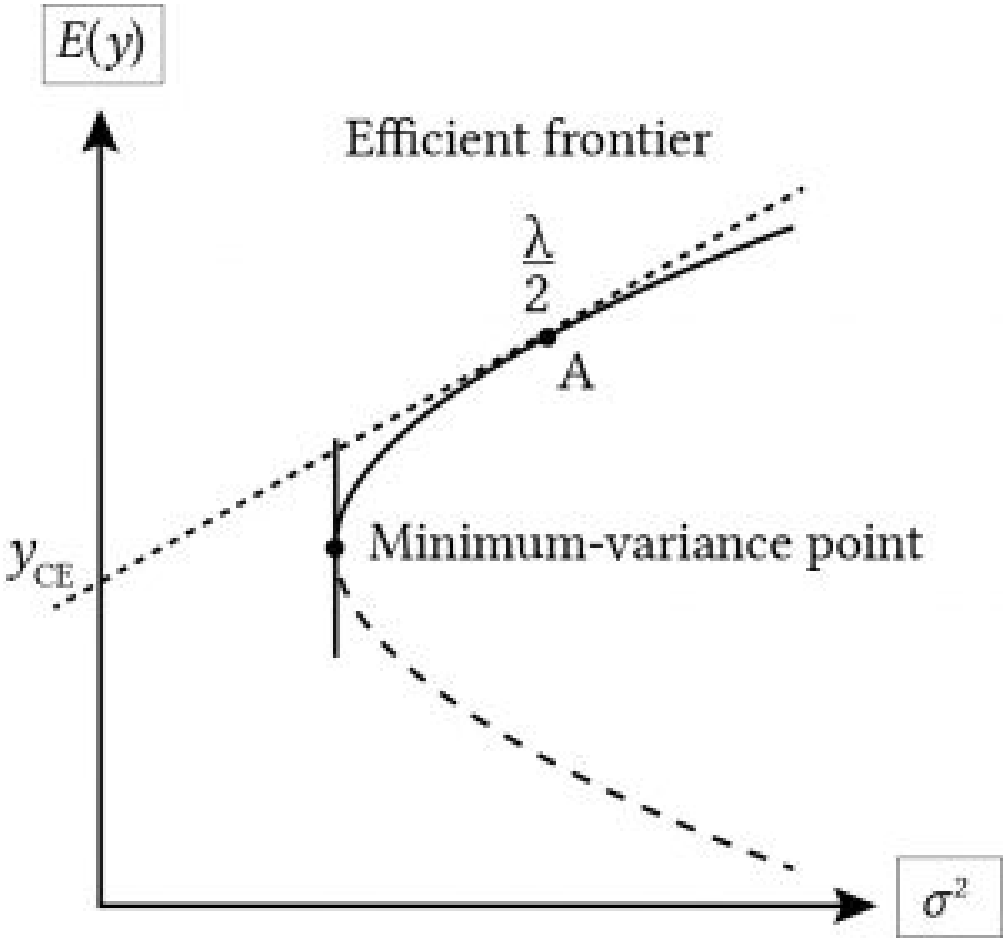



***Figure 4.1 An Efficient Expected Value-Variance Frontier of Investments Represented by their Expected Values E(y) and Variances $\sigma^2$.***

Suppose that we were to draw a line tangent to the relevant section of the EV at point A, representing an investment A. Then the slope of the line at point A would equal the decision maker's risk coefficient at the point. Furthermore, were we to extend the tangent line to intersect with the vertical axis, the point of intersection would equal the certainty equivalent of the investment.

## The Normal Probability Density Function (pdf)

If you have a large enough sample of outcomes from a normal distribution, the distribution will look like a bell-shaped curve.

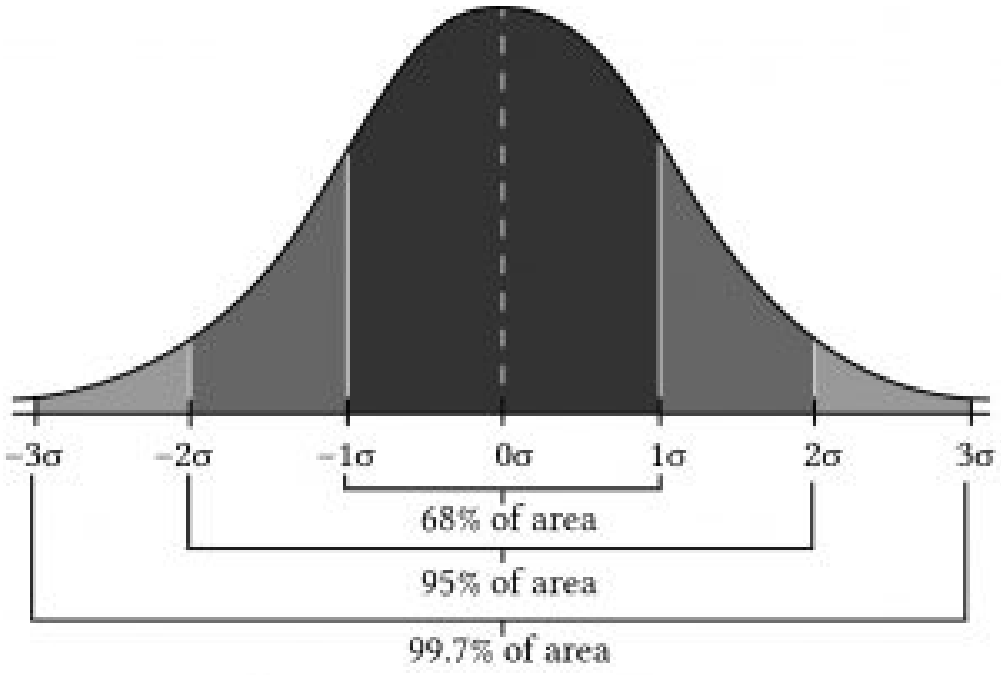



***Figure 4.2. A normal probability distribution that describes probability in areas divided to standard deviations from the mean.***

The normal distribution is symmetric about its expected value. The numbers in the graph correspond to standard deviations measured from the mean of the normal distribution. All of the characteristics of the normal distribution are completely described by the mean and variance (or equivalently, the standard deviation). The mean specifies the average value of the rate of return. The probability of getting a return above or below the mean by a certain amount is determined by the size of the standard deviation.

If the returns are normally distributed, there is a 68% chance that the return for any given period will be within one standard deviation of the expected value; a 95% probability that any particular observed return will be within 2 standard deviations of the expected value; and a 99.74% probability that any return will be within 3 standard deviations of the mean. Clearly, the larger the standard deviation, the more spread out the actual returns that occur will be. Suppose the common stock returns we looked at earlier were generated by a normal distribution. We estimated the expected value of the distribution to be $r = 18.92\%$ and the standard deviation to be $\sigma(r) = 16.18\%$. If we were interested in predicting what next year's return on common stocks will be, we could say that the expected value will be about 18.92%, but, in addition, there is a 68.26% probability that returns will be between 2.74% and 35.1%; a 95.44% probability that returns will be between –13.44% and 51.28%; and a 99.74% chance that the returns will be between –29.62% and 67.46%. The smaller the standard deviation, the less spread out the returns will be and the more accurate the mean will be as a predictor of future returns.

*Sampling error.* The normal distribution is an important distribution from both a theoretical and a practical standpoint. It is important to note that if you are looking at a small sample of data, its empirically based pdf is likely not to have the shape of a normal distribution even if it is actually generated from a normal distribution. In a small sample, the distribution will have gaps and holes in it and is unlikely have a shape that looks like the true distribution that generated the data. If you keep adding observations from the distribution, eventually the gaps will fill in, and it will start to look like the true distribution that generated the data. The point here is, even if the sample pdf generated by a normal distribution does look like a normal distribution, this may be because the sample size is too small. Therefore, because of its usefulness and tractability, we often assume that our sample pdfs are normally distributed.

## Direct and Indirect Outcome Variables

Typically, we connect a risky event $\epsilon$ to a random variable $y(\epsilon)$. For example, $\epsilon$ may represent uncertain prices and $y(\epsilon)$ may represent income which depends on uncertain prices $\epsilon$. We will refer to $\epsilon$ as the direct outcome variable and $y(\epsilon)$ as the indirect outcome variable over which the firm's utility is defined.

In most risk models, the relationship between $\epsilon$ and $y(\epsilon)$ is monotonic, if the direct outcome variable goes up (down) so does the indirect outcome variable. If prices increase, so does income; if the variance of $\epsilon$ increases, so does the variance of $y(\epsilon)$. However, one can easily construct examples in which the linkage is not so direct. For example, suppose the firm faces financial stress and that only very favorable outcomes will permit the firm to meet its cash flow obligations and survive. Under such circumstances, the firm may increase its expected income and its probability of surviving by choosing a strategy that increases its variance of direct outcomes. Consider such a problem by defining an indirect outcome variable $w = 0$ if the firm fails to survive and $w = 1$ if the firm survives. In this model the direct outcome variable is $y$. Then we connect the indirect outcome variable $w$ to the direct outcome variable y by defining a survival income $y_d$ and defining w in terms of $y$ as follows:

$$w = \begin{cases} 0 \text{ for } y < y_d \\ 1 \text{ for } y \geq y_d \end{cases}$$

The ad hoc decision rule can be expresses as:

$$V(y) = \begin{cases} U(0) \text{ for } y < y_d \\ U(1) \text{ for } y \geq y_d \end{cases}$$

Since U(0) and U(1) are arbitrarily assigned values, let U(0) = 0 and U(1) = 1. Then, the ad hoc decision rule to be maximized is:

(4.14) $\text{Max } 1 - Pr(y < y_d)$

which calls for minimizing Pr($y < y_d$). This rule is known as Roy's safety-first rule. When direct outcomes are defined in terms of winning or losing, Roy's safety-first rule is consistent with an expected utility model.

Of course, one can think of other direct and indirect outcome variable relationships. For example, $y$ could represent uninsured income and $w$ could represent insured income, or $y$ could represent unhedged income and w could represent hedged income, or y could represent income produced without risk reducing inputs and $w$ could represent income produced with risk reducing inputs.

> So, what have we learned? We learned that risk responses are defined over direct outcome variables. Failure to distinguish between indirect and direct outcome variables may lead us to view responses to indirect outcome variables as risk preferring when they are indeed risk averting.

## Firm Responses to Risk

Individuals and businesses all face risky events, including the possibility of losses that leave them less well off than before the outcome associated with the risky event occurred. These outcomes may include you or someone you care about becoming ill or unemployed. Business also face the possibility of losing customers, production failures, declining prices, and loss of financial support.

The next section describes alternative responses to risky events available to firms and individuals. If firms and individuals limit their risk responses described by alternatives on an EV frontier and select risky alternatives consistent with their underlying risk preferences, then they will maximize their certainty equivalent income. Higher risk-averse decision makers will select investments with lower expected values and variances. Less risk-averse decision makers will select investments with higher expected values and variances. If the firm's current risk position is an expected value-variance combination off the frontier, then the firm's risk responses may be designed to move the firm closer to a position on the EV frontier.

More to the point, a firm moving up or down its EV frontier involves paying another unit to absorb part or all of its risk (e.g. buying insurance) or changing the relative amount of safe and risky investments in its portfolio.

Someone once claimed that economists can predict the past correctly only 50% of the time. Imagine how successful economists are at predicting future outcomes for risky events? This should suggest

that even though we present risk response solutions in closed forms, we should be cautious and explore alternative assumptions and predictions to explore the robustness of our estimates. With that caution in mind, we proceed to explore external risk responses (pay others to absorb our risk) and internal risk responses (change the firm's holdings of risky and safe investments).

Our discussion of risky and uncertain events and how to measure the probabilities of their outcomes has prepared us to evaluate alternative risk responses including: (1) sharing risk with others through various arrangements including forming partnerships and cooperatives, (2) buying insurance, (3) diversifying one's holdings of risky investments, (4) purchasing risk reducing inputs, and (5) choosing optimal capital structure. In addition, we will introduce the expected value-variance criterion for ranking alternative risky investments.

## Sharing Risky Outcomes

One way to mitigate the impact of adverse outcomes associated with risky events is by forming risk sharing arrangements with others even when they are facing similar risks. The key to successful risk reduction combinations with others is to combine operations that are statistically independent of each other. Statistical independence has a precise meaning, but essentially it means that the expected value of the product of two random variables equals the product of their expected values. In a later section we will discuss combining firms' operations within other firms whose returns tend to move together.

To make the point that combining units experiencing independent risky outcomes can mitigate risk, consider the following. Let $x$ be a random variable with expected value $\mu_x$ and variance $\sigma_x^2$ respectively. Let "a" and "b" equal numerical constants. Then, define a new random variable:

(4.15) $$y = a + bx$$

The variance of $y$, $\sigma_y^2$, is equal to:

(4.16) $$\sigma_y^2 = b^2\sigma_x^2$$

The explanation for equation (4.16) is that the variance of the constant "a" or any constant is always zero while the variance of a constant times a random variable is the constant squared times the variance of the random variable.

In equation (4.15) we created a new random variable $y$ by linearly transforming the random variable $x$. Now consider another way to create a new random variable—by taking the average of two (or more random variables). For example, suppose two businesses were facing independently distributed risky earnings. One business owner faced the random variable $x_1$ and the second business owner faced the random variable $x_2$. Also suppose that the two business owners decided to combine their businesses and agreed that each would receive half of the average earnings. In this process we define a new random variable:

$$y = \frac{x_1 + x_2}{2} \tag{4.17}$$

First, recognize that each random variable is multiplied by the constant (1/2). Then each partner would earn on average the expected value

$$E\left(\frac{x_1 + x_2}{2}\right) = \left(\frac{\mu_{x_1} + \mu_{x_2}}{2}\right) \tag{4.18}$$

and the variance each owner would face would be the variance of the expected return multiplied by the constant (1/2) squared. The variance of the average earnings each firm would receive, $\sigma_y^2$, is equal to:

$$\sigma_y^2 = \left(\frac{1}{4}\right)\left(\sigma_{x_1}^2 + \sigma_{x_2}^2\right) \tag{4.19}$$

In the case that the distributions were identically distributed with expected value and variance of $\mu x$ and $\sigma_x^2$, each partner would face the same expected value as before, $\mu x$. But, the variance of their individual earnings would be $(\sigma_x^2 + \sigma_x^2)/4 = \sigma_x^2/2$, half of what it was before without combining their businesses. Furthermore, the standard deviation of the earnings each partner would face would be:

$$\sqrt{\frac{\sigma_x^2}{2}} = \frac{\sigma_x}{\sqrt{2}} \tag{4.20}$$

And if *n* partners joined together, then they would each face the same expected value as before, but the variance each partner would receive is $\sigma_x/\sqrt{n}$. We now illustrate these important results.

Assume that business one's earnings are determined by outcomes associated with the toss of a fair coin. If the outcome of the coin toss is tails, the firm pays (loses) $5,000. If the toss is a heads, the firm wins $8,000. Thus, the firm wins either $8,000 or loses $5,000 and earns on average (.5) (−5,000) + (.5) (8,000) = $1500.

The standard deviation of this risky outcome is:

$$\sqrt{(.5)(-\$5,000 - \$1,500)^2 + (.5)(\$8,000 - \$1,500)^2} = \$6,500 \tag{4.21}$$

Furthermore, assuming a normal distribution, 68% of the time, the average outcome will be between the mean and plus or minus one standard deviation: ($1,500 + $6,500) = $8,000 and ($1,500 − $6,500) = −$5,000.

Now suppose that two persons decide to combine their operations and share the average of the outcomes. Then the possible outcomes of two coin tosses are two heads (H, H) which earns on average

$16,000 / 2 = $8,000 and occurs with a probability of .25; two tails (T, T) which earns on average −$10,000 / 2 = −$5,000 and occurs with a probability of .25, and one head and one tail (H, T) or one tail and one head (T, H) which both earn on average $3,000 / 2 = $1,500 and each occurs with a probability of .25. The expected value for each of the two players can now can be expressed as:

(4.22)
$$(.25)(\$8,000) + (.25)(-\$5,000) + (.25)(\$1,500) + (.25)(\$1,500) = \$1,500$$

The two players now receive on average the same as before, $1,500, but consider the standard deviation of the average outcome:

(4.23)

$$\sqrt{(.25)(8,000 - 1,500)^2 + (.25)(-\$5,000 - 1,500)^2 + (.5)(\$1,500 - \$1,500)^2} = \$4,596$$

Furthermore, assuming a normal distribution, 68% of the time, the average outcome will be between the mean and plus or minus one standard deviation: ($1,500 + $4596) = $6096 and ($1,500 − $4596) = −$3096. Note that even though the expected value did not change when outcomes were averaged over two persons, the standard deviation was reduced almost 30%. Also note that the results are in accord with equation (4.24):

(4.24)
$$\frac{\sigma_x}{\sqrt{n}} = \frac{\$6,500}{\sqrt{2}} = \$4,596$$

Now imagine ten persons each facing independent and identical distributed earnings outcomes, then the standard deviation each would face would equal:

(4.25)
$$\frac{\sigma_x}{\sqrt{n}} = \frac{\$6,500}{\sqrt{10}} = \$2,055$$

Furthermore, assuming a normal distribution, 68% of the time, the average outcome will range between ($1,500 − $2,055) = −$555.48 and ($1,500 + $2,055) = $3,555. Note that even though the expected value did not change when outcomes were averaged over ten persons, the standard deviation was reduced almost over 70%. Reducing the variability for each person by over 70% by combining ten independent risky events (facing each of 10 independent firms) illustrates the power of reducing risk by sharing independent risky events.

In the previous example we assumed that each partner contributed an equal share. Now assume two persons decided to form a partnership and share the risk and expected returns weighted by their shares contributed to the business. Assume partner 1 contributed $w_1$ = 30% of the assets and partner 2 contributed $w_2$ = 70% of the business. Each partner's business rate of return can be described by ran-

dom variable $y_1$ and $y_2$ with expected values and variances for partner one of $\mu_1 = 10\%$ and $\sigma_1^2 = (5\%)^2$ for the first partner and $\mu_2 = 12\%$ and $\sigma_2^2 = (6\%)^2$ for the second partner. We want to find expected value of the partnership and each partner's share of the expected value. Then, we want to find the variance of the partnership and the variance of returns each partner would face.

First, to find the expected value of the partnership, we weight each partner's contribution by the percentage of their contributions. Call the expected return of the partnership $E(y_p)$:

$$E(y_p) = w_1\mu_1 + w_2\mu_2 = (.3)(10\%) + (.7)(12\%) = 11.4\% \tag{4.26}$$

Meanwhile, the variance of expected return from the partnership is the sum of the individual variances multiplied by the partners' shares squared:

$$\sigma_y^2 = w_1^2\sigma_{x_1}^2 + w_2^2\sigma_{x_2}^2 = (.3)^2(.05)^2 + (.7)^2(.06)^2 = .002 = (4.5\%)^2 \tag{4.27}$$

Furthermore, the standard deviation of the portfolio is 4.5%. Thus, the partnership earns 11.4% on its investments and faces a standard deviation of returns equal to 4.5% which is less than their standard deviation of returns faced alone equal to 5.0% or 6.0%. Of course, they would have to agree on how to distribute profits, but we assume it would be based on the shares they contributed.

## Reducing Risk by Purchasing Insurance

It may be difficult for an individual firm to agree with other independent firms on how to share profits and risk. However, an insurance company that absorbs individual firms' risk in exchange for an insurance premium can reduce the overall risk by combing the risk facing large numbers of individual firms. Furthermore, by carefully selecting businesses from different geographic areas and of different types, the risk absorbed by individual firms can be close to negligible.

For most individuals and businesses, insurance offers a way to reduce their risk when other measures are not available. Insurance is a practical arrangement by which a company or government agency provides compensation for a wide variety of losses and adverse outcomes. For example, we can purchase health insurance in case we become ill, fire insurance in case of a fire, term and whole life insurance for our heirs if we die, revenue insurance in case our expenses exceed income, trip insurance in case our flight gets canceled, and almost any other adverse outcome as long as we are willing to pay someone to assume the possibility of loss. This kind of insurance, discrete disaster event insurance, is described next.

*Discrete disaster event insurance.* Consider a firm with wealth comprised of a risky asset, whose value is W in the best state of nature and zero in the worst state of nature, and risk-free assets valued at $W_0$ regardless of the state of nature. An insurance company is willing to absorb the risk of possible losses of wealth in exchange for an insurance premium $\pi_s$. The firm must determine the maximum insurance premium $\pi_b$ it can pay to avoid a disaster without reducing the level of its certainty equivalent wealth

below the level attained with no insurance coverage. The firm can increase its certainty equivalent income by purchasing insurance if $\pi_s < \pi_b$.

Suppose the firm is considering a comprehensive fire insurance policy and W represents the value of the firm's flammable property being insured. To the find the maximum insurance premium $\pi_b$ that the firm can pay without reducing its certainty equivalent income, we form the decision matrix displayed in Table 4.2.

The matrix has two possible states of nature, two choices, and four different possible outcomes. The states of nature are (1) a fire state $s_1$, and (2) a no-fire state $s_2$ . The choices are buy insurance (choice $A_1$) and remain uninsured (choice $A_2$). If choice $A_1$ is selected, the outcome in both states $s_1$ and $s_2$ is initial wealthy $W + W_0$ less an insurance premium $\pi_s$. This result is obtained because if a fire does occur, the insurance company reimburses the firm for its losses and receives a risk premium. If there is no fire, the insurance company pays for no losses while still earning the insurance premium. In both states the firm purchasing insurance pays a premium. If, on the other hand, the firm decides to remain uninsured (choice $A_2$) and no fire occurs, the firm will be left with both its safe wealth $W_0$ and its risky wealth W and will have saved the insurance premium because it didn't purchase insurance. However, if a fire does occur, the firm will lose its risky wealth W. These results are summarized below.

**Table 4.2. Decision Matrix for Insurance Versus No Insurance with a Discrete Disaster Outcome.**

| States of nature | Probability of outcomes | Choices | |
|---|---|---|---|
| | | $A_1$ (buy insurance) outcomes | $A_2$ (Don't buy insurance) outcomes |
| ($s_1$) fire | $0 < p < 1$ | $W + W_0 - \pi_s$ | $W_0$ |
| ($s_2$) no fire | $1 - p$ | $W + W_0 - \pi_s$ | $W + W_0$ |

If the probability of fire is $p$ and the probability of no fire is $1 - p$, the expected values of the two choices $E(A_1)$ and $E(A_2)$ are:

$$E(A_1) = W + W_0 - \pi_s \tag{4.28}$$

And

$$E(A_2) = pW_0 + (1-p)(W + W_0) = W + W_0 - pW \tag{4.29}$$

The difference between $E(A_1)$ and $E(A_2)$ can be expressed as:

$$E(A_1) - E(A_2) = pW - \pi_s \tag{4.30}$$

If the decision maker was risk neutral and decided between options based on their expected value, the maximum the client would pay for the fire insurance would be $pW = \pi_b$, and as long as $\pi_b < \pi_s$ the client would be better off purchasing insurance than not purchasing insurance.

To illustrate, suppose that the flammable property was W = \$100,000 and $p$ = 1%. Then, the most a client could pay and break-even based on his or her expected values would be $pW$ = (.01)(\$100,000) =

$1,000. If an insurance policy was available for less than $1,000, the client would be advised to purchase the insurance. Suppose the client is risk averse and lays awake at night worrying about the possibility of a fire, and perhaps the client is willing to pay an additional insurance premium based on some function of $p$ and W equal to U($p$,W) $150 to know that, no matter what, the outcome will be $W + W_0 - \pi_b - U(p,W) = \$100{,}00 + W_0 - \$1{,}150$.

*Revenue insurance.* One for the most important forms of insurance available to individual and firms is revenue insurance. The general principles of revenue insurance can be complicated. We describe a simplified version of revenue insurance with discrete outcomes.

Suppose an outcome from a crop operation is a risky event with three possible outcomes: normal income $y$, reduced income $\gamma y$ where $\gamma$ is a percentage between one and zero, or a failed crop resulting in $y = 0$. Let the probability of $y$ be $p_1$. Let the probability of $\gamma y$ be $p_2$. And let the probabilities of a failed crop and zero income be $(1 - p_1 - p_2)$.

The insurance provided does not fully compensate farmers for their losses for moral hazard reasons; they want the farmers to experience some losses for not producing a normal crop.

As a result, lost revenues are only compensated by $\delta$ percent. Furthermore, there is a complicated process to determine what is a normal yield that produces $y$. If a failed crop outcome occurs, the firm receives $\delta y$ or $\delta$ percent of what it normally earns. If a partial crop outcome occurs, then the firm also earns $\delta y$ because the insurance company pays $\delta$ of the firm's lost earnings equal to $\delta y(1 - \gamma)$.

To describe the revenue insurance program described above we construct Table 4.3.

**Table 4.3. Decision Matrix for Revenue with Insurance Versus no Insurance with Discrete Outcomes.**

| States of nature | Probability of outcomes | Choices | |
|---|---|---|---|
| | | $A_1$ (buy insurance) outcomes | $A_2$ (Don't buy insurance) outcomes |
| ($s_1$) full crop | $p_1$ | $y - \pi_s$ | $y$ |
| ($s_2$) partial crop | $p_2$ | $\delta y - \pi_s$ | $\gamma y$ |
| ($s_3$) crop failure | $(1 - p_1 - p_2)$ | $\delta y - \pi_s$ | 0 |

To solve for $\pi_s$ we equate the expected value for the two choice options:

$$p_1(y - \pi_s) + (1 - p_1)(\delta y - \pi_s) = p_1 y + p_2(\gamma y) \tag{4.31}$$

And solving for the insurance premium $\pi_s$ we find:

$$\pi_s = [\delta(1 - p_1) - p_2\gamma]y \tag{4.32}$$

To illustrate, suppose $y = 100$ and $\gamma y = 50$ so that $\gamma = 50\%$. Assume that the probability of a normal income is 60%, the probability of a partial crop and a reduced income is 30%, and the probability of a complete crop failure and no income is 10%. Finally, assume that your revenue insurance policy cov-

ers $\delta = 80\%$ of lost revenue. We restate these conditions in Table 4.4 and then solve for the break-even insurance premium $\pi_s$.

**Table 4.4. Decision Matrix for Revenue Insurance Versus No Insurance with Discrete Outcomes.**

| States of nature | Probability of outcomes | Choices | |
|---|---|---|---|
| | | $A_1$ (buy insurance) outcomes | $A_2$ (Don't buy insurance) outcomes |
| ($s_1$) full crop | $p_1 = 60\%$ | $y - \pi_s = 100 - \pi_s$ | $y = 100$ |
| ($s_2$) partial crop | $p_2 = 30\%$ | $\delta y - \pi_s = 80 - \pi_s$ | $\gamma y = 50$ |
| ($s_3$) crop failure | $(1 - p_1 - p_2) = 10\%$ | $\delta y - \pi_s = 80 - \pi_s$ | 0 |

Finally, we solve for the break-even insurance premium $\pi s$:

$$\pi_s = [\delta(1 - p_1) - p_2\gamma)]y = [(.8)(.40) - (.30)(.5)]100 = 17 \tag{4.33}$$

In other words, a manager could afford to pay up to 17% of its normal income as revenue insurance under the conditions described in Table 4.3.

## Diversification of Firm Investments

Investors rarely hold investments in isolation. Indeed, holding a single investment by itself may be very risky. Most investors attempt to reduce risk by holding a portfolio of (two or more) investments. Adding a risky investment to a portfolio of investments may actually decrease the risk of the portfolio without adversely affecting the expected return on the portfolio. We illustrate the point that adding risky investments to one's portfolio may decrease risk with an example.

*Umbrellas and sunglasses.* Suppose that on any given day there are three possible weather outcomes: there may be rain, there may be a mix of clouds and sun, and there may be bright sunny skies. For simplicity, assume that the probability of each outcome is 1/3. A firm whose outcomes depend on the weather state can invest in umbrellas or sunglasses or a mix of the two. Both investments in umbrellas and sunglasses earn an expected rate of return equal to 10%. These results are summarized in Table 4.5 below:

**Table 4.5. Expected Returns and Variances on Investments in Sunglasses and Umbrella**

| Weather states $i$ = 1,2,3: | Probability of weather states | Random Returns on Sunglasses in the $i^{th}$ weather state: $r_i^S$ | Random Returns on Umbrellas in the $i^{th}$ weather state: $r_i^W$ | Return on portfolio |
|---|---|---|---|---|
| Rain | 1/3 | 0% | 20% | .5(0) +.5(20%) = 10% |
| Mix clouds and sunshine | 1/3 | 10% | 10% | .5(10) +.5(10%) = 10% |
| Sunny | 1/3 | 20% | 0% | .5(20) +.5(0%) = 10% |
| Expected return on investments: | | $E(r_i^S)$ = (1/3)(0% + 10% + 20%) = 10% | $E(r_i^W)$ = (1/3)(20% + 10% + 0%) = 10% | $.5E(r_i^S) + .5E(r_i^S)$ = (1/3)(10% + 10% + 10%) = 10% |
| Standard deviation of returns: | | 8.16% | 8.16% | 0% |

Notice that when it rains, return on umbrellas is favorable (20%) but the return on sunglasses is low, 0%. The reverse is true when there are bright sunny skies; the return on umbrellas is low (0%) while the return on sunglasses is favorable, 20%. The standard deviation for both investments equals:

(4.34a) $$\sqrt{.33(0-.10)^2+.33(.10-.10)^2+.33(.20-.10)^2}=8.16\%$$

Now assume that the firm diversified and created a portfolio in which 50% of its investments were in sunglasses and the other 50% were in umbrellas. The results are described in the last column of Table 4.5. Notice that the return in each state is 10% because when returns on low on sunglasses, return on umbrellas are favorable and vice versa. Note also that while each individual investment has a standard deviation of returns equal to 8.16%, the return on the portfolio is constant and the standard deviation of portfolio returns is zero.

(4.34b) $$\sqrt{.33(.10-.10)^2+.33(.10-.10)^2+.33(.10-.10)^2}=0\%$$

This is an extreme example of how adding a risky investment may actually decrease the firm's risk. However, this favorable result occurred because the returns on umbrellas and sunglasses were perfectly and negatively correlated.

*Covariance measures.* To be perfectly and negatively correlated means that returns on one investment is above its mean by exactly same amount as the other investment is below its mean in the same state. One measure of correlation between two random variables is the covariance measure. Using the notation from the umbrellas and sunglasses example, we define the covariance as:

$$
\begin{aligned}
Cov(r_i^S, r_i^U) &= E[(r_i^S - E(r_i^S)][(r_i^U - E(r_i^U)] \\
&= \left(\frac{1}{3}\right)(0\% - 10\%)(20\% - 10\%) \\
&+ \left(\frac{1}{3}\right)(10\% - 10\%)(10\% - 10\%) \\
&+ \left(\frac{1}{3}\right)(20\% - 10\%)(10\% - 20\%) \\
&= \left(\frac{2}{3}\right)(-10\%)(10\%) = -.00666
\end{aligned}
\tag{4.35}
$$

Notice that the covariance is similar to a variance measure except that instead of a deviation from the expected value being squared, the deviation for both variables in the same state are multiplied, so the covariance measures whether the two variables are moving in opposite directions from their means (negative covariance) or whether the two variables are moving in the same direction from their means (positive covariance). To emphasize the difference between variance and covariance measures, when calculating variance, we squared deviations from the mean, and as a result all variances are positive. In contrast, deviation in covariance measures are not squared which allows them to be positive or negative. Note that the first and third term in the covariance calculation in equation (4.35) were negative while the second term was zero. Thus, the covariance of investments in sunglasses and umbrellas is negative.

Obviously the sunglasses and umbrellas example is simplified to illustrate a point, that risk is completely eliminated because the returns from the two investments have perfect negative correlation. The level of correlation between returns is measured by the correlation coefficient ρ defined as:

$$
\rho = \frac{Cov(r_i^S, r_i^U)}{\sigma_{r_i^S}\sigma_{r_i^U}} \tag{4.36}
$$

Thus, in our example, the correlation coefficient is negative one:

$$
\rho = \frac{Cov(r_i^S, r_i^U)}{\sigma_{r_i^S}\sigma_{r_i^U}} = \frac{-.00666}{(.0816)(.0816)} = -1.0 \tag{4.37}
$$

Obviously, other things being equal, we would prefer to add investments to our portfolio that are negatively correlated with our overall portfolio returns.

Let's return to our investigation of the partnership, only this time allow for a single firm to consider its rate of return on its portfolio of investments. Assume that it has two investments and the percent of the total portfolio invested in each investment is indicated by a weight $w_1$ and $w_2$ that sum to one. The expected value for the firm's portfolio can be expressed as before:

$$E(y_p) = w_1\mu_1 + w_2\mu_2 \tag{4.38}$$

Now consider the variance of the investor's portfolio. If the investments are represented by independent random variables, the portfolio variance is as before—the weighted sum of the individual variances. When the investments are not independent, the portfolio variance also includes a covariance term. We can write the variance of the portfolio allowing for dependence between the two investments as:

$$\sigma_y^2 = w_1^2\sigma_{x_1}^2 + w_2^2\sigma_{x_2}^2 + 2w_1w_2Cov(r_i^1, r_i^2) \tag{4.39}$$

We now apply our portfolio approach to the umbrellas and sunglasses example. Recall that both investments earned an expected rate of return of 10% and their standard deviations were both equal to 8.16%. If the firm divided their portfolio between the two investments, then we would write the expected value and variance of the portfolio as:

$$E(y_p) = w_1\mu_1 + w_2\mu_2 = (.5)(10\%) + (.5)(10\%) = 10\% \tag{4.40}$$

And we write the portfolio variance as:

$$\begin{aligned} \sigma_y^2 &= w_1^2\sigma_{x_1}^2 + w_2^2\sigma_{x_2}^2 + 2w_1w_2Cov(r_i^1, r_i^2) \\ &= (.5)^2(.0816)^2 + (.5)^2(.0816)^2 + 2(.5)(.5)(-.00666) = 0 \end{aligned} \tag{4.41}$$

In this special example, that the returns on sunglasses and umbrellas moved in perfectly opposite direction means that combining investments in both eliminated the variability of returns on the firm's portfolio.

*Beta coefficients and risk diversification.* An important risk concept applied to securities markets but which also has application to the firm is the beta coefficient (β). The beta coefficient is a measure associated with an individual investment which reflects the tendency of an investment's returns to move with the average return in the market. Applied to the individual firm, the beta coefficient measures the tendency of an individual investment's returns to move with the average return on the firm's portfolio of investments.

To explain beta coefficient, suppose we have past rate of return observations $r_t^j$ on a potential new investment and on the firm's portfolio of returns $r_t^p$ in time period $t$. Table 4.6 summarizes our observations:

**Table 4.6. Observations of Returns on the Firm's Portfolio of Investments $r_t^P$ and on a Potential New Investment (a Challenger).**

| Time t | Observed returns on the firm's portfolio over time $r_t^P$ | Observed returns on a potential new investment for the firm's $r_t^j$ |
|---|---|---|
| 2012 | 10% | 7% |
| 2013 | 6% | 8% |
| 2014 | 7% | 5% |
| 2015 | 3% | 2% |
| 2016 | 5% | 3% |

Another way to represent the two rates of return measures and their relationship to each other is to represent them in a two dimensional scatter graph.
We may visually observe how the two sets of rates of return move together by drawing a line through the points on the graph in such a way as to minimize the squared distance from the point to the line. Our scatter graph is identified as Figure 4.3.

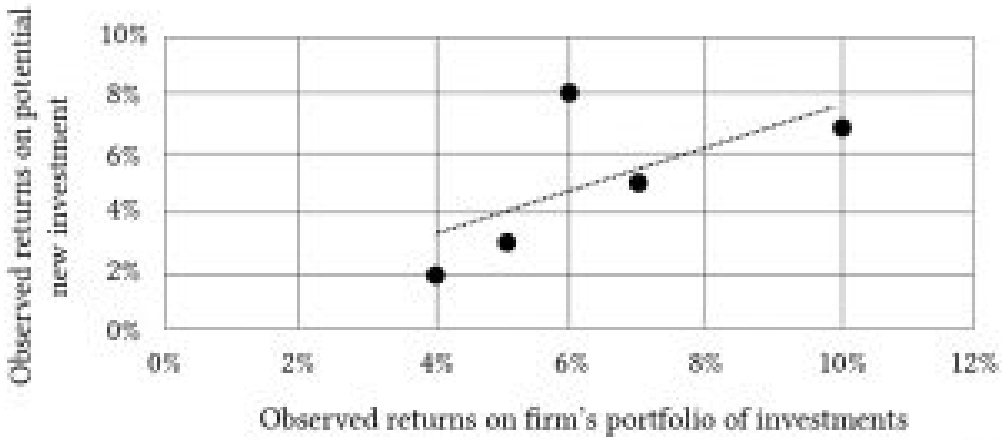



***Figure 4.3. Scatter Graph of Returns on the Firm's Portfolio of Investments and Returns on the Potential New Investment***

The relationship between the returns on the new investment and the firm's portfolio can be expressed as:

$$r_t^j = a + \beta r_t^p + \epsilon_t \tag{4.42}$$

Notice that the equation above describes the straight line drawn through the point plus the vertical distance from the line to each point. The slope of the line is the beta coefficient β and tells us how the returns on the portfolio and potential new investment have moved together in the past. We can find the equation for this line using a statistical method called "least squares" regression analysis. The

method essentially finds a line so that the average squared deviations from the line, $\varepsilon_t^2$, are minimized. The formula for beta is equal to the covariance between the returns on the new investment $r_t^j$ and the returns on the firm's portfolio $r_t^p$ over some time period divided by the variance of portfolio returns:

$$\beta_j = \frac{Cov(r_t^j, r_t^p)}{\sigma_p^2} \tag{4.43}$$

Fortunately, the calculations for the beta coefficient as well as the coefficients in equation (4.16) can be found using Excel[2]. We find the beta coefficient and the coefficients for equation (4.16) using the data in Table 4.6.

The estimated equation for the line is:

$$E(r_t^j) = a + \beta r_t^p + E(\epsilon_t) = a + \beta r_t^p = .02 + .48 r_t^p \tag{4.44}$$

So, what have we learned? We learned that, in particular, a beta coefficient of .48 means that a 10% change in the return on the firm's portfolio will likely be accompanied by an increase of 4.8% in the expected returns on the potential new investment. Furthermore, a decrease of 10% in the returns on the firm's portfolio of investments will likely be accompanied by a 4.8% decrease in the expected returns on the potential new investment. It also means that the variability of the returns on the potential investment are less than the variability of returns on the firm's portfolio of returns. It also says that adding the potentially new investment will not diversify all of the firm's risk. There will still be 48% that is not diversified; it varies with the returns on the firm's overall rate of return. It reduces some of the risk faced by the firm, but not all of it—only about 52%.

*Diversifiable and non-diversifiable risk.* Assume a beta coefficient of minus one (–1). This would mean that for a 10% increase (decrease) in the firm's overall rate of return, that the expected rate of return on the potentially new investment decreases (increases) by 10%. Like investments in sunglasses and umbrellas, a sufficient investment in the new investment would eliminate the firm's risk. Thus, a beta of –1 means that all of its risk can be diversified. In contrast, assume a beta coefficient of one. This would

2. The linear regression equation that includes the Beta coefficient is found in Excel by first plotting a scatter diagram and then hovering over a data point in the graph. A complete discussion of linear regression models is outside the scope of this class. However, we will return to the subject of linear regression when we discuss forecasting.

mean that for a 10% increase (decrease) in the firm's overall rate of return, that the expected rate of return on the potentially new investment increases (decreases) by 10%. Unlike investing in sunglasses and umbrellas, adding the potentially new investment to the firm's portfolio of investment only accentuates its risk, and the new investment has no potential to diversify the firm's overall risk.

## Purchase Risk Reducing Investments

It is useful to distinguish between two primary reasons for investing: first, to increase expected earnings for the firm and second, to reduce the variability of earnings. If one can increase expected returns without increasing variance of return, certainty equivalent income has increased. If one can reduce variance of returns without also reducing expected returns, certainty equivalent income has increased. See equation (4.12). Of course if from one's current expected value-variance position, one could increase one's expected value of returns without increasing the variance of returns—or if one could reduce one's variance without also reducing one's expected value—then the firm would be in an inefficient expected value-variance position off the EV frontier. However, we can identify investments whose primary purpose is to reduce variability even though they alter expected incomes. We call these risk reducing investments. We analyze risk reducing inputs using the certainty equivalent income model described in equation (4.12) that accounts for both variance and expected value in the ranking criterion.

We will illustrate risk reducing investments with a case study involving an irrigation investment. Consider a firm facing five moisture states with an equally likely chance of occurring: normal, low stress, moderate stress, high stress, and drought. The returns per acre with and without the irrigation system are reported in Table 4.7. The annualized cost of the irrigation system, which is expected to have a 20 year life and no liquidation value, is π per acre. We assume the defender's IRR associated with the certainty equivalent cash flow stream to be 8%.

**Table 4.7. Returns per Acre under Alternative Moisture States with and without an Irrigation System.**

| Moisture states | Probability of moisture states | Return per acre without the irrigation investment $r_i^{w/0}$ | Return per acre with the irrigation system $r_i^{w}$ minus irrigation costs per acre π |
|---|---|---|---|
| Normal | 20% | $128 | $113– π |
| Low stress | 20% | $105 | $100 – π |
| Moderate stress | 20% | $90 | $80 – π |
| High stress | 20% | $75 | $75 – π |
| Drought | 20% | $50 | $70– π |
| Expected returns | | $89.60 | $87.60 |
| Standard deviation of returns | | $26.43 | $16.28 |

Assume that π is $15 per acre. Then the expected value of the crop production per acre without irrigation is still $89.60 and greater than $87.60. If the decision maker were risk neutral, he or she would not invest in the irrigation system. Allow that the decision maker is risk averse and chooses between investments based on their certainty equivalent incomes rather than the difference in their expected values. If this were the case, then the certainty equivalent income without irrigation is:

$$y_{CE}^{w/0} = E(y) - \frac{\lambda}{2}\sigma_y^2 = \$89.60 - \frac{\lambda}{2}(26.43)^2 \tag{4.45}$$

In contrast, the certainty equivalent income with the irrigation system is:

$$y_{CE}^{w} = E(y) - \frac{\lambda}{2}\sigma_y^2 = \$87.60 - \frac{\lambda}{2}(16.28)^2 \tag{4.46}$$

We cannot decide between the two systems because one has a higher expected value and the other has a lower variance. It all depends on how risk averse the decision maker is. Recall that λ reflects the decision maker's preferred trade-off between expected return for variance. The break-even λ in this case is found by equating the two certainty equivalent incomes:

$$\$89.60 - \frac{\lambda}{2}(26.43)^2 = \$87.60 - \frac{\lambda}{2}(16.28)^2 \tag{4.47}$$

and solving for λ:

$$\lambda = \frac{2(89.60 - 87.60)}{(26.43)^2 - (16.28)^2} = .009 \tag{4.48}$$

Thus, all decision makers more risk averse than is reflected by the risk aversion coefficient of λ = .009 will be earning a lower expected value on average than would be earned without the irrigation system.

## Choosing an Optimal Capital Structure

*Leverage and risk.* In an later chapter, we will use leverage as a measure of the firm's risk. We now make the connection between risk and leverage using a single period rate-of-return model that connects the rate of return on a firm's equity (ROE) to its rate of return on its assets (ROA). We call this relationship the rate of return identity (RORI). We define it here and explain it in more details in later chapters. We write the RORI equation as: :

$$ROE = (ROA - i)\frac{D}{E} + ROA \tag{4.49}$$

where $i$ is the average interest rate the firm pays on its liabilities and $D$ and $E$ represent the firm's debt and equity respectively. In equation (4.49), note the leverage ratio $D/E$ and that it multiplies the difference between the ROA and the average interest rate $i$. And now we return to a risk principle introduced earlier—that multiplying a random variable by a constant, in this case the leverage ratio, increases the variance of the random variable by the constant squared. Consider the application of this principle.

Suppose the random variable ROA is described by pdf $f(r^{ROA})$ with expected value $r^{ROA}$ and variance $\sigma^2$. Now suppose that we were to multiply the random variable ROA by some scalar, say 2. Then the expected value of the random variable would be $2r^{ROA}$ and the variance would be $2^2\sigma^2$, or $4\sigma^2$.

In equation (4.49), the debt-to-equity ratio is the scaler that multiplies and exaggerates the difference between $r^{ROA}$ and $i$. To illustrate, suppose that ROA can take on values of −8%, −3%, 3%, 5%, and 12% and i = 3%. Then in Table 4.8 we find ROE for leverage ratios of 0, 2, 5, and 10.

**Table 4.8. ROEs whose Expected Values and Standard Deviations depend on Leverage Ratios.**

| Values of the random variable ROA ($i$ = 3%) | ROE values for alternative Leverage Ratios ($L = D/E$) and values of the random variable ROA | | | |
|---|---|---|---|---|
| | L = 0 | L = 2 | L = 5 | L = 10 |
| −8% | −8% | -30% | -63% | -118% |
| -3% | -3% | -15% | -33% | -63% |
| 3% | 3% | 3% | 3% | 3% |
| 5% | 5% | 9% | 15% | 25% |
| 12% | 12% | 30% | 57% | 102% |
| Standard deviations for ROEs associated with each leverage ratio $L$ | | | | |
| Expected values | 1.8 % | -0.6% | -4.2% | -10.2% |
| Standard deviation σ | 0.077 | 0.23 | 0.460 | 0.843 |

The first thing to note about the outcomes in Table 4.8 is that whenever the ROA exceeds the average interest rate $i$, that ROE > ROA. For example, for a leverage ratio of 2 and an ROA of 5%, ROE is 9%. The second point to observe is that even though the $E$(ROA) > 0, as the leverage ratio increased, the $E$(ROE) was mostly less than zero. In other words, the effect of leverage was more pronounced when the ROA < $i$ than when ROA > $i$. Another thing to note is that if the ROA outcome is −8% and the firm has a leverage ratio of 10, it loses 118% of its equity. In other words, one unfavorable outcome with a high leverage ratio can destroy the firm. Finally, due to the cost of debt that must be paid regardless of ROA outcomes, ROA's less-than-average cost of debt with high leverage ratios have significant adverse effects on the firm's equity. Thus, we conclude that a high leverage ratio, even though it can exaggerate unusually high ROA outcomes, is still a risky state for the firm. For that reason, many firms view leverage reduction as an important strategy for reducing the riskiness of the outcomes they face.

*Capital structure.* A firm's capital structure is its combination of debt and equity used to finance its overall operations and growth. The small to medium-size firm may finance its overall operations and

growth by using long-term debt, equity, and notes payable. We will discuss the small to medium-size firm's optimal capital structure using a simplified expected value-variance (EV) profit model.

In our simplified model, we let the firm's assets A be funded by a combination of debt D and equity E. We let $\tilde{r}^a$ be the stochastic rate of return on the firm's assets whose variance is $\sigma_a^2$ and whose expected rate of return is $r^a$. We let the average non-stochastic cost of debt per dollar be represented by the variable $i^D$. The firm decision maker's risk-return trade-off is measured by $\lambda/2$.

We represent the firm's stochastic profits $\tilde{\pi}$ to equal the stochastic rate of return on assets times assets less the firm's average cost of debt times the firm's debt. Then we substitute for assets A the sum of debt D plus equity E and collect like terms and express the stochastic results in equation (4.50).

$$\tilde{\pi} = \tilde{r}^a A - i^D D = \tilde{r}^a (D + E) - i^D D = (\tilde{r}^a - i^D) D + \tilde{r}^a E \tag{4.50}$$

We write the expected value of stochastic profits as:

$$E(\tilde{\pi}) = r^a A - i^D D = (r^a - i^D) D + r^a E \tag{4.51}$$

We write the variance of profits as:

$$\sigma^2(\tilde{\pi}) = (D + E)^2 \sigma_a^2 \tag{4.52}$$

Finally, we substitute the expected value and variance of profits into equation (4.52) to find the firm's certainty equivalent of profits $\pi_{CE}$ that we refer to as the EV model.

$$\pi_{CE} = E(\tilde{\pi}) - \left(\frac{\lambda}{2}\right) \sigma^2(\tilde{\pi}) = (r^a - i^D) D + r^a E - \left(\frac{\lambda}{2}\right) (D + E)^2 \sigma_a^2 \tag{4.53}$$

*Finding the firm's optimal capital structure.*[3] Having our EV model defined over the expected value and variance of profits and accounting for the decision maker's risk attitudes, we use calculus to find the optimal debt level by differentiating the certainty equivalent function $\pi_{CE}$ with respect to D.

$$\frac{d\pi_{CE}}{dD} = (r^a - i^D) - \lambda (D + E) \sigma_a^2 = 0 \tag{4.54}$$

The second order conditions are satisfied allowing us to solve for the optimal debt $D^*$ (assuming fixed equity). We find the optimal debt $D^*$ to equal:

3. This section uses calculus to find the firm's optimal debt level and its optimal capital structure or leverage ratio (D/E). Those not interested in the derivation may skip to the next section without loss of continuity in the discussion.

$$D^* = \left( \frac{r^a - i^D}{\lambda \sigma_a^2} \right) - E \tag{4.55}$$

Equation (4.55) reveals an interesting detail. If the cost of debt equals the expected return on assets, the firm holds negative debt—preferring to lend out its equity at a safe rate $i^D$ rather than earning a stochastic return on firm assets.

Dividing equation (4.55) by the firm's equity E, we can find its optimal leverage ratio $l^*$ equal to:

$$l^* = \frac{D^*}{E} = \left( \frac{r^a - i^D}{\lambda \sigma_a^2 E} \right) - 1 \tag{4.56}$$

We illustrate equation (4.56) using HQN's data described in Chapter 5. We substitute for $r^a$ the ROA value equal to 6.5% (equation 6.13), the average cost of debt $i^D$ equal to 6% (equation 6.20), equity E equal to $2,000 (Table 5.1), the risk aversion coefficient calculated in equation (4.48) equal to .009, and finally, we let the standard deviation—the amount that returns on assets vary on average—equal 1.25% or .0125 that we square to find the variance of profits $\sigma^2(\tilde{\pi})$ equal to .000156. Making the substitutions for the variables in equation (4.56) we find the firm's optimal leverage ratio equal to:

$$l^* = \frac{D^*}{E} = \left( \frac{r^a - i^D}{\lambda \sigma_a^2 E} \right) - 1 = \frac{(.065 - .06)}{(.009)(.000156)(\$2,000)} - 1 = 0.78 \tag{4.57}$$

compared to the firm's actual leverage ratio of 4.0.

*Changing variables affecting the optimal capital structure.* We can imagine how the optimal leverage would change in response to changes in the value of the variables included in equation (4.57). In other words, we ask: how would the optimal leverage change if the value of one of the variables in equation (4.56) changed? We can infer the answer to this question by looking at changes in the optimal leverage ratio in response to a change in one of the variables holding the other variables constant.

Increasing the expected value of asset returns $r^a$ makes it more profitable to use borrowed funds and increases the optimal leverage ratio. Increasing the average cost of debt $i^D$ makes using debt less profitable and reduces the optimal leverage ratio. As a decision maker becomes more risk averse, represented by an increase in the risk aversion coefficient $\lambda$, the decision maker is less willing to risk losing equity with an unfavorable outcome and reduces leverage. As the firm's equity increases, it can achieve the same risk return combination with less debt and the optimal leverage ratio decreases. Finally, as the variance of return on firm assets $\sigma_a^2$ increases, the firm reduces its leverage ratio to return to its preferred trade-off between equity and debt.

We emphasize the importance of the decision maker's risk attitudes characterized by the risk aversion coefficient of .009. To illustrate, if we reduce the risk aversion coefficient to .003 and recalculate the optimal leverage ratio, we find it increased from 0.78 to:

$$\frac{(.065 - .06)}{(.003)(.000156)(\$2,000)} - 1 = 4.34. \tag{4.58}$$

This is close to HQN's actual leverage ratio. Alternatively, leaving HQN's risk aversion coefficient unchanged and increasing the expected value of the return on assets to 0.07. we find the new optimal leverage ratio to equal:

$$\frac{(.07 - .06)}{(.009)(.000156)(\$2,000)} - 1 = 2.56 \tag{4.59}$$

We conclude with a note of caution. The calculation of risk aversion coefficients can be complicated and changed by the scale used to measure the random variable—dollars versus percentages. Our main message is that optimal leverage ratios are sensitive to not only rates of returns but also the decision maker's attitude toward risk.

So, what have we learned? We learned that firms generally dislike risk (however it is defined) and prefer expected earnings. Generally, we are willing to assume some risk if the increase in expected returns is sufficient. The firm selects its optimal combination of debt and equity to achieve its preferred expected profits and variance of profits. Increases in the value of variable that increase the firm's expected profits increase the firm's optimal leverage ratio. Increases in the value of variables that increase the firm's variance of profits reduce the firm's optimal leverage ratio.

## Summary and Conclusions

Some sage is reported to have said that only death and taxes are certain. If that statement is anywhere close to being true, then risk and uncertainty fill the world we live in and try to manage. One important step toward managing the outcomes of risky events is to understand the tools that have been developed to report and measure it. In this effort, precision is not expected. It is best to explore the influence of risk in a variety of settings and assumptions.

The second thing to note about risk, emphasized in the irrigation example, is that individual risk preferences may have significant effects. As a result, two individuals facing the same investment opportunities may make different choices because of the different risk preferences. As a result, it is important for managers to explore their own risk preferences and apply them when making risky decisions.

# References

Robison, Lindon J. and Peter J. Barry (1987). The Competitive Firm's Response to Risk. New York: Macmillan Publishing Co., 1987.

# Questions

1. This question has several parts.
    1. What is the difference between a sample of observations and the population of possible values?
    2. Explain the difference between an expected value and variance (standard deviation) calculated from a sample and the expected value and variance (standard deviation) of a population.
    3. Find the expected value and variance (standard deviation) for the numbers 5, 8, −3, 9, and 0. Assume each number has an equally likely chance of being observed.
    4. Find the expected value and population variance (standard deviation) for the numbers 5, 8, −3, 9, and 0 if their probability of occurring were .1, .2, .4, .2, and .1 respectively.
    5. Compare the results obtained in parts 3 and 4.
2. Return to Table 4.1 in the text. Suppose that the investor decided to invest half of her assets in investment A and half in investment B. Describe the random variable for the combined investment. Then describe its pdf, expected value, and variance (standard deviation). Based on the respective expected values and variances for investment A, investment B, and the combined investment—which would you prefer, assuming you are risk averse?
3. Assume two people decide to form a partnership and share the risk and expected returns based on their shares contributed to the business. Assume partner 1 contributed 40% of the assets and partner 2 contributed 60% of the assets. Each partner's business can be described by random variables y1 and y2 with expected values and variances of $\mu 1 = 8\%$ and $\sigma 12 = 0.006$ for the first partner and $\mu 2 = 12\%$ and $\sigma 22 = .007$ for the second partner. Find the expected value standard deviation of the partnership.
4. Assume that Kelly wants to provide for her heirs in case she dies during the coming year. Therefore, she purchases a term life insurance policy that pays $1,000,000 in case she dies in return for an insurance premium of $800. Assuming Kelly is risk neutral, what must Kelly assume is the probability of her death in order for her to purchase the insurance policy?
5. Assume the conditions described in Table 4.3 except allow for the insurance coverage $\delta$ to increase from 80% to 85%. Find the increase in the break-even insurance premium.
6. Assume the conditions described in Table 4.4. Also assume that instead of purchasing revenue insurance the investor could purchase an irrigation system that would increase the probability of a normal revenue income year from 60% to 75%, reduce the probability of a reduced income year from 30% to 20%, and reduce the probability of zero income from 10% to 5%. What would be the most that the manager could pay to reduce its risk through the purchase of an irrigation system

and still be as well as he was before? (Hint: compare the value provided by the irrigation system less the cost of the irrigation system compared to the outcomes without an irrigation system.)

7. One of the differences between the purchase of an irrigation system and revenue insurance is that one has to purchase revenue insurance each year while the irrigation system continues to provide risk reduction services during its useful life. If the irrigation system described in the previous question were available for 10 years and the discount rate were 8%, what is the NPV of the irrigation system?
8. Use the data in Table 4.5 to find the beta coefficient for the investment in umbrellas and sunglasses.
9. A firm has two investments in its portfolio. The historical rates of return on the two investments are reported below. Find the expected rate of return for the firm's portfolio, the covariance between the two investments, and the variance of the portfolio returns. Rank investment 1, investment 2, and the combined investment using the EV criterion.

**Table Q4.1. Observations of Returns on the Firm's Two Investments**

| Time *t* | Observed returns on investment one. | Observed returns on investment two. |
|---|---|---|
| 2012 | 10% | 7% |
| 2013 | 6% | 8% |
| 2014 | 7% | 5% |
| 2015 | 3% | 6% |
| 2016 | 5% | 4% |

PART II

# PART II: STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND THREATS

# 5. Financial Statements

**LINDON ROBISON**

*Learning goals.* After completing this chapter, you should be able to (1) construct consistent and accurate coordinated financial statements (CFS) (2) describe the differences and connections among balance sheets, accrual income statements (AIS), and statements of cash flows; and (3) distinguish between endogenous and exogenous variables and how they influence the construction of CFS.

*Learning objectives.* To achieve your learning goals, you should complete the following objectives:

- Learn how to construct the financial statements included in the CFS.
- Learn how the fundamental accounting equation organizes the firm's balance sheet entries.
- Learn how to organize a firm's cash flow data into a Sources and Uses of Funds (SAUF) statement.
- Learn how to distinguish between a firm's cash income statement and its accrual income statements (AIS).
- Learn how to compute a firm's cash income statement using cash flow and depreciation data.
- Learn how to distinguish between exogenous and endogenous variables.
- Learn how to compute a firm's statement of cash flow using data from its checkbook and other cash flow records.
- Learn the consistency requirements that connect data from the firm's balance sheets, AIS and statement of cash flow.
- Learn the distinction between consistency of financial statements and accuracy of financial statements.
- Learn how to organize firm financial data into a consistent and (as far as possible) accurate set of CFS.

## Introduction

Financial statements include balance sheets, the cash income statement, an accrual income statement (AIS), the statement of cash flow (SCF), and the sources and uses of funds (SAUF) statement. Coordinated financial statements (CFS) include beginning and ending period balance sheets, an AIS, and a SCF. We are particularly interested in the financial statements included in CFS because they are interdependent and when constructed consistently can help us identify inaccuracies in our data.

The purpose of financial statements is to provide the firm the information it needs to identify its strengths and weaknesses, to evaluate its performance, to assess its alternative futures, and to guide its choices between alternative futures to the one most consistent with its mission, goals, and objectives.

Financial managers are expected to conduct financial analysis. To be effective in this role, financial managers need to have a basic understanding of financial statements—how to construct them and how to analyze them. The material that follows provides a basic understanding of financial statements and how to construct them. Later chapters will focus on how to analyze them.

There are, of course, other reasons why familiarity with financial statements may be important. We may have an interest in learning about successful firms, and one way to do this is to examine their financial statements. We may be interested in investing in a firm and want to evaluate its financial condition. We may be employed in a job that requires an understanding of financial statements. Or, we may simply want to make informed decisions that influence the financial conditions of firms in which we have an interest.

Ideally, firms maintain properly constructed financial statements which financial managers can use to conduct financial analysis. But the reality is that many firms, especially small firms, do not maintain a properly constructed set of financial statements. Furthermore, many firms do not record all the data necessary to construct an accurate set of financial statements. On the other hand, nearly all firms maintain cash receipts and cash expense records needed to calculate income tax liabilities. And these same tax record lists the book value of long-term assets necessary to construct balance sheets. Fortunately, with balance sheet data and a cash income statement computed from tax records, we can construct a set of financial statements including an AIS.

## Financial Statements

Financial statements may vary by type of firm. For example, financial statements prepared for corporations must satisfy generally accepted accounting practices (GAAP) in which ownership claims are represented by shares of stock. Financial statements prepared for sole proprietorships and partnerships are not subjected to GAAP requirements. In addition, some financial statements are based on accrual methods that record transactions when they occur, while others record transactions only when cash is exchanged.

Different financial statements may report the value of assets differently. Some financial statements represent the value of assets at the price at which they could be sold in the current accounting period. These values are referred to as *market* values. Other financial statements represent the value of assets at the price at which they were purchased less depreciation. In these statements, allowable depreciation is usually described in tax codes. These values are referred to as *book* values.

> So, what have we learned? We learned that financial managers need access to the following financial statements: book value balance sheets, accrual and cash income statements,

sources and uses of funds (SAUF) statement, and statement of cash flow. Of these statements we make particular mention of the book value balance sheets, the accrual income statement (AIS) and the statement of cash flow. We refer to these as coordinated financial statements (CFS) because they are interdependent and their proper connections to each other—their consistency—can be easily checked. In addition, consistently constructed CFS can help us identify inaccuracies in our data. In what follows we describe firm financial statements.

## The Balance Sheet

The balance sheet describes the firm's assets—what the firm owns or controls. It also lists the claims on the firm's assets from outside the firm called liabilities. The difference between assets and liabilities equals net worth and represents the firm's equity. The balance sheet is constructed at a point in time, e.g. the last day of the year, leading some to describe it as a snapshot of the firm's financial condition.

In the balance sheets presented in this class, the value of assets and liabilities is a combination of current and book values. Long-term assets are recorded at their book value—their purchase prices less accumulated depreciation determined by tax codes. Most liabilities and current assets are valued at their current values.

The underlying principal for constructing any balance sheet is the fundamental accounting equation: Assets = Liabilities + Equity. The fundamental accounting equation declares that each of the firm's assets must be financed either by liabilities (funds supplied by those outside the firm) or equity (funds supplied by the firm's owners). Moreover, the fundamental accounting equation separates the firm's assets from its liabilities and equity on the balance sheet. We can check the fundamental accounting equation by noting that the total value of assets equals the total value of liabilities and equity for each year the balance sheet is calculated.

Table 5.1 reports 2016, 2017 and 2018 year-end balance sheets for the hypothetical proprietary firm called HiQuality Nursery. Since we will repeatedly use data associated with this hypothetical firm and refer to the firm frequently, we will refer to it in the future using the acronym HQN. When reporting balance sheets for multiple years, the balance sheets in this text will appear in increasing time periods from least current to most current: 2016, 2017, and 2018 in the case of HQN.

**Table 5.1. Year End Balance Sheet for HQN (all numbers in 000s)**

| Balance Sheet | Year | | |
|---|---|---|---|
| | **12/31/16** | **12/31/17** | **12/31/18** |
| Cash and Marketable Securities | $1,200 | $930 | $600 |
| Accounts Receivable | $1,560 | $1,640 | $1,200 |
| Inventory | $3,150 | $3,750 | $5,200 |
| Notes Receivable | $0 | $0 | $0 |
| **CURRENT ASSETS** | **$5,910** | **$6,320** | **$7,000** |
| Depreciable Long-term Assets | $3,270 | $2,990 | $2,710 |
| Non-depreciable Long-term Assets | $710 | $690 | $690 |
| **LONG-TERM ASSETS** | **$3,980** | **$3,680** | **$3,400** |
| **TOTAL ASSETS** | **$9,890** | **$10,000** | **$10,400** |
| Notes Payable | $1,400 | $1,500 | $1,270 |
| Current Portion LTD | $700 | $500 | $450 |
| Accounts Payable | $2,400 | $3,000 | $4,000 |
| Accrued Liabilities | $870 | $958 | $880 |
| **CURRENT LIABILITIES** | **$5,370** | **$5,958** | **$6,600** |
| **NONCURRENT LONG-TERM DEBT** | **$2,560** | **$2,042** | **$1,985** |
| **TOTAL LIABILITIES** | **$7,930** | **$8,000** | **$8,585** |
| Contributed capital | $1900 | $1900 | $1,900 |
| Retained earnings | $60 | $100 | ($85) |
| **TOTAL EQUITY** | **$1,960** | **$2,000** | **$1,815** |
| **TOTAL LIABILITIES AND EQUITY** | **$9,890** | **$10,000** | **$10,400** |

## Assets

Assets represent everything of value that the firm controls. Assets have value to the firm, mostly because they represent what can be used to generate earnings. The firm's assets are typically listed in order of liquidity, or nearness to cash. In most cases asset liquidity depends on the ease or cost of converting them to cash.

*Current Assets.* Current assets are cash and near-cash assets that are expected to be liquidated or converted to cash during the next year. Current assets are typically assets whose liquidation will not significantly disrupt the operation of the firm. We describe current assets next in their order of liquidity, or their nearness to cash.

- Cash balances are the firm's most liquid assets.
- Marketable securities are interest-bearing deposits with low risk of losing principal and can easily be converted to cash if needed.
- Accounts receivable include completed sales, for which payment has not been received.
- Notes receivable represent short-term loans the firm has made to others that are expected to be repaid during the coming year. Notes receivables are important for firms for whom lending money and earning interest on their loans is a significant source of income.
- Finally, inventories may be of two kinds. One kind of inventory represents the value of inputs on hand that can be used in future production or manufacturing of goods. A second kind of inventory are products available for sale. Inventories are often the least liquid of the firm's current assets, and their value is often not known until they are sold.

*Long-term assets.* Long-term assets yield services over several time periods. Liquidation of long-term assets would typically disrupt the operations of the firm and would occur only if the firm were facing a solvency crisis or replacing long-term assets with more productive ones.

Some balance sheets distinguish long-term assets by the length of time they will be held by the firm before being liquidated, referring to them as intermediate versus long-term assets. We prefer to distinguish between long-term assets by whether or not they depreciate. Depreciable long-term assets include machinery, equipment, breeding stock, contracts, long-term notes receivable, building and improvements. Non depreciable long-term assets are mostly land.

*Book value versus market value of long-term assets.* The book value of long-term assets is equal to their purchase price less accumulated depreciation: book value = acquisition cost – accumulated depreciation.

Accumulated depreciation is intended to reflect the loss in value of long-term assets due to use or the passage of time. As a practical matter, the depreciation rate is usually determined by tax codes.

While long-term assets are valued at their book value in the balance sheet, firms are also interested in the market value of their long-term assets. An asset's market value is the price at which it could be sold in the current market. An asset's book value is almost always different than its market value, the

price at which the asset could be sold in the current period. Two reasons why an asset's book value and market value differ are because an asset's book value ignores appreciation and its depreciation is set by predetermined rates (rather than market forces), most often reflected in tax codes.

Tax consequences created by depreciable assets are complicated. Consider an example. Suppose a firm purchased a depreciable asset for $1,000 and then depreciated its value by $100 for four years and then sells the asset for $1,300. The difference between the realized market value of $1,300 and its book value of $600 consists of recaptured depreciation of $400 and capital gains of $300. The $300 of capital gains are taxed at the capital gains tax rate. Because the depreciation shielded the firm's income from income tax, the tax savings from $400 of depreciation is recaptured at the firm's income tax rate.

To better understand why book value is not equal to market value, think about what determines market value. As will be demonstrated later, the market value of an asset generally depends on the discounted value of future cash flow the asset is expected to generate. The cash flow characteristics that are important in establishing the market value of an asset include:

- the size and/or number of expected future cash flow;
- the timing of expected future cash flow; and
- the risk and variability of future cash flow.

In general, the larger the size and/or number of expected future cash flow, the larger will be the market value of the asset. Likewise, the sooner the asset is expected to generate cash flow, the higher will be the asset's market value, because a dollar today is generally preferred to a dollar later. Finally, as the risk or variability of an asset's future cash flow increase, the lower will be the asset's market value. To account for the influence of the size, timing, and risk of an asset's cash flow on an asset's value, later chapters will introduce the concepts of the time value of money. The concept of certainty equivalent measures was introduced in the chapter Managing Risk.

> So, what have we learned? We learned that with so many variables affecting the market value of an asset, we cannot expect that any predetermined depreciation schedule will accurately predict a depreciable asset's market value. Therefore, depreciable assets are valued at their book value in our balance sheets.

## Liabilities

Liabilities are obligations to repay debt and accrued interest charges. They are listed according to the date they become due. Current liabilities are debt and interest payments due during the current period and pose the greatest liquidity demands on the firm's resources. Long-term liabilities are debts that

will come due after the current year. Equity, which represents residual ownership of the firm's assets, has no fixed due date and is consequently listed after current and fixed liabilities.

*Current liabilities.* Current liabilities include the following:

- Notes payable are short-term debt (written promises) the firm is obligated to pay during the current year.
- The current portion of long-term debt (LTD) is the portion of LTD that is due during the upcoming year.
- Accounts payable equal the value of purchases made for inputs but not paid.
- Accrued liabilities are expenses that have been incurred through the operation of the firm and the passage of time, but have not been paid. Examples of accrued expenses include taxes payable, interest payable, and salary and wages payable.

*Non-current long-term debt* is the final category of liabilities, a long-term liability. Non-current long-term debt is that portion of the firm's debt due after the current period. These are usually long-term notes payable, mortgages, or bond obligations.

## Equity

Equity, or net worth, is the difference between assets and liabilities, the difference between what one owns and what one owes. The firm's equity is an estimate of what owners of the firm would have left if they sold all their assets at their book value and paid all their liabilities valued at their market value. Therefore, equity is an important indicator of a firm's financial health.

The actual difference between what one owns and what one owes, if required to sell all of one's assets and repay one's liabilities, depends not only on the difference between the market value and book value of assets but also on the liquidity of the firm. Therefore, some caution is called for when interpreting the equity appearing on the firm's balance sheet as an indicator of its financial well-being.

Equity consists of accumulated retained earnings reported in the AIS and contributed capital by the firm's owners. One practical note is that when reconciling assets and liabilities, contributed capital is sometimes treated as a residual variable.

# Checkbooks and Sources and Uses of Funds (SAUF) Statement

Most small firms record cash flow data in checkbooks, credit card statements, or other financial worksheets. These data are important for the construction of financial statements. They also supply the information needed to construct the firm's income tax returns. Consider HQN's cash flow data

recorded in its checkbook reported in Table 5.2. To simplify the reporting of cash flow data, individual entries of the same kind have been combined into general categories.

## Checkbooks

*Beginning cash balance.* Beginning cash balance is the cash the firm had on hand at the end of the previous period. It also appears on the first line of the firm's checkbook.

*Cash receipts.* Cash receipts may include cash received from the sale of tangible products like grain and livestock. Cash receipts may also include cash received from services the firm sells to other firms such as tiling, harvesting, and veterinary services. Cash receipts may include government payments from sponsored activities and insurance payments. Finally, cash receipts include reductions in accounts receivables and inventories that represent previous sales and production converted to cash in the present period.

*Cash cost of goods sold (COGS).* Cash COGS reflect the direct cost of materials and labor used to produce the goods that were sold to generate the firm's revenue. Cash COGS vary with the production levels and are usually the largest expense in most businesses. Finally, cash COGS include reductions in accounts payable that represent expenses incurred in the previous periods paid for in the present period.

*Cash overhead expenses (OE).* Cash OE represent the cost of operating and administrating the business beyond those included in COGS. These expenses typically include such things as administrative expenses, general office expenses, rents, salaries, and utilities. OE are difficult to assign to a particular production activity because they contribute to more than one project. Moreover, they tend not to vary with changes in production levels although they may vary over time. Cash OE may also include payments on accrued liabilities. Finally, cash OE include reductions in accrued liabilities incurred in previous periods paid for in the present period.

*Taxes.* Taxes include all compulsory contributions to and determined by governmental units. Taxes may be imposed on property, profits, and some goods used in production and sales.

*Interest.* Interest is the cost paid to use money provided by others during the current period. We sometimes distinguish between interest paid on long-term and short-term debt obligations.

*Cash purchases or sales of long-term assets.* Depreciable and non-depreciable long-term assets provide services for more than one period providing the firm a measure of control over its capital service flow not afforded by rental agreements.

*Loan payments and account and note payments.* Loan payments and account and note payments reflect payments on the amount of financial resources owed others. Sometimes referred to as principal payments, in the case of loans, note payment reflect reductions in the financial obligations of the firm as opposed to interest payments charged for the use of the financial resources of others.

*Owner draw.* Owner draw represents funds withdrawn from proprietary firms by its owners. These payments may be in exchange for services rendered by the firm's owner. In other cases, owner draws are funds withdrawn from the firm to meet financial needs of the firm's owner.

**Table 5.2. HQN's 2018 Checkbook**

| Date | Item | Withdrawal | Deposit | Balance |
|---|---|---|---|---|
| 12/31/17 | Beginning cash balance | | | $930 |
| | Cash receipts | | $38,990 | $39,920 |
| | Cash cost of goods sold (COGS) | $27,000 | | $12,920 |
| | Cash overhead expenses (OE) | $11,078 | | $1,842 |
| | Interest paid | $480 | | $1,362 |
| | Taxes paid | $68 | | $1,294 |
| | Purchase of long-term assets | $100 | | $1,194 |
| | Sale of long-term assets | | $30 | $1,224 |
| | Current portion of long-term debt paid | $157 | | $1,067 |
| | Long-term borrowings | | $50 | $1,117 |
| | Notes payable | $230 | | $887 |
| | Owners' draw | $287 | | $600 |
| 12/31/18 | Ending cash balance | | | $600 |

## The Sources and Uses of Funds (SAUF) statement.

The data recorded in the firm's checkbook and other cash flow records can be organized as an SAUF statement that identifies sources of cash for the firm (cash inflows) and uses of funds (cash outflows). The SAUF statement is consistent with the cash flow data reported in HQN's checkbook in Table 5.2. HQN's SAUF statement is reported in Table 5.3.

At the beginning of the period, firm managers make cash flow projections recorded in the SAUF statement. These projections allow the firm to plan in advance for cash flow shortages or for investment and savings opportunities. Obviously, a negative ending cash balance is not possible; therefore, the firm adjusts its cash expenses or cash receipts so that the firm remains solvent. In the last column of HQN's SAUF, ending period cash balances were projected to equal $51.

**Table 5.3. HQN's 2018 SAUF Statement**

| Date | *Sources of Cash* | Actual | Projected |
|---|---|---|---|
| 12/31/17 | Beginning cash balance | $930 | $930 |
| | Cash receipts | $38,990 | $39,000 |
| | Sale of long-term assets | $30 | $50 |
| | Long-term borrowing | $50 | $25 |
| 12/31/18 | Total sources of funds | $40,000 | $40,005 |
| | | | |
| | ***Uses of Cash*** | | |
| | Cash COGS | $27,000 | $25,000 |
| | Cash OE | $11,078 | $12,000 |
| | Interest paid | $480 | $480 |
| | Taxes paid | $68 | $70 |
| | Cash purchases of long-term assets | $100 | $150 |
| | Pay current portion of long-term debt payment | $157 | $1,067 |
| | Notes payable | $230 | $887 |
| | Owners' draw | $287 | $300 |
| 12/31/18 | Total uses of funds | $39,400 | $39,954 |
| 12/31/18 | Ending cash balance (Total sources – total uses of funds) | $600 | $51 |

Notice that the entries in the Checkbook reported in Table 5.2 match those in the SAUF statement reported in Table 5.3, except that they are organized as sources of funds coming into the firm and uses of funds representing funds flowing out of the firm. Consistency between the firm's SAUF statement and its checkbook requires cash at the ending periods in the balance sheet and the SAUF are equal.

So, what have we learned? We learned that records of cash flow whether recorded in checkbooks or similar records is one of the most important data sources for constructing CFS for the firm. This data can be used to construct SAUF statements and statements of cash flow.

## Statement of Cash Flow (SCF)

The firm's balance sheet describes its financial position at a point in time while the firm's statement of cash flow (SCF) describes the firm's cash flow over a period of time between the firm's beginning and

ending balance sheets. The main purpose of the SCF is to find the change in the firm's cash position during the accounting year.

*Three major cash flow activities.* The firm's SCF is similar to its SAUF statement except that it separates cash flow into the three categories: (1) cash flow from operations, (2) cash flow from investments, and (3) and cash flow from its financing activities.

The cash flow from operations reflect the cash flow generated by the firm in producing and delivering its goods and services. Cash flow from operations reflect the firm's management of its production and marketing activities.

The cash flow from investment activities result from the firm's sale and purchase of long-term assets. Sales of long-term assets whose market value exceeds its book value create realized capital gains and depreciation recapture. Cash flow from investment activities reflect the firm's investment management strategies.

The cash flow from financing activities result from borrowing new debt, repaying old debt, raising new equity capital, and returning capital to owners. Cash flow from financing reflect the firm's management of its debt and equity.

Cash flow for the firm during the accounting period are summarized by its change in cash position. By adding cash on hand at the end of the previous period to the change in cash position reported in the statement of cash flow, we obtain cash on hand at the end of the period. As a result, the change in cash position links the beginning and ending cash on hand reported in the balance sheet.

The SAUF statement derived from the checkbook contains all the data required to construct a statement of cash flow (SCF) for the firm. While cash flow can occur in any order in real life, we have arranged them in the SAUF statement by categories: cash flow associated with operations, cash flow associated with investment, and cash flow associated with financing.

*Net cash flow from operations.* The first entry in HQN's checkbook is cash receipts of $38,990. This represents a source of cash, and is therefore entered in the "credit" or "deposit" column of the checkbook. The next items that appear in the checkbook are cash COGS of $27,000, cash OE of $11,078, interest paid of $480, and taxes paid equal to $68. We find net operating cash flow by subtracting from cash receipts, cash expenditures or COGS, cash OE, interest and taxes.

| | | |
|---|---|---|
| + | Cash receipts | $38,990 |
| − | Cash COGS | $27,000 |
| − | Cash OE | $11,078 |
| − | Interest paid | $480 |
| − | Taxes paid | $68 |
| = | *Net Cash Flow from Operations* | $364 |

*Net cash flow from investments.* Net cash flow from investment activity is calculated from checkbook entries equal to $70 which corresponds to net cash flow from investment. It is calculated as the differ-

ence between purchases of long-term assets ($100) less sales of long investments assets equal to $30. These calculations for HQN in 2018 are recorded below.

| | | |
|---|---|---|
| + | Realized capital gains + depreciation recapture | $0 |
| + | Sales of non-depreciable assets | $0 |
| – | Purchases of non-depreciable assets | $0 |
| + | Sales of long-term assets | $100 |
| – | Purchases of long-term assets | $30 |
| = | *Net Cash Flow from Investments* | ($70) |

It is important to recognize that some purchases may be paid for with borrowed funds. In this case the borrowed funds would be entered in the SAUF as a source of funds while the purchase reflects own plus borrowed funds expended to acquire the long-term asset.

*Net cash flow from financing.* Cash flow from financing activities recorded in the checkbook reflect the difference between borrowing and repayment of long-term debt and payments of notes payable. Interest paid on long-term debt and notes payable is included in net cash flow from operations. Finally, dividends paid and owner draw are subtracted and the difference between new equity contributed and purchased is reflected in the net cash flow from financing. HQN's 2018 net cash flow from financing are recorded below.

| | | |
|---|---|---|
| – | Long-term debt payments | $157 |
| + | Long-term borrowings | $50 |
| – | Payments on notes payable | $230 |
| – | Owner draw | $287 |
| = | *Net Cash Flow from Financing* | ($624) |

An alternative to calculating net cash flow from financing is to use the difference between the ending and beginning balance sheet to the find the change in long-term debt and current long-term debt plus the change in notes payable. Finally, we subtract payment of dividends and owner draw. Net cash flow calculated using the balance sheet rather than the checkbook is reported next.

| | | |
|---|---|---|
| + | Change in non-current LTD | ($57) |
| + | Change in current portion of LTD | ($50) |
| + | Change in notes payable (borrowing less payments) | ($230) |
| – | Payment of dividends and owner draw | $287 |
| = | *Net Cash Flow from Financing* | ($624) |

We demonstrate that cash flow associated with borrowing LTD, repaying current and noncurrent portions of LTD, and converting noncurrent LTD to current LTD are properly accounted for by adding changes in current and noncurrent LTD. To this end, consider the following. We assume transac-

tions occur at the end of each period. Current and noncurrent LTD at the end of the previous period are designated $LTD_0^C$ and $LTD_0^N$ respectively. Current and noncurrent LTD at the end of the current period are designated $LTD_1^C$ and $LTD_1^N$ respectively. Assume that at the end of the current period: (1) the firm reduces its outstanding LTD by paying amounts $LTD^{PayN}$ and $LTD^{PayC}$ on noncurrent and current LTD balances respectively ; (2) it increases its LTD by borrowing amount $LTD^{Borrow}$; and (3) some noncurrent $\text{LTD}^{\text{N}}$ becomes current $\text{LTD}^{\text{C}}$—an amount equal to $LTD^{Converted}$. We can now write the identity:

$$LTD_1^C = LTD_0^C + LTD^{Converted} - LTD^{PayC}. \tag{5.1}$$

In words, current LTD at the end of the period equals current LTD at the beginning of the period plus noncurrent LTD converted to current LTD less current LTD payments made at the end of the period. Then we find the difference between current LTD at the end of the previous and current periods as:

$$\Delta LTD^C = LTD_1^C - LTD_0^C = LTD^{Converted} - LTD^{PayC}. \tag{5.2}$$

Similarly, we write the identity

$$LTD_1^N = LTD_0^N + LTD^{Borrow} - LTD^{Converted} - LTD^{PayN}. \tag{5.3}$$

In words, noncurrent LTD at the end of period one is equal to noncurrent LTD at the beginning of the period plus additional LTD borrowings, less noncurrent LTD converted to current LTD minus noncurrent LTD payments. Then we find the difference between noncurrent LTD at the end of the previous and current periods as:

(5.4)
$$\Delta LTD^N = LTD_1^N - LTD_0^N = LTD^{Borrow} - LTD^{Converted} - LTD^{PayN}$$

Finally we add $\Delta LTD^C + \Delta LTD^N$ to find:

$$\Delta LTD^C + \Delta LTD^N = LTD^{Borrow} - LTD^{PayC} - LTD^{PayN} \tag{5.5}$$

Since $LTD^{Converted}$ cancels when the two equation are added together, we prove that including the difference in current and noncurrent LTD in the financing cash flow section of the statement of cash flow properly accounts for borrowing and payment of LTD and transferring funds from noncurrent to current LTD.

We are now prepared to calculate the change in the net cash position of the firm by combining HQN's cash flow from operations, investing, and financing.

**Table 5.4a. HQN's 2018 Statement of Cash Flow**

| | | |
|---|---|---|
| + | Cash receipts | $38,990 |
| – | Cash COGS | $27,000 |
| – | Cash OE | $11,078 |
| – | Interest paid | $480 |
| – | Taxes paid | $68 |
| = | **Net Cash Flow from Operations** | **$364** |
| + | Realized capital gains / depreciation recapture | $0 |
| – | Purchases of long-term assets | $100 |
| + | Sales of long-term assets | $30 |
| = | **Net Cash Flow from Investments** | **($70)** |
| + | Long-term borrowing | $50 |
| – | Long-term debt payments | $157 |
| – | Note payments | $230 |
| – | Dividends and owner's draw | $287 |
| = | **Net Cash Flow from Financing** | **($624)** |
| | **Change in Cash Position of the Firm** | **($330)** |

An alternative statement of cash flow calculates Net Cash Flows from financing, logically equivalent to Table 5.4a, using changes in Current and Non-current LTD and Changes in notes payable, including as before dividends and owner's draw. The alternative to Table 5.4a, especially useful when data on borrowings and payment data is not available, is reported below:

**Table 5.4b. HQN's 2018 Statement of Cash Flow**

| | | |
|---|---|---|
| + | Cash receipts | $38,990 |
| – | Cash COGS | $27,000 |
| – | Cash OE | $11,078 |
| – | Interest paid | $480 |
| – | Taxes paid | $68 |
| = | **Net Cash Flow from Operations** | **$364** |
| + | Realized capital gains / depreciation recapture | $0 |
| – | Change in non-depreciable long-term assets | $0 |
| – | Change in depreciable long-term assets + depreciation | $70 |
| = | **Net Cash Flow from Investments** | **($70)** |
| + | Change in noncurrent LTD | ($57) |
| + | Change in current portion of LTD | ($50) |
| + | Change in notes payable | ($230) |
| – | Payment of dividends and owner's draw | $287 |
| = | **Net Cash Flow from Financing** | **($624)** |
| | **Change in Cash Position of the Firm** | **($330)** |

Since the ending cash position of the firm in the previous period was $930, a change in the cash position associated with the firm's cash flow implies that the ending cash position of the firm is: $930 – $330 = $600. This amount, $600, corresponds to the cash balance appearing at the end of the current period's balance sheet. Indeed, a check on the consistency of the calculation that uses a checkbook to construct a statement of cash flow is that the change in cash position reconciles the cash balances appearing in the end of period balance sheets. Furthermore, the beginning and ending cash balances in the checkbook must equal the ending cash balances in the end of period balance sheets. In this case, the beginning and ending cash balances in the checkbook are $930 and $600, respectively, which matches the ending cash balances in the previous and current end of period balance sheets.

So, what have we learned? We learned that it is essential to understand that the individual financial statements included in CFS are interdependent and all are important for describing the financial condition of the firm. Their interdependence can be verified with the following consistency checks. The fundamental accounting identity requires that total assets equal liabilities plus net worth. The change in cash position calculated in the SCF equals the difference in cash and marketable securities in the beginning and ending period balance sheets. And finally, the change in retained earnings calculated in the AIS must equal the change in retained earnings in the ending and beginning period balance sheets.

# Cash Income Statements

Unlike the balance sheet—which is a picture of the firm's assets, liabilities, and net worth at a point in time—the firm's income statement is a record of the firm's income and expenses incurred between two points in time. Profits (losses) reported in the firm's income statement are reflected in the firm's balance sheet as an increase (decrease) in the firm's equity. Therefore, the firm's income statement provides the details that explain changes in the firm's equity. To complicate matters, there are two distinct income statements, cash and accrual. We first discuss the firm's cash income statement.

Cash income statements record the firm's income and expenses when they generate a cash flow. One of the most important uses of a cash income statement is to determine the firm's tax obligations. The cash income statement is also an important tool for determining the liquidity of the firm—to determine if its cash receipts are sufficient to meet its cash expenses.

*HQN's 2018 Cash income statement.* Using data from the firm's checkbook or its SAUF statement plus the ending balance sheets, we are prepared to complete a cash income statement. Sometimes the cash income statement is referred to as a modified cash income statement because it includes depreciation which is not a cash flow event but which is an expense allowed when computing taxable income. The 2018 HQN cash income statement constructed using data from HQN's checkbook plus book value asset data from ending balance sheets used to calculate depreciation is reported below:

**Table 5.5. HQN's 2018 Cash Income Statement (all number in $000s)**

| | | |
|---|---|---|
| | Cash receipts | $38,990 |
| + | Realized Cap. Gains and Depreciation Recapture | 0 |
| – | Cash COGS | $27,000 |
| – | Cash Overhead Expenses | $11,078 |
| – | Depreciation | $350 |
| = | **Cash Earnings Before Interest and Taxes (CEBIT)** | **$562** |
| – | Interest paid | $480 |
| = | **Cash Earnings Before Taxes (CEBT)** | **$82** |
| – | Taxes paid | $68 |
| = | **Cash Net Earnings After Taxes (CNIAT)** | **$14** |
| – | Dividends and Owner Draws | $287 |
| = | **Cash Additions to Retained Earnings** | **($273)** |

Notice that all of the entries in the cash income statement are entries in the firm's checkbook and SAUF statement except for realized capital gains and depreciation recapture and depreciation. Depreciation is listed as an expense even though it may not reflect a cash flow event because it represents a loss in value to the firm of assets previously purchased. To find the depreciation for HQN we begin with a fundamental relationship that applies to all depreciable long-term assets (DLTA):

*Beginning DLTA + purchases of DLTA – sales of DLTA (book value) – depreciation = Ending (book value) DLTA*

Notice that the sale of DLTA is listed at their book value. This is necessary to maintain the value of DLTA at their book value in the balance sheets. Solving for depreciation in the identity above and substituting data from the checkbook and balance sheets we find:

*Depreciation = Beginning DLTA + purchases of DLTA – sales of DLTA (book value) – Ending DLTA*

*Depreciation* = $2990 + $100 – $30 – $2710 = $350.

Finally, depreciation recapture is treated a separate category of cash receipts to the firm because it represents a value that was previously deducted as an expense included in depreciation and is now received as an unexpected income (or loss). Depreciation recapture plus capital gains is equal to the market value of DLTA sold less the book value of DLTA sold provided the sale price is not greater than the original purchase price.

*Realized capital gains (losses) + depreciation recapture = Sale of DLTA (market value) – sale of DLTA (book value)*

= $30 – $0 = $30.

In this example, we assume that DLTA were sold at their book value so realized capital gains plus depreciation recapture are zero.

## Accrual Income Statement (AIS)

HQN's 2018 accrual income statement (AIS) is reported in Table 5.6. Because the accrued income statement is the more common of the two income statements, we sometimes drop the word accrual and refer to it as the firm's income statement. We create HQN's income statement by adding to cash transactions non cash exchanges affecting the financial condition of the firm.

**Table 5.6. HQN's 2018 Accrual Income Statement (all numbers in $000s)**

| | | |
|---|---|---|
| + | Cash receipts | $38,990 |
| + | Δ Accounts Receivable | ($440) |
| + | Δ Inventories | $1450 |
| + | Realized Capital Gains / Depreciation Recapture | $0 |
| = | **Total Revenue** | **$40,000** |
| + | Cash COGS | $27,000 |
| + | Δ Accounts Payable | $1,000 |
| + | Cash OE | $11,078 |
| + | Δ Accrued Liabilities | ($78) |
| + | Depreciation | $350 |
| = | **Total Expenses** | **$39,350** |
| | **Earnings Before Interest and Taxes (EBIT)** | **$650** |
| – | Interest | $480 |
| = | **Earnings Before Taxes (EBT)** | **$170** |
| – | Taxes | $68 |
| = | **Net Income After Taxes (NIAT)** | **$102** |
| – | Dividends and owner draws | $287 |
| = | **Additions To Retained Earnings** | **($185)** |

An important check on the consistency of HQN's balance sheets and its AIS is that additions to retained earning of ($185) should equal the difference between beginning and ending retained earning in the balance sheet.

We now explain in more detail the calculation of the individual entries in the AIS. In addition, by rearranging the numbers used to find AIS entries, we can find cash income statement entries.

*Finding accrued income.* Our first checkbook entry records cash receipts of $38,990. So, what is the difference between cash receipts and accrued income? Accrued income includes cash receipts from the sale of products, insurance, and government payments plus credit sales—creating accounts receivable. In addition, accrued income includes inventory increases—production essentially sold into inventory. Both increases in accounts receivable and inventory increase accrued income. While cash receipts are recorded in the checkbook, changes in accounts receivable (Δ Accounts Receivable) and changes in inventories (Δ Inventories) are found as the differences between accounts receivable and inventory entries in the two ending period balance sheets. Since we can find changes in accounts receivable and changes in inventories, we can now calculate accrued income equals the following:

*Accrued Income = Cash Receipts + Δ Accounts Receivables + Δ Inventories*

$40,000 = $38990 + ($440) + $1450

Notice that cash receipts understate actual income in this example.

*Total revenue.* Adding cash receipts, realized capital gains / depreciation recapture, changes in inventory, and changes in accounts receivable provides a measure of the firm's total accrued income.

*Finding accrued COGS.* The checkbook records cash COGS of $27,000. But accrued COGS must add to cash COGS the COGS that the firm purchased on credit which increased the firm's accounts payable. The amount of goods the firm purchased on credit can be calculated as the difference between accounts payable at the beginning and at the end of the year recorded in the firm's balance sheets. For HQN, changes in accounts payable (Δ Accounts Payable) equal $1,000, allowing us to find accrued COGS as:

*Accrued COGS = Cash COGS + Δ Accounts Payable*

$28,000 = $27,000 + $1000

Note that cash COGS understate actual COGS.

*Finding accrued OE.* The checkbook records cash OE of $11,078. But accrued OE must add to cash OE the overhead expenses that were purchased on credit increasing the firm's accrued liabilities. In general, changes in accrued liabilities (Δ Accrued Liabilities) equal the difference between accrued and cash overhead expenses, and can be found as the difference between accrued liabilities recorded in the ending period balance sheets. The difference between ending period accrued liabilities equals ($78), meaning that the firm actually paid off some accrued liabilities incurred in earlier periods in addition to paying for overhead expenses incurred during the current period. We express accrued overhead expenses as:

*Accrued OE = Cash OE + Δ Accrued Liabilities*

$11,000 = $11,078 + ($78)

Note that cash OE overstate actual overhead expenses.

*Calculating depreciation in the accrual income statement.* We previously calculated depreciation in the cash income statement and found it to equal to $350. The calculation of depreciation is the same in both the accrual and cash income statement.

*Earnings Before Interest and Taxes (EBIT).* After subtracting from the firm's total revenue, its cash COGS, change in accounts payable, cash OE, changes in accrued liabilities and depreciation, we obtain a measure of the firm's profits (total revenue minus total expenses). But the profit measure obtained is before subtracting interest costs and taxes. Therefore, we call this profit measure Earnings Before Interest and Taxes are paid (EBIT).

*Earnings Before Taxes (EBT).* Subtracting interest expenses from EBIT gives the firm's earnings before taxes (EBT), which are the firm's profits after paying all expenses except taxes.

*Net Income After Taxes* (NIAT). Subtracting the firm's tax liabilities from EBT gives the firm's net income after taxes (NIAT), generally referred to as the firm's profits. NIAT is also what is available to be reinvested in the firm or withdrawn by the owners.

*Interest costs, taxes, and withdrawals.* The checkbook records interest costs of $480, taxes equal to $68, and withdrawals of $287. These are paid in cash and can be entered directly in the AIS.

*Dividends and owner draw.* Dividends and owner draw represent payments make to owners of the firms from the firm's profits. In the case of dividends, these reflect payments made to compensate owners of the firm for their investments in the firm. In the case of owner draw, these may include payments to owners for services rendered or to meet the financial needs of the firm's owners.

*Finding Cash Receipts, Cash COGS, and Cash OE from the accrual statement.* Usually, firms have access to cash receipts, cash COGS, and cash OE from which it can find accrued income, accrued COGS, and accrued OE. This was our approach in the previous section. However, we could reverse the calculations beginning with accrued income, accrued COGS, and accrued OE and then solve for cash receipts, cash COGS, and cash OE. These calculations are described next and are essential in order to complete the firm's statement of Cash Flow when we begin with accrual data rather than cash flow data.

Suppose that we knew that accrued income were equal to $40,000. We could find cash receipts by subtracting from accrued income, change in accounts receivable and change in inventory:

$38,990 = $40,000 – ($440) – $1450

*Finding cash COGS.* Suppose that we knew that accrued COGS were equal to $28,000. We could find cash COGS by subtracting accrued COGS change in Accounts Payable:

$27,000 = $28,000 – $1,000

*Finding accrued OE.* Suppose that we knew that accrued OE were equal to $11,078. We could find cash OE by subtracting from accrued OE, change in accrued liabilities.

$11,078 = $11,000 – ($78)

## More Complicated Financial Statements

Compared to HQN's balance sheets, income statements, and SCF described in this chapter, balance sheets, income statements, and SCF for an actual firm are often much more complicated. In what follows, we highlight the main differences between HQN's financial statements and financial statements of actual firms.

*Level of detail.* One of the main differences between HQN's financial statements and financial statements of actual firms is the level of detail. For example, the income statement may separate total sales into sales of livestock and livestock products, crops sales, and sales of services. Expenses may be

separated into seed, fertilizer, other crop supplies, machinery hire, feed purchased, feeder livestock purchased, veterinary services, livestock supplies, fuel and oil, utilities, machinery repairs, insurance, rents, hired labor to name a few. Additional inventory details may include livestock and crops held for sale and feed, value of growing crops, farm supplies, and prepaid expenses.

*Data deficiencies.* Another difference between HQN's financial statements and financial statements of actual firms is the quality of the data. HQN's data are assumed to be accurate and consistent. Data supplied by actual firms is sometimes neither accurate nor consistent. Other data deficiencies of actual firms may include the following. 1) The data are rarely complete, especially for large complex firms with several activities. 2) Data from the firm's activities may be reported by different persons using different metrics. 3) Some of the same data are provided from different sources and are not equal. 4) Personal data may be confounded with firm data.

*Exogenous and endogenous variables.* There are two types of variables in CFS: exogenous versus endogenous. The value of exogenous variables are determined outside of the CFS . It can be observed and supplied by sources other than the firm. Endogenous variables are calculated using exogenous variables so that any change in exogenous variables produces changes in endogenous variables. For example, the cash flow variable is an exogenous variable because it can be observed and recorded. Other data, such as firm's equity or additions to retained earnings are computed using exogenous and sometimes other endogenous variables. The problem occurs where the value in the CFS can be observed and calculated. For example, end of period cash is calculated from beginning period cash plus change in cash position. But end of period cash may be observed by referring to the firm's checkbook. If the exogenous variable is accurate, then the observed and calculated numbers will be equal and consistent. But in some cases they are not equal and the firm will be required to take steps designed to reconcile the differences.

*Consistency versus accuracy.* Two words describe financial statements: "consistency" and "accuracy". Consistency means that we compute values for variables in the CFS in the same way every time so that changes in primary data produce predictable changes in calculated data. Accuracy means that our measurement conforms to the correct value of what is being measured. The financial statements are consistent if the following are true: "additions to retained earnings" reported in the accrued income statement reconciles retained earnings in the ending period balance sheets. The reconciling equation is: beginning retained earnings plus additions to retained earnings equals retained earnings in the ending period balance sheet. A second consistency requirement is that the change in cash position reported in the statement of cash flow reconciles cash balances in the ending period balance sheets. The reconciling equation is: beginning cash plus change in cash position equal ending cash. Finally, the third consistency condition is that the fundamental accounting identity is true; namely, that assets equal liabilities plus equity.

The financial statements may be consistent, but not all the data may be accurately recorded. On the other hand, if the financial statements are not consistent, we can be sure they are not accurate. We summarize our description of financial statements by declaring that consistency is a necessary condition for an accurate set of financial statements but consistency is not sufficient for an accurate set of financial statements.

*Hard and soft data.* Faced with the data challenges described above, financial managers are charged with the task of preparing the most accurate and consistent set of CFS possible. Guidelines for this task include determining which data is "soft" and which data is "hard." Soft data is estimated or may lack a supporting data trail. Still, it represents the best guesstimates available. Hard data has a reference or an anchor. For example, the sale of a product is usually recorded although there may be some benefits or costs associated with the sale that are not recorded. Interest costs and taxes are recorded and can be considered hard data. Inventories are more difficult to determine if they are hard or soft because they change over a reporting cycle and their estimated value at the beginning and ending balance sheets may not be available. So, an important task of the financial manager is to assess the reliability of the different data.

## Over-identified Variables

An over-identified variable is one whose endogenously calculated value can be observed and recorded as an exogenous variable. For example, consider ending cash balances recorded in the ending period balance sheet. Calculated as an endogenous variable, ending cash balances equal beginning cash balances recorded in the beginning period balance sheet plus changes in cash position calculated in the statement of cash flow. In addition, the financial manager may observe the ending cash balance recorded in the firm's checkbook. In some cases, however, the financial managers can observe data reflecting the value of endogenous variables. For example, financial managers may observe ending cash balances and have calculated them as an endogenous value using consistency conditions of coordinated financial statements. In this case, values for the variable ending cash balances are over identified. When entries in the CFS can be both observed as an exogenous variable and calculated as an endogenous variable, the CFS variables are over identified.

Ideally, the observed exogenous variable value equals the endogenous variable value. In such fortunate cases, the datum is most likely accurate and consistent with other variable values. When the values for the over-identified variables are not equal, the financial manager can be assured that either the endogenous or the exogenous variable values or both are inaccurate. If the observed value is from hard data, then the financial manager must revisit the values of other exogenous data that were used to calculate the endogenous variable value. Therefore, over-identified variables provide a useful means for evaluating the accuracy of one's financial statements and exogenous data values used to find the values of endogenous variables.

## Constructing Consistent Coordinated Financial Statements (CFS): A Case Study

We now construct a consistent set of financial statements for an actual firm using the data they supplied. In the process, we will experience some of the data deficiencies described earlier and the challenge of having our CFS be both accurate and consistent. We will call our case study firm, Friendly Fruit Farm (FFF) because producing and selling fruit is the firm's main commercial activity.

To assure that our financial statements are consistent, we will use the template prepared for analyzing HQN and described in more detail in the appendix to the chapter System Analysis. The categories in the HQN template are aggregated compared to actual firms. To fit the data supplied by FFF to the HQN template will require side-bar calculations that organize the data to correspond with the general categories described in Tables 5.1, 5.4, 5.5, and 5.6. The general rule for deciding when side-bar calculations are required is the following: if for any given entry of the CFS there are two or more instances of that item supplied by FFF, a side bar calculation is required. Therefore, the number of side-bar calculations will depend on the firm being examined and the data which the firm supplies.

*FFF balance sheets.* FFF supplied the following balance sheet data.

**Table 5.7. FFF supplied Ending Period Balance Sheets**

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Cash and checking balance | ($7,596) | ($24,333) |
| Prepaid expenses & supplies | $7,467 | $15,369 |
| Growing crops | $0 | $0 |
| Accounts receivable | $33,400 | $45,668 |
| Hedging accounts | $0 | $0 |
| Crops held for sale or feed | $178,098 | $204,530 |
| Crops under government loan | $0 | $0 |
| Market livestock held for sale | $7,933 | $6,500 |
| Other current assets | $278 | $278 |
| **Total current farm assets** | **$219,581** | **$248,011** |
| Breeding livestock | $10,583 | $18,019 |
| Machinery and equipment | $85,001 | $87,387 |
| Titled vehicles | $2,889 | $2,667 |
| Other intermediate asses | $9,689 | $8,893 |
| **Total intermediate farm assets** | **$108,162** | **$116,966** |
| Farm Land | $166,200 | $179,348 |
| Buildings and improvements | $76,852 | $81,021 |
| Other long-term assets | $6,229 | $6,229 |
| **Total long-term assets** | **$249,281** | **$266,599** |
| **Total Farm Assets** | **$577,023** | **$631,576** |
| Accrued interest | $1,078 | $1,487 |
| Accounts payable | $2,080 | $1,637 |
| Current notes | $67,935 | $74,644 |
| Government crop loans | $0 | $0 |
| Principal due on term debt | $28,511 | $30,072 |
| **Total current farm liabilities** | **$99,604** | **$107,840** |
| **Total intermediate farm liabilities** | **$43,793** | **$31,782** |
| **Total long-term farm liabilities** | **$118,617** | **$124,420** |
| **Total Farm Liabilities** | **$262,015** | **$264,042** |

Having collected financial data for FFF's balance sheets we proceed to organize it into categories described by the balance sheets prepared for HQN. The main reason for doing so is to insure consistency. The second reason for doing so is to organize it into categories amenable to ratio analysis important for financial analysis and management. The balance sheet categories used by HQN which we want to duplicate for FFF are described in Table 5.1 .

*Cash and marketable securities.* We begin by noting that ending period cash balances cannot be negative. Otherwise they are liabilities. But in the balance sheets provided by FFF, they report negative cash balances in both end of period balance sheets. We set them to zero and include them as liabilities included in accounts payable. Our first line in FFF's ending period balance sheets is:

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Cash and marketable securities | $0 | $0 |

*Accounts receivable.* FFF lists accounts receivables. They also lists prepaid expenses and hedging accounts that have properties similar to accounts receivable. All three measures represent short-term sacrifices by the firm for benefits they have not yet received. Usually, accounts receivables reflect firm sales for which it has not yet been compensated in cash. In the case of prepaid expenses, it represents payments for goods they have not yet received. In the case of a hedging account, they represent funds paid for options not yet exercised. Adding to accounts receivable, prepaid expenses and hedging funds produces a more inclusive measure of accounts receivable equal to:

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Accounts receivable | $33,400 | $45,668 |
| Prepaid expenses and supplies | $7,467 | $15,369 |
| Hedging accounts | $0 | $0 |
| Accounts receivable | $40,867 | $61,037 |

*Inventories.* FFF lists several inventories in its ending period balance sheets. We list and sum these below.

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Growing crops | $0 | $0 |
| Crops for sale or feed | $178,098 | $204,530 |
| Crops under government loan | $0 | $0 |
| Market livestock for sale | $7,933 | $6,500 |
| Other current assets | $278 | $278 |
| Inventories | $186,309 | $211,308 |

We now find the sum of FFF's current assets by adding cash and marketable securities, accounts receivable, and inventories and report the results below.

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Cash and marketable securities | $0 | $0 |
| Total accounts receivable | $40,867 | $61,037 |
| Total inventories | $186,298 | $211,308 |
| Current assets | $227,165 | $272,345 |

We now find FFF's depreciable long-term assets. Note that FFF listed intermediate and long-term assets. In the HQN template, we distinguish long-term as either depreciable or non-depreciable. We consider property, plant, and equipment as depreciable long-term assets and land and buildings as non-depreciable long-term assets. Note that in the FFF supplied balance sheets, they list non-farm assets, which we ignore since our analysis is focused on the farm firm. We now list FFF's depreciable and non-depreciable long-term assets and find their sum.

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Breeding livestock | $10,583 | $18,019 |
| Machinery and equip. | $85,001 | $87,387 |
| Titled vehicles | $2,889 | $2,667 |
| Other intermediate assets | $9,689 | $8,893 |
| **Depreciable long-term assets** | **$108,162** | **$116,966** |
| Land | $166,200 | $179,348 |
| Buildings and improvements | $76,852 | $81,021 |
| Other long-term assets | $6,229 | $6,229 |
| **Non-depreciable long-term assets** | **$249,281** | **$266,598** |
| **Total long-term assets** | **$357,443** | **$383,564** |

We find FFF's total assets as the sum of current and long-term assets and report the result below.

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Total current assets | $227,165 | $272,345 |
| Total long-term assets | $357,443 | $383,564 |
| **Total assets** | **$584,608** | **$655,909** |

Notice that the total firm assets calculated above do not match the total firm assets calculated by FFF. This is because the negative cash balances have been shifted to the liabilities section of the balance sheet.

Next we prepare FFF's liabilities data to match HQN's reduced categories template. We begin by listing notes payable. We include in this category current notes payable and government loans.

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Current notes | $67,935 | $74,644 |
| Government crop loans | $0 | $0 |
| Notes payable | $67,935 | $74,644 |

Next we include accrued interest and current portion of the long-term debt and current payments on loans in the category current portion of long-term debt.

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Accrued interest | $1,078 | $1,487 |
| Principal due on long-term debt | $28,511 | $30,072 |
| Current portion of long-term debt | $29,589 | $31,559 |

Next we list FFF's accounts payable including negative balances in cash reported in the asset portion of the balance sheet.

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Accounts payable | $2,080 | $1,637 |
| Negative cash balances | $7,596 | $24,333 |
| Accounts payable | $9,676 | $25,970 |

Combining our current liabilities entries and summing we find the sum of FFF's current liabilities:

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Notes payable | $67,935 | $74,644 |
| Current portion of LTD | $29,589 | $31,559 |
| Accounts payable | $9,676 | $25,970 |
| Accrued liabilities | $43,793 | $31,782 |
| **Total current liabilities** | **$150,993** | **$163,955** |

Now we consider our long-term liabilities described as long-term debt. The first long-term liabilities is noncurrent long-term debt which is listed below.

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Noncurrent long-term debt | $118,617 | $124,420 |

We add current liabilities to noncurrent long-term debt to find FFF's total liabilities.

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Current liabilities | $150,993 | $163,955 |
| Noncurrent long-term debt | $118,617 | $124,420 |
| Total Liabilities | $269,610 | $288,375 |

Finally, we compute FFF's equity as the difference between its total assets and it total liabilities and find it equal to:

| | | 12/31/17 | 12/31/18 |
|---|---|---|---|
| + | TOTAL ASSETS | $584,608 | $655,909 |
| – | TOTAL LIABILITIES | $269,610 | $288,375 |
| = | EQUITY | $314,998 | $367,534 |

**Table 5.8. FFF's 2018 Ending Period Balance Sheets**

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Cash and marketable securities | $0 | $0 |
| Accounts receivable | $40,867 | $61,037 |
| Inventories | $186,298 | $211,308 |
| Total current assets | $227,165 | $272,345 |
| Depreciable long-term assets | $108,162 | $116,966 |
| Non-depreciable long-term assets | $249,281 | $266,598 |
| Total long-term assets | $357,443 | $383,564 |
| **TOTAL ASSETS** | **$584,608** | **$655,909** |
| Notes payable | $67,935 | $74,644 |
| Current portion of LTD | $29,589 | $31,559 |
| Accounts payable | $9,676 | $25,970 |
| Accrued liabilities | $43,793 | $31,782 |
| Total current liabilities | $150,993 | $163,955 |
| Noncurrent long-term debt | $118,617 | $124,420 |
| **TOTAL LIABILITIES** | **$269,610** | **$288,375** |
| **EQUITY** | **$314,998** | **$367,534** |
| **TOTAL LIABILITIES AND EQUITY** | **$584,608** | **$655,909** |

# Populating FFF's Cash Income Statements to Conform to HQN's Income Templates

To enable FFF to populate its income statements, it supplied the following data.

| | | |
|---|---|---|
| + | Apples | $274,069 |
| + | Cherries | $52,123 |
| + | Peaches | $23,046 |
| + | Grapes | $1,467 |
| + | Pears | $638 |
| + | Plums | $508 |
| + | Raspberries | $2,580 |
| + | Blueberries | $900 |
| = | **Total cash fruit sales** | **$355,331** |
| + | Asparagus | $7,872 |
| + | Cordwood | $31 |
| + | Pumpkins | $360 |
| + | Rhubarb | $179 |
| + | Squash | $246 |
| + | Sweet corn | $1,666 |
| + | Tomatoes | $429 |
| + | Other crops | $7,560 |
| = | **Total cash crops and vegetable sales** | **$18,343** |

Finally we sum the cash receipts categories:

| | | |
|---|---|---|
| + | Total cash fruit sales | $355,331 |
| + | Total cash crops and vegetable sales | $18,343 |
| + | Total cash receipts of finish beef calves | $1,898 |
| + | Government payments | $5,376 |
| + | Dividend and Insurance Payments | $1,651 |
| + | Other farm income | $7,144 |
| = | Cash farm income | $389,743 |
| + | Seed | $2,039 |
| + | Fertilizer | $4,652 |
| + | Chemicals | $55,640 |
| + | Crop insurance | $4,523 |
| + | Packaging and supplies | $7,266 |
| + | Marketing | $137 |
| + | Crop miscellaneous | $31,940 |
| + | Feed | $128 |
| + | Livestock supplies | $794 |
| = | **Total Cash COGS** | **$107,119** |
| + | Supplies | $638 |
| + | Fuel | $13,458 |
| + | Repairs | $19,882 |
| + | Custom hire | $3,317 |
| + | Hired labor | $99,671 |
| + | Land rent | $29,777 |
| + | Machinery lease | $2,827 |
| + | Insurance | $8,593 |
| + | Utilities | $7,177 |
| + | Hauling | $86 |
| + | Dues | $4,288 |
| + | Miscellaneous | $7,092 |
| = | **Total Cash OE** | **$196,806** |

FFF also reported that in 2018 it paid $12,712 in interest charges, $4,628 in taxes, and that the owners withdrew $44,402. FFF also reported the purchase and sale of assets as $57,048 and $1,185 respectively. We assume that the sale of assets was at their book value.

We now populate FFF's AIS, using cash receipts and expense data supplied by FFF and changes in FFF's completed balance sheet entries.

**Table 5.9. FFF's 2018 Accrual Income Statement (all numbers in $000s)**

| | | |
|---|---|---|
| + | Cash receipts | $389,743 |
| + | Change in Accounts Receivable | $20,170 |
| + | Change in Inventories | $25,010 |
| + | Realized Capital Gains / Depreciation Recapture | $0 |
| = | **Total Revenue** | **$434,923** |
| + | Cash Cost of Goods Sold (COGS) | $107,119 |
| + | Change in Accounts Payable | $16,294 |
| + | Cash Overhead Expenses (OE) | $196,806 |
| + | Change in Accrued Liabilities | ($12,011) |
| + | Depreciation | $47,059 |
| = | **Total Expenses** | **$355,267** |
| | **Earnings Before Interest and Taxes (EBIT)** | **$79,656** |
| – | Interest | $12,712 |
| | **Earnings Before Taxes (EBT)** | **$66,944** |
| – | Taxes | $4,628 |
| | **Net Income After Taxes (NIAT)** | **$62,316** |
| – | Dividends and owner draws | $44,402 |
| | **Additions To Retained Earnings** | **$17,914** |

Detailed explanations of the AIS entries follow.

- FFF reported total cash receipts equal to $389,743.
- Change in accounts receivables was calculated by finding the difference between accounts receivable in FFF's ending period balance sheets equal to ($61,037 – $40,867) = $ 20,170.
- Change in inventory was calculated by finding the difference between inventories in FFF's ending period balance sheets equal to ($211,308 – $186,298) = $25,010.
- FFF reported Cash COGS equal to $107,119.
- Change in Accounts Payable was calculated by finding the difference between accounts payable reported in FFF's ending period balance sheets equal to $25,970 – $9,676 = $16,294.
- FFF reported Cash OE equal $196,806.
- Change in accrued liabilities was calculated by finding the difference between accrued liabilities in FFF's ending period balance sheets equal to ($31,782 – $43,793) = ($12,011).

The next expense category required by FFF's AIS is depreciation. The data for calculating the change in long-term assets was available in FFF's balance sheets. FFF also reported its sale and purchases of long-term assets as $57,048 and $1,185 respectively. The formula for depreciation is:

*Purchases of depreciable LTAs – sales of depreciable LTAs (book value) – Δ depreciable LTAs (book) = depreciation.*

Making the necessary substitutions, we find FFF's 2018 depreciation:

$57,048 – $1,185 – ($116,966 – $108,162) = $47,059.

- Summing cash and noncash receipts we find total revenue.
- Summing cash and noncash expenses we find total expenses.
- Subtracting total expenses from total revenue, we find earnings before interest and taxes (EBIT) equal to $79,656.
- FFF reported interest costs equal to $12,712 which were subtracted from EBIT to obtain Earning Before Taxes (EBT) equal to $66,944.
- FFF reported taxes equal to $4,628 which were subtracted from EBT to obtain Net Income after paying interest and taxes (NIAT) of $62,316.
- FFF reported paying dividends and owner withdrawals of $44,402 which were subtracted from NIAT to find changes in retained earnings of $17,914.

*Cash income statement.* Using the cash receipts and expense data supplied by FFF, we can easily find its cash income statement

**Table 5.10. FFF's 2018 Cash Income Statement**

| | | |
|---|---|---|
| | Cash receipts | 389,743 |
| + | Realized Capital Gains | $0 |
| – | Cash COGS | $107,119 |
| – | Cash overhead expenses | $196,806 |
| – | Depreciation | $47,059 |
| = | **Cash Earnings Before Interest and Taxes (CEBIT)** | **$38,759** |
| – | Interest paid | $12,712 |
| = | **Cash Earnings before Taxes (CEBT)** | **$26,047** |
| – | Taxes paid | $4,628 |
| = | **Cash Net Earnings After Taxes (CNIAT)** | **$21,419** |
| – | Dividends and owner draws | $44,402 |
| = | **Cash Additions to Retained Earnings** | **($22,983)** |

*Statement of Cash Flow.* We now have all of the data required to find FFF's statement of cash flow. We begin by finding FFF's net cash flow from operations.

| | | |
|---|---|---|
| + | Cash receipts | $389,743 |
| – | Cash COGS | $107,119 |
| – | Cash OE | $196,806 |
| – | Interest paid | $12,712 |
| – | Taxes paid | $4,628 |
| = | **Net Cash Flow from Operations:** | **$68,478** |

Net cash flow from investment activity is calculated from data used to find depreciation and equals

| | | |
|---|---|---|
| + | Sale of long-term assets | $1,185 |
| – | Purchases of long-term assets | $57,048 |
| = | **Net Cash Flow from Investments** | **($55,863)** |

Net cash flow from financing activities reflects the difference between borrowing of long-term debt and notes payable and principal and interest payments on long-term debt and notes payable. Finally, dividends paid are subtracted and the difference between new equity contributed and purchased is computed.

| | | |
|---|---|---|
| | Change in non-current LTD (borrowing less payments) | $5,803 |
| + | Change in current portion of LTD | $1,970 |
| + | Change in notes payable (borrowing less payments) | $6,709 |
| – | Payment of dividends and owner withdrawal | $44,402 |
| = | **Net Cash Flow from Financing** | **($29,920)** |

**Table 5.11. Statement of Cash Flow**

| | | |
|---|---|---|
| + | Cash receipts | $389,743 |
| – | Cash COGS | $107,119 |
| – | Cash OE | $196,806 |
| – | Interest paid | $12,712 |
| – | Taxes paid | $4,628 |
| = | **Net Cash Flow from Operations** | **$68,478** |
| + | Realized capital gains + depreciation recapture | $0 |
| – | Purchases of depreciable long-term assets | $57,048 |
| + | Sales of depreciable long-term assets | $1,185 |
| = | **Net Cash Flow from Investments** | **($55,863)** |
| + | Change in  non-current long term debt | $5,803 |
| + | Change in current portion long term debt | $1,970 |
| + | Change in notes payable | $6,709 |
| – | Dividends and owner's draw | $44,402 |
| = | **Net Cash Flow from Financing** | **($29,920)** |
| | **Change in cash position of the firm** | **($17,305)** |

*What to do*? Consider the following example. You are visiting in a new town and are trying to find your way to an important site. Suppose that you stop a person you assume is familiar with the location and ask for directions which the person provides. You thank the person for directions and begin your journey to your destination. But just to make sure you are on the right path, you consult your map and find

that the directions you just received are in conflict with your map. You are faced with a choice. Which set of directions do you choose? They both can't be correct.

We face a similar problem when our completed financial statements aren't consistent. Somewhere in our entries there is an error(s). Therefore to populate our template we have to decide what numbers to believe.

In our case the conflict arises when reported primary data and calculated data required to reconcile the various financial statements are inconsistent. The first requirement is to establish consistency beginning with the calculated entries. Consistency is a necessary condition for accuracy and makes it a logical place to begin. Then we determine if the primary data that conflicts with the calculated number is hard or soft. If it is reasonably hard data, and is higher that the calculated data we explore the data for under estimates of cash inflows and over estimates of cash outflows. We follow the reverse process if the primary data is less than the calculated data. If we can find soft data that can be changed to make the calculated data consistent with the primary data—we make the changes.

> So, what have we learned? We learned from the FFF example that actual firms have more complicated data sets that we illustrated using the HQN example. Yet, the variable categories we used when computing the HQN study apply generally even though some sidebar calculations may be required to reduce actual firm data to the variable categories used to describe HQN.

## Summary and Conclusions

In this chapter we have learned how to construct CFS. Coordinated financial statements are tools that we will use in the next chapter to analyze the firm's strengths and weaknesses. Constructing financial statements for actual firms with less than perfect and complete data is somewhat of an art.

## Questions

1. Define the differences between consistent financial statements and accurate financial statements.
2. Discuss the statement: "consistent financial statements are necessary but not sufficient for accurate financial statements."
3. What are some conditions required for financial statements to be consistent?
4. In a typical data set provided by a farm firm, what data is most reliable (hard) and which data is

least likely to reliable (soft)?

5. Below is a completed 2018 checkbook and 2017 and 2018 ending period balance sheets for the "Grow Green" vegetable farm. Use the numbers in their checkbook and their two balance sheets to create a 2018 cash and AIS and statement of cash flow.

| Grow Green 2018 Checkbook | | | | |
|---|---|---|---|---|
| **Date** | **Item** | **Check amount** | **Deposit amount** | **Checkbook balance** |
| 12/31/17 | Beginning cash balance | | | $930 |
| | Cash receipts | | $40,940 | $41,870 |
| | Seed, feed, fertilizer | $20,000 | | $21,870 |
| | Labor cost of producing products | $8,350 | | $13,520 |
| | Insurance | $2,000 | | $11,520 |
| | Utilities | $9,632 | | $1,888 |
| | Purchase of LTAs | $100 | | $1,788 |
| | Sale of LTAs (at book value) | | $30 | $1,818 |
| | Interest paid | $504 | | $1,314 |
| | Taxes paid | $71 | | $1,243 |
| | Payment on current-term debt | $50 | | $1,193 |
| | Long-term debt payments | $57 | | $1,139 |
| | Payment on notes | $230 | | $906 |
| | Owner draw | $390 | | $516 |
| 12/31/18 | Ending cash balance | | | $516 |

| Grow Green Balance Sheet | | |
|---|---|---|
| | **12/31/17** | **12/31/18** |
| Cash and Marketable Securities | $930.00 | $516.00 |
| Accounts Receivable | $1,640.00 | $1,200.00 |
| Inventory | $3,750.00 | $5,200.00 |
| **Total Current Assets** | **$6,320.00** | **$6,916.00** |
| Depreciable long-term assets | $2,990.00 | $2,800.00 |
| Non-depreciable long-term assets | $690.00 | $600.00 |
| **Total Long-term Assets** | **$3,680.00** | **$3,400.00** |
| **Total Assets** | **$10,000.00** | **$10,316.00** |
| Notes Payable | $1,500.00 | $1,270.00 |
| Current Portion of LTD | $500.00 | $450.00 |
| Accounts Payable | $3,000.00 | $4,000.00 |
| Accrued Liabilities | $958.00 | $880.00 |
| **Total Current Liabilities** | **$5,958.00** | **$6,600.00** |
| **Noncurrent Long-term Debt** | **$2,042.00** | **$1,985.00** |
| **Total Liabilities** | **$8,000.00** | **$8,585.00** |
| Other Capital | $1,900.00 | $1,689.00 |
| Retained Earnings | $100.00 | $42.00 |
| **Equity** | **$2,000.00** | **$1,731.00** |
| **Total Liabilities and Equity** | **$10,000.00** | **$10,316.00** |

6. Compare the differences and the advantages and disadvantages of cash and AIS.
7. In problem 5, you should have found ending cash to equal $630 which is the same as the observed ending cash. Instead assume that the ending cash balance recorded in the balance sheets provided was equal to $650. Describe the possible adjustments you might make to observed variables to make consistent observed ending cash and the calculated ending cash. Provide a revised set of CFS that are consistent with ending cash calculated and observed.
8. Most firm managers who are also the firm's financial manager keep less than the complete data set required to construct a complete set of financial statements. And even the data they collect are not in the format we expect, requiring us to reformat the data we do have. With less than complete data sets, we are forced to do the best we can with what we have. What follows is a typical data set which ABM 435 teams have used in the past to construct a set of consistent and accurate set of financial statements. Using the data provided, construct a consistent and, to the extent possible, accurate set of financial statements.

| Farm A | 12/31/18 |
|---|---|
| Acres owned | 488 |
| Acres rented | 449 |
| Machinery investment / crop acre @ cost | $95 |
| Machinery investment / crop acre @ market | $520 |
| Average price received | |
| Corn | $6 |
| Soybeans | $13 |
| Wheat | $7 |
| Hay | $97 |
| Average yield | |
| Corn | $175 |
| Soys | $54 |
| Wheat | $76 |
| Gross Cash farm income including government payments & patronage dividends | $863,561 |
| Cash Farm Expense including land rent but excluding interest | $637,231 |
| Interest | $23,232 |

Other balance sheet related data include the following:

| | 12/31/17 | 12/31/18 |
|---|---|---|
| Cash and checking | $63,211 | $66,696 |
| Crops and Feed | $470,632 | $430,532 |
| Market livestock | 46,696 | $55,463 |
| Accounts receivable | $34,062 | $44,550 |
| Prepaid expenses and supplies | $104558 | $101,381 |
| Hedging activities | $1916 | $2374 |
| Other current assets | $18,901 | $15,822 |
| Other capital assets | $29,140 | $36,539 |
| Breeding livestock | $29,140 | $40,053 |
| Accounts payable | $26,149 | $29,789 |
| Accrued interest | $7,222 | $7470 |
| Current notes | $111,819 | $127,402 |
| Government crop loans | $1,400 | $1,733 |
| Loan principal due | $59,849 | $68,559 |
| Intermediate liabilities | $130,409 | $124,872 |
| Long-term liabilities | $344,658 | $347,834 |
| Machinery and Equipment (book) | $132,656 | $179,366 |
| Titled vehicles (book) | $3,096 | $3,563 |
| Buildings/improvements (book) | $105,559 | $110,232 |
| Land (book) | $508,571 | $574,410 |

| | |
|---|---|
| Purchases of Breeding Livestock | $901 |
| Sale of Breeding Livestock | $291 |
| Purchases other capital assets | $11,924 |
| Sale of other capital assets | $8,443 |
| Land sales (50% of sale were realized cap. Gains | $21,970 |
| Purchase of titled vehicles | $1,948 |
| Sale of titled vehicles | $636 |
| Investments in buildings/improvements | $21,970 |

# 6. Financial Ratios

**LINDON ROBISON**

*Learning goals.* After completing this chapter, you should be able to: (1) calculate financial ratios using information included in a firm's coordinated financial statements (CFS); and (2) answer the question: "what are the firm's financial strengths and weaknesses?"

*Learning objectives.* To achieve your learning goals, you should complete the following objectives:

- Learn how to distinguish between rates, ratios, and percentages.
- Learn how financial ratios allow us to compare the financial condition of different firms.
- Learn how to construct (S)olvency, (P)rofitability, (E) fficiency, (L)iquidity, and (L)everage ratios—what we refer to collectively as SPELL ratios.
- Learn how SPELL ratios help us describe the financial strengths and weaknesses of a firm.
- Learn how the times interest earned (TIE) ratio and the debt-to-service (DS) ratio can provide information about the firm's solvency.
- Learn how the profit margin (m) ratio, the return on assets (ROA) ratio, and the return on equity (ROE) ratio can provide information about the firm's profitability.
- Learn how to find the after-tax ROE where T is the average tax rate paid by the firm on its earnings before taxes (EBT).
- Learn how to relate ROE and ROA to each other.
- Learn how the inventory turnover (ITO) ratio, the inventory turnover time (ITOT) ratio, the asset turnover (ATO) ratio, the asset turnover time (ATOT) ratio, the receivable turnover (RTO) ratio, the receivable turnover time (RTOT) ratio, the payable turnover (PTO) ratio, and the payable turnover time (PTOT) ratio can provide important efficiency information about the firm.
- Learn how the current ratio (CT) and the quick ratio (QK) can provide information about the firm's liquidity.
- Learn how leverage ratios including the debt-to-equity (DE) ratio and the equity multiplier (EM) ratio can be used to monitor and measure the firm's risk.
- Understand how comparing the firm's SPELL ratios to industry standard ratios can help answer the question: what are the financial strengths and weaknesses of the firm?
- Learn how to construct after-tax ROE and after-tax ROA measures.
- Learn how unpaid family labor affects ROE and ROA measures.
- Learn why the firm may consider profit and solvency ratios key to a firm's survival and success.
- Learn how the DuPont ratio demonstrates the interdependencies of some SPELL ratios.

# Introduction

*Ratios, Percentages, and rates.* Coordinated financial statements (CFS) contain exogenous and endogenous variables. Exogenous variables take on values that can be observed or are determined by activities occurring outside of the firm. Endogenous variables take on values determined by activities within the firm and the values of exogenous variables.

The variables included in CFS become more valuable, especially for analyzing the strengths and weaknesses of the firm, when formed into ratios. We could look at the variables included in the CFS and draw some conclusions about the firm's strengths and weaknesses by comparing them with other firms, but our conclusions would be limited because no two firms are alike. Ratios, however, provide a means for comparing the performance of firms using a standardized measure which is easier to interpret.

A ratio consists of two numbers when one number is divided by the other. Suppose two numbers are represented by the variables X and Y and form a ratio (X/Y). The ratio tells us how many units of X exist for each unit of Y. This standardized number, the number of units of X that exists for each unit of Y, allows us to make comparisons between firms using similarly constructed ratios. We distinguish between two kinds of ratios, percentages and rates.

When ratios are measured in the same units (dollars, inches, pounds, etc.), the units in the ratio cancel and the result is a decimal number which becomes a percent when multiplied by 100. Since all numbers in the CFS are measured in dollars, all ratios of numbers in the CFS are percentages. Therefore, financial ratios tell us what percent Y is of X.

Now consider a ratio that consists of two numbers divided by each other but measured in different units. In this case, the units do not cancel, and the result is a rate. For example, if y is measured in dollars and x is measured in ounces, then y/x tells us the price per ounce.

To illustrate the importance of ratios, consider the purchase of a breakfast cereal. Suppose you go to the grocery store to purchase your favorite breakfast cereal (Super Sweet Sugar Snacks). You find a 10-ounce box of Super Sweet Sugar Snacks that sells for $3.20 and a larger 15-ounce box of the same cereal that sells for $4.50. Which box of cereal is the best buy? The price of each box of cereal won't tell you the answer because the more expensive box also contains more cereal. However, if we divide the price of each box by the amount of cereal in the box we can compare "apples to apples," or in this example we can compare the price per ounce of cereal in each box, two similar rates. Finding the ratio of dollars to ounces in the box, we see that cereal in the small box costs $0.32 per ounce ($3.20/10 oz.) while cereal in the large box costs $0.30 per ounce ($4.50/15 oz.). The large box of cereal costs less for each ounce of cereal and is the better buy.

The cereal example illustrates an important fact: one ratio without another ratio to compare it with is not very helpful. Knowing the price of cereal per ounce of the small box makes the information about the price per ounce of cereal in the large box more meaningful. Similarly, having standardized industry

ratios against which we can compare our ratios is important for a financial manager's efforts to discover the firm's strengths and weaknesses.

> So, what have we learned? We learned that when answering the question what the firm's financial strengths and weaknesses are, it is important that we look at the firm from several different points of view represented by the SPELL ratios.

We discuss next the different views required to adequately describe the firm's financial condition. Each of the different views are represented by a set of ratios. As is customary, it is understood that financial ratios are really percentages or decimal representations of two numbers measured in the same units.

## Financial Ratios

Financial ratios constructed using coordinated financial statement variables can be grouped into five categories. The categories can be remembered using the acronym SPELL. The five categories of financial ratios include: (S)olvency ratios, (P)rofitability ratios, (E)fficiency ratios, (L)iquidity ratios, and (L)everage ratios. Ratios in each of these five categories provide a different view of the firm's financial strengths and weaknesses.

*Ratios and points in time measures.* When constructing financial ratios using data from the CFS, the "point in time" or the "period of time" reflected by the ratio deserves careful attention. Numbers from balance sheets reflect the financial condition of the firm at a point in time. Numbers from income statements and statements of cash flow describe financial activity over a period of time. When forming a ratio using two numbers from the balance sheet, the numbers should reflect the same point in time.

*Ratios of points and period of time measures.* There are two approaches when forming a ratio with one number from the income statement or statement of cash flow describing activity over a period of time and another number from the balance sheet reflecting financial conditions at a point in time. One approach uses a number from the previous period's end of period balance sheet that corresponds with the point in time in which activities reported in the income statement begin. The second approach uses the average of beginning and ending period balance sheet measures that span the period of time during which activities reported in the income statement occurred. Later we will discuss in more detail when each of the two methods is preferred.

*Cash versus accrual ratios.* We construct several ratios in this chapter that include an income or a COGS variable. The question is: should these be cash receipts and cash COGS or accrued income and accrued COGS? We use accrual variables that focus on when financial transactions occurred rather than when transactions were converted to cash.

*Useful comparisons.* The usefulness of ratios depends on having something useful to compare them to. Suppose we wish we compare ratios of different firms. Obviously, we would expect ratios constructed for different firms to have been calculated at comparable points and periods of time. We would also expect that firms being compared are of the same size and engaged in similar activities. Fortunately, we can often find such measures described as industry average ratios.

Sometimes the relevant comparison for the firm is with itself at different points in time. Having the same ratio over a number of time periods for the same firm allows the firm manager to identify trends. One question trend analysis may answer is: in what areas is the firm is improving (not improving) compared to past performances. Of course, trend analysis can be performed using absolute numbers as well as ratios.

*What follows.* In what follows, we will introduce several ratios from each of the "SPELL" categories. Then we will discuss how each of them, alone and together with other SPELL ratios, can help answer the question: what are the firm's financial strengths and weaknesses. Since data from HQN's financial statements will be used to form the SPELL ratios, HQN's balance sheets, AIS, and statement of cash flow for 2018 are repeated in Table 6.1.

> So, what have we learned? We learned that the ratio of variables X and Y (X/Y) tells us how many units of X are associated with each unit of Y. As a result we can compare the ratio X/Y in firms A and B because the two ratios provide the same information about the same variable in the two firms—the number of units of X that exist for each unit of Y.

**Table 6.1. Coordinated financial statement for HiQuality Nursery (HQN) for the year 2018**
Open HQN Coordinated Financial Statement in MS Excel

| BALANCE SHEET | | | ACCRUAL INCOME STATEMENT | | | STATEMENT OF CASH FLOW | | |
|---|---|---|---|---|---|---|---|---|
| | 12/31/17 | 12/31/18 | | | 2018 | | | 2018 |
| Cash and Marketable Securities | $930 | $600 | + | Cash Receipts | $38,990 | + | Cash Receipts | $38,990 |
| Accounts Receivable | $1,640 | $1,200 | + | Δ Accounts Receivable | ($440) | – | Cash COGS | $27,000 |
| Inventory | $3,750 | $5,200 | + | Δ Inventories | $1450 | – | Cash OE | $11,078 |
| Notes Receivable | $0 | $0 | + | Realized Capital Gains / Depreciation Recapture | $0 | – | Interest paid | $480 |
| **CURRENT ASSETS** | $6,320 | $7,000 | = | **Total Revenue** | **$40,000** | – | Taxes paid | $68 |
| Depreciable Long-term Assets | $2,990 | $2,710 | + | Cash Cost of Goods Sold (COGS) | $27,000 | = | **Net Cash Flow from Operations** | **$364** |
| Non-depreciable Long-term Assets | $690 | $690 | + | Δ Accounts Payable | $1,000 | + | Realized capital gains + depreciation recapture | $0 |
| **LONG-TERM ASSETS** | $3,680 | $3,400 | + | Cash Overhead Expenses (OE) | $11,078 | + | Sales non-depreciable assets | $0 |
| **TOTAL ASSETS** | $10,000 | $10,400 | + | Δ Accrued Liabilities | ($78) | – | Purchases of non-depreciable assets | $0 |
| Notes Payable | $1,500 | $1,270 | + | Depreciation | $350 | + | Sales of depreciable assets | $30 |
| Current Portion LTD | $500 | $450 | = | **Total Expenses** | **$39,350** | – | Purchases of depreciable assets | $100 |
| Accounts Payable | $3,000 | $4,000 | | **Earnings Before Interest and Taxes (EBIT)** | **$650** | = | **Net Cash Flow from Investments** | **($70)** |
| Accrued Liabilities | $958 | $880 | – | Interest | $480 | + | Change in noncurrent LTD | ($57) |
| **CURRENT LIABILITIES** | **$5,958** | **$6,600** | | **Earnings Before Taxes (EBT)** | **$170** | + | Change in current portion of LTD | ($50) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **NONCURRENT LONG-TERM DEBT** | **$2,042** | **$1,985** | – | Taxes | $68 | + | Change in notes payable | ($230) |
| **TOTAL LIABILITIES** | **$8,000** | **$8,585** | | **Net Income After Taxes (NIAT)** | **$102** | – | Payment of dividends and owner's draw | $287 |
| Contributed Capital | $1,900 | $1,900 | – | Dividends and owner draws | $287 | = | Net Cash Flow from Financing | ($624) |
| Retained Earnings | $100 | ($85) | | **Additions To Retained Earnings** | **($185)** | | Change in cash position of the firm | ($330) |
| **TOTAL EQUITY** | **$2,000** | **$1,815** | | | | | | |
| **TOTAL LIABILITIES AND EQUITY** | **$10,000** | **$10,400** | | | | | | |

# Solvency Ratios

Solvency ratios, sometimes called repayment capacity ratios, can be used to answer questions about the firm's ability to meet its long-term debt obligations. Here we will examine two solvency ratios: (1) times interest earned (TIE) and (2) debt-to-service ratio (DS).

## Times interest earned (TIE) ratio

The TIE ratio measures the firm's solvency or repayment capacity. The TIE ratio combines two period of time measures obtained from the firm's income statement and is defined as:

$$TIE = \frac{EBIT}{INT} \tag{6.1}$$

In the above formula, INT represents the firm's interest obligations accrued during the period. EBIT measures the firm's earnings during the period before paying interest and taxes. The TIE ratio answers the question: how many times can the firm pay its interest costs using the firm's operating profits (for every dollar of interest costs how many dollars of EBIT exist? Generally, a healthy firm's TIE ratio exceeds one (TIE > 1), otherwise the firm won't be able to pay its interest costs using its current income. HQN's TIE ratio for 2018 is:

$$TIE = \frac{\$650}{\$480} = 1.35 \tag{6.2}$$

HQN's 2018 TIE ratio indicates for every dollar of interest the firm owes, it has $1.35 dollars of EBIT to make its interest payments.

## Debt-to-service (DS) ratio

Like the TIE ratio, the DS ratio answers questions about the firm's ability to pay its current long-term debt obligations. In contrast to the TIE ratio, DS ratio recognizes the need to pay the current portion of its long-term debt in addition to interest. Finally, the DS ratio (in contrast to the TIE ratio) adds depreciation to EBIT because depreciation is a non-cash expense. Subtracting depreciation from revenue to obtain EBIT understates the liquid funds available to the firm to pay its current long-term debt obligations.

To illustrate the logic behind this formula, assume that cash receipts equals $100, depreciation equals $30, other expenses equal $10, and EBIT is equal to $60. But more than $60 is available to pay interest and principal because depreciation of $30 is a non-cash expense. Thus we add depreciation to EBIT to improve our measure of income available for interest and debt repayment: $60 + $30 = $90, which is the numerator in the DS ratio equation.

This book recommends that the current portion of the long-term debt at the beginning of the current period be used to calculate the denominator in the firm's DS ratio. After making these adjustments, we obtain the firm's DS ratio equal to:

$$DS = \frac{EBIT + Depreciation}{INT + Current\,portion\,long - term\,debt} \tag{6.3}$$

If the DS < 1, a firm will not be able to make principal and interest payments using EBIT plus depreciation. In this case, the firm will be required to obtain funding from other sources such as restructuring debt, selling assets, delaying investments in assets, and/or increasing EBIT to meet current debt and interest obligations. If the firm were unable to meet its interest and principal payment over the long term, the firm's survival would be threatened.

We can solve for HQN's 2018 DS ratio. According to HQN's income statement EBIT was $650 and depreciation was $350. Interest paid equaled $480 and the current portion of the long-term debt listed on the firm's 2017 end of period balance sheet was $500. Making the substitutions into equation (6.3) we find HQN's DS ratio equal to:

$$DS = \frac{\$650 + \$350}{\$480 + \$500} = 1.02 \tag{6.4}$$

According to HQN's DS ratio, its EBIT plus depreciation are sufficient to meet 102 percent of its interest and current principal payments, a more accurate reflections of its solvency than its TIE ratio of 1.35.

## Profitability Ratios

Profitability ratios measure the firm's ability to generate profits from its assets or equity. The firm's accrual income statement (AIS) provides three earnings or profit measures useful in finding rates of return: earnings before interest and taxes (EBIT), earnings before taxes (EBT), and net income after interest and taxes (NIAT).

We examine three profitability ratios: (1) profit margin (m), (2) return on assets (ROA), and (3) return on equity (ROE). In some cases, the profitability measures are reported on an after-tax basis requiring that we know the average tax rate for the firm which we calculate next.

*Finding the average tax rate.* In some cases, particularly with profitability measures, we need to know the average tax rate paid by the firm. We find the average tax rate by solving for T in the following formula that equates net income after taxes (NIAT) to EBT adjusted for the after-tax rate T:

$$NIAT = EBT(1 - T) \tag{6.5}$$

And solving for T in equation (6.5):

$$T = 1 - \frac{NIAT}{EBT} \tag{6.6}$$

Solving T for HQN in 2018 using EBT and NIAT values from Table 6.1 we find:

$$T = 1 - \frac{102}{170} = .4 \tag{6.7}$$

### Profit margin (m) ratio

The ratio $m$ measures the proportion of each dollar of cash receipts that is retained as profit after interest is paid but before taxes are paid.

The ratio $m$, is defined as:

$$m = \frac{EBT}{Total\ Revenue} \tag{6.8}$$

In 2018, HQN had a before-tax profit margin equal to:

$$m = \frac{\$170}{\$40,000} = .00425 = .425\% \tag{6.9}$$

In other words, for every $1 of revenue earned by the firm, HQN earned $0.00425 in before-tax profits. Meanwhile, the after-tax profit margin m is defined as:

$$m(1-T) = \frac{EBT(1-T)}{Total\ Revenue} = \frac{NIAT}{Total\ Revenue} \tag{6.10}$$

In 2018, HQN had an after-tax profit margin equal to:

$$m(1-.4) = \frac{\$102}{\$40,000} = .00255 = .255\% \tag{6.11}$$

In other words, for every $1 of cash receipts, HQN earned $0.00255 in after-tax profits.

## Return on assets (ROA) ratio

The ROA measures the amount of profits generated by each dollar of assets and is equal to:

$$ROA = \frac{EBIT}{A} \tag{6.12}$$

HQN's 2018 before-tax ROA using beginning period assets is equal to:

$$ROA = \frac{\$650}{\$10,000} = 6.5\% \tag{6.13}$$

Interpreted, each dollar of HQN's assets generates $.065 cents in before-tax profits.

## Return on equity (ROE) ratio

The ROE ratio measures the amount of profit generated by each dollar of equity after interest payments to debt capital are subtracted but before taxes are paid. Profits after interest is subtracted equals EBT (earnings before taxes). The ROE ratio can be expressed as:

$$ROE = \frac{EBT}{E} \tag{6.14}$$

HQN's 2018 before-tax ROE using beginning period equity is equal to:

$$ROE = \frac{\$170}{\$2,000} = 8.5\% \tag{6.15}$$

After-tax return on equity, ROE(1 – T), can be expressed as EBT adjusted for taxes, or NIAT. Therefore, ROE(1 – T) can be expressed as NIAT divided by equity:

$$ROE(1-T) = \frac{NIAT}{E} \tag{6.16}$$

HQN's 2018 after-tax ROE is equal to:

$$ROE(1-T) = \frac{\$102}{\$2,000} = 5.1\% \tag{6.17}$$

Interpreted, each dollar of equity generated about $0.085 in before-tax profits and $0.051 in after-tax profits during 2018.

*The relationship between ROE and ROA.* Before leaving profitability ratios, there is one important question: which is greater for a given firm: ROE or ROA? To answer this question, we simply define (ROE)/(E) as equal to the return assets (ROA)(A) less the cost of debt (i)(D):

$$(ROE)(E) = (ROA)(A) - (i)(D) \tag{6.18}$$

After substituting for A, (D + E) and collecting like terms and dividing by equity E, we obtain the result in equation (6.19):

$$ROE = (ROA - i)\left(\frac{D}{E}\right) + ROA \tag{6.19}$$

Equation (6.19) reveals ROE > ROA if ROA > *i*; ROE = ROA if ROA = *i*; and ROE < ROA if ROA < *i*.

If ROE is not greater than ROA, then the firm is losing money on every dollar of debt. For HQN, ROE is 8.5% and greater than its ROA of 6.5%. Meanwhile HQN's average interest rate on its debt (total interest costs divided by debt at the beginning of the period equal to i) during 2018 was equal to:

$$i = \frac{int}{debt} = \frac{\$480}{\$8,000} = 6\% \tag{6.20}$$

# Efficiency Ratios

Efficiency ratios compare outputs and inputs. Efficiency ratios of outputs divided by inputs describe how many units of output each unit of input has produced. More efficient ratios indicate a unit of input is producing greater units of outputs than smaller efficiency ratios.

Consider two types of efficiency ratios: turnover (TO) ratios and turnover time (TOT) ratios. The turnover ratios measure output produced per unit of input during the accounting period, in our case 365 days. For example, suppose our TO ratio is 5. A TO ratio of 5 tells that during 365 days, every unit input produced 5 units of output.

We may want to find the number of days required for a unit of input to produce a unit of output. We can answer the question by dividing 365 days by the number of turnovers that occurred during the year. This tells us the number of days required for a unit of input to produce a unit of output, what we call a turn over time, or TOT, ratio. Continuing with our example, if an input was turned into an output 5 times during the year, then dividing 365 days by 5 tells us that every turnover required (365 days)/5 = 73 days.

We now consider four TO efficiency measures: (1) the inventory turnover (ITO) ratio, (2) the asset turnover (ATO) ratio, (3) the receivable turnover (RTO) ratio, and (4) the payable turnover (PTO) ratio. We also find for each TO ratio their corresponding TOT ratio.

## Inventory turnover (ITO) ratio

The ITO ratio measures the output (total revenue) produced by the firm's inputs (inventory). Total revenue is a period of time measure. Inventory is a point-in-time measure. We use the beginning of the period inventory measure because it reflects the inventory on hand when revenue generating activities began. ITO is defined below.

$$ITO = \frac{Total\ Revenue}{Inventory} \tag{6.21}$$

The 2018 ITO ratio for HQN is:

$$ITO = \frac{\$40,000}{\$3,750} = 10.67 \tag{6.22}$$

The ITO ratio indicates that for every $1 of inventory, the firm generates an estimated 10.67 dollars of revenue during the year. A small ITO ratio suggests that the firm is holding excess inventory levels

given its level of total revenue. Likewise, a large ITO ratio may signal potential "stock outs" which could result in lost revenue if the firm is unable to meet the demand for its products and services.

We can find the number of days required to sell a unit of the firm's beginning inventory, its inventory turnover time (ITOT) ratio, by dividing one year (365 days) by the firm's ITO:

$$ITOT = \frac{365}{ITO} \tag{6.23}$$

The ITOT ratio for HQN in 2018 is equal to:

$$ITOT = \frac{365}{10.67} = 34.21 \tag{6.24}$$

In other words, a unit of inventory entering HQN's inventory is sold in roughly 35 days.

## Asset turnover (ATO) ratio

The ATO ratio measures the amount of total revenue (output) for every dollar's worth of assets (inputs) during the year. The ATO ratio measures the firm's efficiency in using its assets to generate revenue. Like the ITO ratio, the ATO ratio reflects the firm's pricing strategy. Companies with low profit margins tend to have high ATO ratios. Companies with high profit margins tend to have low ATO ratios.

Let A represent the value of the firm's assets. The ATO ratio is calculated by dividing the firm's total revenue by its total assets:

$$ATO = \frac{Total\ Revenue}{A} \tag{6.25}$$

Using beginning of the period assets, HQN's 2018 ATO ratio is equal to:

$$ATO = \frac{\$40,000}{\$10,000} = 4.0 \tag{6.26}$$

We can find the firm's asset turnover time (ATOT) ratio, the number of days required for a dollar of assets to generate a dollar of sales, by dividing 365 by the firm's ATO ratio. Using the ATO previously calculated for HQN in 2018 we find:

$$ATOT = \frac{365}{ATO} = \frac{365}{4.0} = 91.3 \tag{6.27}$$

In other words, a dollar of HQN's assets generates a dollar of cash receipts in roughly 91 days.

## Receivable turnover (RTO) ratio

The RTO ratio measures the firm's efficiency in using its accounts receivables to generate cash receipts. The RTO ratio is calculated by dividing the firm's total revenue by its accounts receivables. Using account receivables measured at the beginning of the year, the firm's RTO ratio measures how many dollars of revenue are generated by one dollar of accounts receivables held at the beginning of the period. The RTO reflects the firm's credit strategy. Companies with high RTO ratios (strict customer credit policies) tend to have lower levels of total revenue than those with low RTO ratios (easy credit policies). We express the RTO ratio as:

$$RTO = \frac{Total\ Revenue}{Account\ Receivables} \tag{6.28}$$

Using data from HQN for 2018, cash receipts from the income statement, and accounts receivables from the ending 2017 balance sheet, we find HQN's RTO to equal:

$$RTO = \frac{\$40,000}{\$1,640} = 24.39 \tag{6.29}$$

In the case of HQN during 2018, every dollar of account receivables generated $24.39 in revenue or an output to input ratio of 24.39.

We can estimate the firm's receivable turnover time (RTOT) ratio or what is sometimes called the firm's average collection period for accounts receivable ratio, the number of days required for a dollar of credit sales to be collected, by dividing 365 by the firm's RTO ratio.

$$RTOT = \frac{365}{RTO} \tag{6.30}$$

In the case of HQN during 2018, we find its RTOT ratio equal to:

$$RTOT = \frac{365}{24.39} = 14.96 \tag{6.31}$$

Interpreted, it takes an average of nearly 15 days from the time of a credit sale until the payment is actually received. The RTOT ratio, like the RTO ratio, reflects the firm's credit policy. If the RTOT is too low, the firm may have too tight of a credit policy and might be losing revenue as a result of not offering customers the opportunity to purchase on credit. On the other hand, remember that accounts receivable must be financed by either debt or equity funds. If the RTOT is too high, the firm is extend-

ing a lot of credit to other firms, and the financing cost may become excessive. Another concern is that the longer a firm extends credit, the greater is the risk that the firm's accounts receivable will ever be repaid.

In some cases, it is useful to construct a schedule that decomposes accounts receivable into the length of time each amount has been outstanding. For example, the schedule might break the accounts receivable into: 1) the amount that is less than 30 days outstanding, 2) the amount that is 30–60 days outstanding, and 3) the amount that is more than 60 days outstanding. This breakdown provides additional information on the risk of the firm's accounts receivable and the likelihood of repayment.

## Payable turnover (PTO) ratio

The PTO ratio measures the firm's efficiency in using its accounts payable to acquire its accrued COGS. The PTO is calculated by dividing accrued COGS (equal to cash COGS plus change in account payable) by accounts payable measured at the beginning of the year. The firm's PTO ratio measures how many dollars of accrued COGS are generated by one dollar of accounts payable held at the beginning of the period. The PTO reflects the firm's credit strategy. Does it prefer equity or debt financing. Firms with low PTO ratios tend to favor the use of debt to finance the firm which tends to generate higher variability in its ROE. The PTO ratio is expressed as:

$$PTO = \frac{Accrued\,COGS}{AP} \tag{6.32}$$

Using data from HQN for 2018, we find its PTO to equal:

$$PTO = \frac{\$28,000}{\$3,000} = 9.33 \tag{6.33}$$

In the case of HQN, every dollar of accounts payable produced 9.33 dollars in accrued COGS.

We can estimate the firm's payable turnover time (PTOT) ratio by dividing 365 days by the firm's PTO ratio.

The PTOT ratio measures the number of days before a firm repays its credit purchases. The PTOT formula, like the other average period ratios, is found by dividing 365 by the PTO ratio. The PTOT ratios can be expressed as:

$$PTOT = \frac{365}{PTO} \tag{6.34}$$

HQN's 2018 PTOT ratio is calculated as:

$$PTOT = \frac{365}{9.33} = 39.12 \tag{6.35}$$

Interpreted, HQN's PTOT ratio of nearly 39 days implies that it takes the firm an average of 39 days from the time a credit purchase is transacted until the firm actually pays for its purchase. The PTOT ratio, like the PTO ratio, reflects the firm's credit policy. If the PTOT is too low, the firm may not be using its available credit efficiently and relying too heavily on equity financing. On the other hand, PTOT ratios that are too large may reflect a liquidity problem for the firm or poor management that depends too much on high cost short term credit.

*Note of caution.* Economists and others frequently warn against confusing causation and correlation between variables. Descriptive data reflected in the ratios derived in this section on efficiency ratios do not generally reflect a causal relationships between variables nor should they be used to make predictions. For example, in the previous section, we are not suggesting that PTOT can be predicted by the PTO or vice versa. The only thing that can be inferred is that PTOT times PTO will always equal 365 days.

## Liquidity Ratios

A firm's liquidity is its ability to pay short-term obligations with its current assets. Also implied by liquidity is the firm's ability to quickly convert assets into cash without a loss in their value which would be the case if the exchange of an asset for cash required a large discount. However, before we review important liquidity ratios, we review an important liquidity measure that is not a ratio: a firm's net working capital.

*Net working capital* (NWC). Even though NWC is not a ratio, it provides some useful liquidity information that should not be ignored. If NWC is positive, then CA which are expected to be converted to cash during the upcoming year will be sufficient to pay for CL, those liabilities expected to come due during the upcoming year. HQN's net working capital, described in Table 6.2, is positive for years 2016, 2017, and 2018, suggesting the firm was capable of meeting its short-term debt obligations by using only the assets expected to be liquidated during the upcoming year.

**Table 6.2. Net Working Capital for HQN**

| Year | Current Assets | – | Current Liabilities | = | Net Working Capital |
|---|---|---|---|---|---|
| 2016 | $5,910,000 | – | $5,370,000 | = | $540,000 |
| 2017 | $6,320,000 | – | $5,958,000 | = | $362,000 |
| 2018 | $7,000,000 | – | $6,600,000 | = | $400,000 |

Another aspect of HQN's NWC is its trend. Is NWC increasing or decreasing over time? We measure the trend in NWC by calculating the change in NWC between calendar years. HQN's NWC decreased

by $178,000 during 2017 ($362,000 – $540,000). It increased by $38,000 during 2018 ($400,000 – $362,000).

The decrease in NWC during 2017 and the slight increase in 2018 calls for an explanation. Was the drop in NWC justified? Did it represent a conscious liquidity decision by the firm? Was it due to external forces? It is the duty of financial managers to find answers to these questions.

## Current (CT) ratio

Liquidity ratios measure a firm's ability to meet its short-term or current financial obligations with short-term or current assets. The CT ratio is the most common liquidity measure. It combines two point-in-time measures from the balance sheet, current assets (CA), and current liabilities (CL). The point-in-time measures of the two numbers must be the same. We write the CT ratio as:

$$CT = \frac{CA}{CL} \tag{6.36}$$

In principle we would like to see the CT ratio exceed one (CT > 1), because it suggests that for every dollar of CL there is more than one dollar of CA sufficient to cover the liquidation of CL if necessary. If the CT ratio is less than one (CT < 1), then liquidating current assets will not generate enough funds to pay for the firm's maturing current liabilities obligations which may create a significant problem. If the firm's current liabilities exceed its current assets, the firm may have to liquidate long-term assets to meet it current obligations. But liquidating long-term (usually illiquid) assets is often costly to do because they cannot be easily converted to cash and end up being sold for a price less than their value to the firm.

The current ratio is constructed from the firm's balance sheet (see Table 6.1). The CT ratio for HQN at the beginning of 2018 (the end of 2017) was:

$$CT = \frac{\$6,320}{\$5,958} = 1.06 \tag{6.37}$$

HQN's beginning 2018 CT ratio value of 1.06, suggests that its current liquid resources were just sufficient to meet its current obligations.

As with all the ratios we will consider, there is generally no "correct" CT ratio value. Clearly a firm's CT ratio can be too low, in which case the firm might have difficulty paying its maturing short-term liabilities. Nevertheless, a CT < 1 does not mean that a firm will not be able to meet its maturing obligations. The firm may have access to other resources that can be used to help meet maturing obligations, such as earnings from operations, long-term assets that could be liquidated, debt which could be restructured, and/or investments in depreciating assets which can be delayed.

On the other hand, a firm's CT ratio can be too high. CA usually earn a low rate of return and holding large levels of current assets may not be profitable to the firm. It may be more efficient to convert some of the CA to long-term assets that generate larger expected returns. To illustrate, think of the extreme case of a firm that liquidates all of its long-term assets and holds them as cash. The firm might have a large CT ratio and be very liquid, but liquid assets are unlikely to generate a high rate of return or profits.

## Quick (QK) ratio

The QK ratio is sometimes called the acid-test ratio. The QK ratio is very similar to the CT ratio, except that inventories (INV), another point-in-time measure obtained from the firm's balance sheet, are subtracted from CA. The QK ratio is defined as:

$$QK = \frac{CA - INV}{CL} \tag{6.38}$$

In forming the QK ratio, inventories are subtracted because inventories are most often the least liquid of the current assets, and their liquidation value is often the most uncertain. Thus the QK ratio provides a more demanding liquidity measure than the firm's CT ratio.

Using balance sheet data from Table 6.1, we find the beginning 2018 QK ratio for HQN equal to:

$$QK = \frac{(\$6,320 - \$3,750)}{\$5,958} = 0.43 \tag{6.39}$$

In other words, liquidating all current assets except inventory will generate enough cash to pay for only 43 percent of HQN's current liabilities. Once again, there is no right or wrong QK ratio. This partly depends on the form of one's inventories. Product inventories are liquid. Inventories of inputs are less liquid. Clearly, HQN's liquidity is much lower if its inventory is not available to meet currently maturing obligations. Nevertheless, similar to the CT ratio, a QK ratio of less than one does not necessarily mean the firm will be unable to meet the maturing obligations.

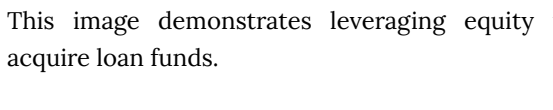
# Leverage Ratios

A lever is bar used for prying or dislodging something. We can move more weight with a lever than by applying force directly. The concept of leverage has application in finance. In finance, we define leverage ratios as those ratios used to describe how a company obtains debt and assets using its equity, as a lever. There are several different leverage ratios, but the main components of leverage ratios include

debt, equity, and assets. A common expression that associates leverage with equity and debt is: How much debt can we raise (leverage) with our equity?

In general, higher leverage ratios imply greater amounts of debt financing relative to equity financing and greater levels of risk. Greater levels of firm risk also imply less ability to survive financial reversals. On the other hand, higher leverage is usually associated with higher expected returns. Here, we consider two key leverage ratios: (1) debt-to-equity ratio (DE) and (2) equity multiplier ratio (EM).

## Debt-to-equity (DE) ratio



This image demonstrates leveraging equity to acquire loan funds.

DE ratios are the most common leverage ratios used by financial managers. They combine two point-in-time measures from the same balance sheet. The DE ratio measures the extent to which the firm uses its equity as a lever to obtain loan funds. As the firm increases its DE ratio, it also increases its control over more assets.

The DE ratio is equal to the firm's total debt (D) divided by its equity (E). If dollar returns on assets exceed the dollar costs of the firm's liabilities, having higher DE ratios (greater leverage) increases profits for the firm. We write the firm's DE ratio as:

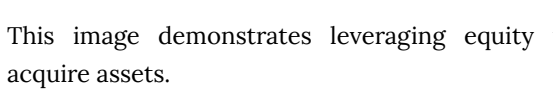
$$DE = \frac{D}{E} \tag{6.40}$$

In general, having a lower DE ratio is preferred by creditors, because more equity funds are available to meet the firm's financial obligations. (Why?) HQN's DE ratio at the beginning of 2018 was:

$$DE = \frac{\$8,000}{\$2,000} = 4.0 \tag{6.41}$$

Interpreted, HQN's DE ratio of 4 implies that each dollar of its equity has leveraged $4.00 of debt. As with liquidity ratios, there is no magic value for DE ratios. If too much debt is used per dollar of equity, the risk of being unable to meet the fixed debt obligations can become excessive. On the other hand, if too little debt is used, the firm may sacrifice returns that can be realized through leverage.

## *Equity multiplier (EM) ratio*



This image demonstrates leveraging equity to acquire assets.

The EM ratio is equal to the firm's total assets A divided by its equity E. The EM ratio tells us the number of assets leveraged by each dollar of

equity. The EM ratio like the DE ratio combines two point-in-time measures from the balance sheet. The EM ratio is a financial leverage ratio that evaluates a company's use of equity to gain control of assets. The EM ratio is particularly useful when decomposing the rate of return on equity using the DuPont equation that we will discuss later in this chapter. The formula for EM can be written as:

$$EM = \frac{A}{E} \tag{6.42}$$

HQN's assets and equity are used to calculate its EM at the beginning of 2018, and can be expressed as:

$$EM = \frac{\$10,000}{\$2,000} = 5.00 \tag{6.43}$$

Leverage ratios are often combined with income statement measures to reveal important information about the riskiness of the firm beyond those provided by leverage ratios. We need to include income and cash flow data to answer the question: what is the optimal leverage ratio? We considered these issues when we earlier examined repayment capacity ratios.

## Other Sets of Financial Ratios

Other sets of financial ratios besides SPELL ratios have been proposed and used elsewhere. For example, one popular set of ratios is referred to as the Sweet 16 ratios. These are compared to the SPELL ratios in Table 6.3.

**Table 6.3. Comparing Sweet 16 Ratios with SPELL ratios**

| SPELL Ratios | Sweet 16 List | Comments |
|---|---|---|
| (S)olvency | Solvency | Same ratios. |
| (P)rofitability | Profitability | Same ratios. |
| (E)fficiency | Efficiency | Same ratios. |
| (L)iquidity | Liquidity | Same ratios. |
| (L)everage | Repayment Capacity | Different interpretation. Equates repayment capacity with leverage. |

## The DuPont Equation

The DuPont equation equals ROE multiplied by two identities assets (A) over A and total revenue over total revenue.

$$ROE = \frac{EBT}{E}\frac{A}{A}\frac{total\ revenue}{total\ revenue} = \frac{EBT}{total\ revenue}\frac{total\ xrevenue}{A}\frac{A}{E} \tag{6.44}$$

The second half of equation (6.44), after substituting and rearranging ratios, shows that ROE depends on the asset turnover ratio (ATO), sales margin (m) and the equity multiplier (EM) ratio:

$$ROE = \frac{EBT}{total\ revenue}\frac{total\ revenue}{A}\frac{A}{E} = m(ATO)(EM) \tag{6.45}$$

The DuPont equation is important because it provides a detailed picture of the firm's ability to generate profits efficiently from its equity across several of the SPELL ratios. The first ratio measures operating efficiency using the firm's profit margin ratio m. The second ratio measures asset use efficiency using the firm's asset turnover ratio ATO. And the third ratio measures financial leverage or risk using the firm's equity multiplier ratio EM.

| | | | | | | |
|---|---|---|---|---|---|---|
| ROE depends on = | ( | Efficiency in generating profits from sales | )( | Efficiency in generating sales from assets | )( | Amount of assets leveraged by each dollar of equity |

The DuPont is only one of a large number of DuPont-like equations. Multiplying by ROE assets/assets and one of the following: accounts receivables/accounts receivables, inventories/inventories, and accounts payables/accounts payables produces many versions of the DuPont equation. We list a few possibilities below:

$$\begin{aligned} ROE &= (m)(ATO)(EM) = (m)(RTO)(EM) \\ &= (m)(ITO)(EM) = (m)(PTO)(EM) \end{aligned} \tag{6.46}$$

The interdependencies described in the DuPont equation help us to perform strengths and weaknesses analysis. HQN's DuPont equation for 2018 is found using previously calculated values for *m*, ATO, and EM:

$$ROE = (m)(ATO)(EM) = (.00425)(4.0)(5.0) = 8.5\% \tag{6.47}$$

Since our ROE calculation of 8.5% equals the DuPont calculation of ROE, we are confident that our calculations, which mix point and period of time measures, are consistently calculated and reflect the interdependencies of the system. Comparing the components of the DuPont equation with industry standards we find:

| | | | | | | |
|---|---|---|---|---|---|---|
| ROE depends on = | ( | m: lowest quartile of the industry | )( | ATO: highest quartile of the industry | )( | EM: significantly higher than the highest quartile of the industry |

Based on the above analysis, the ROE is at or near the industry average despite a weak profit margin because its ATO and EM are both high. HQN is efficient in its generation of cash receipts from assets and it is also highly leveraged so that as long as its average cost of debt is less than its ROA, its ROE increases.

To explore the profit margin further, note that the low profit margin is determined by EBT that in turn depends on the level of cash receipts and the cost to generate that level of cash receipts. Our earlier analysis suggested that operating costs and interest costs were relatively high, and these may be having a major impact on the profit margin.

Looking at the ATO ratio, we see that fixed assets impact the ratio, and we were concerned that the firm may not be reinvesting enough in replacing assets. Failing to replace assets as they are used up would artificially inflate the ATO and the firm's ROE. Also, the inventory levels may be too high. Lowering the inventory levels would increase the ATO and improve ROE. Finally, the high level of leverage helped ROE but is putting the firm in a risky position. The large withdrawal of equity in 2018 has further increased this risk.

## Comparing Firm Financial Ratios with Industry Standards

Financial ratios calculated for an individual firm can be made more useful by having a set of standards against which they can be compared. One might think of the limited usefulness of one's blood pressure readings without some reference level of what is considered a normal of healthy blood pressure. Consider how one can learn more about a firm by comparing it to similar firms in the industry or by comparing it to the distribution of ratios of similar firms.

Major sources of industry and comparative ratios include: Dun and Brad- street, a publication of Dun and Bradstreet, Inc.; Robert Morris Associates, an association of loan officers; financial and investor services such as the Standard and Poor's survey; government agencies such as the Federal Trade Commission (FTC), Securities and Exchange Commission (SEC), and Department of Commerce; trade associations; business periodicals; corporate reports; and other miscellaneous sources such as books and accounting firms. Table 6.4 shows selected HQN's ratios for 2018, as well as ratios for other firms in the industry. The industry ratios are broken into quartiles. For example, 1/4 of the firms in the industry have current ratios above 2.0.

**Table 6.4. HQN ratios for 2018 & Industry Average Ratios in Quartiles**
Open HQN Coordinated Financial Statement in MS Excel

| Ratios | HQN for 2018 | Lower Quartile | Median | Upper Quartile |
|---|---|---|---|---|
| **SOLVENCY RATIOS** | | | | |
| TIE (times interest earned) | 1.35 | 1.6 | 2.5 | 5.8 |
| DS (debt-to-service) | 1.02 | 0.9 | 1.4 | 3.3 |
| **PROFITABILITY RATIOS** | | | | |
| *m* (margin) | 0.43% | 0.44% | 1.03% | 1.79% |
| ROA (return on assets) | 6.50% | 0.66% | 3.30% | 7.00% |
| ROE (return on equity) | 8.50% | 2.10% | 10.70% | 17.20% |
| **EFFICIENCY RATIOS** | | | | |
| ITO (inventory turnover) | 10.67 | 4.8 | 7.7 | 14.9 |
| ITOT (inventory turnover time) | 34.21 | 76.04 | 47.40 | 24.50 |
| ATO (asset turnover) | 4 | 1.5 | 3.2 | 3.9 |
| ATOT (asset turnover time) | 91.25 | 243.33 | 111.06 | 93.59 |
| RTO (receivables turnover) | 24.40 | 15.21 | 11.41 | 8.90 |
| RTOT (receivables turnover time) | 14.96 | 24 | 32 | 41 |
| PTO (payable turnover) | 9.33 | 9.36 | 12.59 | 15.21 |
| PTOT (payable turnover time) | 39.12 | 39 | 29 | 24 |
| **LIQUIDITY RATIOS** | | | | |
| CT (current) | 1.06 | 0.9 | 1.3 | 2 |
| QK (quick) | 0.43 | 0.5 | 0.7 | 1.1 |
| **LEVERAGE RATIOS** | | | | |
| DE (debt-to-equity) | 4 | 2.8 | 1.9 | 0.9 |
| EM (equity multiplier) | 5 | 3.8 | 2.2 | 3.24 |

## Using Financial Ratios to Determine the Firm's Financial Strengths and Weaknesses

Comparing SPELL ratios with industry standards. In what follows we compare the ratios computed for HQN with the ratios calculated for similar firms. Comparing HQN's SPELL ratios with industry standards is the essence of strengths and weaknesses analysis and answers the question: what is the financial condition of the firm?

In Table 6.4, the industry is described by the ratio for the firm, the median firm, and the average of firms in the upper and lower quartile of firms. Consider how comparing HQN to the other firms in

its industry might allow us to reach some conclusions about HQN's strengths and weaknesses and to determine its financial condition.

*Solvency ratios.* HQN's solvency ratio compared to its industry indicates that it may have a difficult time paying its fixed debt obligations out of earnings. The TIE ratio in 2018 is 1.35 which is less than the industry's lowest quartile. HQN's DS ratio in 2018 is 0.94, which implies that only about 94 percent of the firm's interest and principal can be paid out of current earnings which is only slightly higher than the industry's lowest quartile. In effect, compared to industry standards, HQN's significant weakness is its solvency. HQN will need to refinance, raise additional capital, or liquidate some assets in order to make the interest and principal payments and remain in business.

*Profitability ratios.* Compared to industry averages, HQN is profitable. Its ROE is reasonably close to the industry average and its ROA is close to the upper quartile industry average. Paradoxically, HQN's m margin is close to the industry's lowest quartile average.

*Efficiency ratios.* Compared to the industry averages, HQN is very efficient. Both HQN's ITO and ATO ratios are near the top in its industry. Its ITO ratio in 2018 was 10.67, indicating that HQN has sold its inventory over 10 times during the year. This ITO ratio is above the median value for firms in this industry of 7.7, and strong. The ATO ratio has a 2018 value of 4.0, indicating the firm had sales of 4 times the value of its assets, compared to an industry median of 3.2 which is in the upper quartile of firms in its industry. The firm appears to be using assets efficiently which undoubtedly contributes to HNQ's profitability even though its margin in low.

The RTOT ratio has a 2018 value of 14.96. This value is well below industry averages, and raises a question about the firm's credit policies. The industry average RTOT was 32 and suggests that HQN might consider a more generous credit policy. On the other hand, HQN's PTOT ratio is 39 and is in the lowest quartile for the industry. This suggests that HQN is depending on dealer supplied credit more than other firms in its industry because of its low solvency. Still, HQN's strength may be its efficiency.

*Liquidity ratios.* The current ratio is 1.06, which suggests the firm is liquid, but barely. Its ratio is near the lower quartile of firms in the industry. The quick ratio is 0.43, suggesting the firm cannot meet its short-term obligations without relying on inventory. HQN's quick ratio is in the lower quartile of firms in the industry, indicating that the firm is less liquid than most of its competitors and is an HQN weakness.

*Leverage ratios.* The leverage ratios indicate that the HQN's use of debt is high. Comparison with industry ratios shows that HQN is highly leveraged relative to other firms in the industry. As long as ROA exceeds the average interest costs of debt, high leverage increases the firm's profitability—but increases its risk associated with adverse earnings.

## Limitations of Ratios

While ratio analysis can be a powerful and useful tool, it does suffer from a number of weaknesses. We discussed earlier how the use of different ac- counting practices for such items as depreciation can change a firm's financial statements and, therefore, alter its financial ratios. Thus, it is important to be aware of and understand accounting practices over time and/or across firms.

Difficult problems arise when making comparisons across firms in an industry. The comparison must be made over the same time periods. In addition, firms within an "industry" often differ substantially in their structure and type of business, making industry comparisons less meaningful. Another difficulty is that a departure from the "norm" may not indicate a problem. As mentioned before, a firm might have apparent weaknesses in one area that are offset by strengths in other areas.

Furthermore, things like different production practices in a firm may require a different financial structure than other firms in the industry. Additionally, shooting for financial ratios that look like the industry average may not be desirable. Would you want your business to be average?

Inflation can have a significant impact on a firm's balance sheet and its corresponding financial ratios. As a results, it is important to keep in mind the difference between a capital item's book value and it market value. Firms that keep a set of market value financial statements in addition to their book value financial statements should conduct financial analysis with both their book value and market value financial statements.

We should recognize that a single ratio does not provide adequate information to evaluate the strength or weakness of a firm. A weak ratio in one area might be offset by a strong ratio in another area. Likewise, a perfectly healthy firm, from a financial standpoint, may have some special characteristics which result in a ratio which would be out of line for other firms in the industry who do not have these characteristics.

Finally, it must be understood that financial analysis does not in itself provide a management decision. The analysis provides information which will be a valuable input into making management decisions, but there is no "cook book" formula into which you plug the financial analysis number and produce the correct management decisions.

Financial ratios can be an effective strengths and weaknesses analysis tool. However, not all ratios are equally important. Their principal use is to assess the firm's ability to survive. To survive in the long term, the firm must be profitable and solvent. Profitability is defined as the difference between a firm's revenues and its expenses. Solvency is the firm's ability to meet its cash obligations when they become due. Solvency depends on the firm's holdings of liquid assets—assets that can easily and with little expense be converted into cash in the current period.

If a firm is not both profitable and solvent, it cannot survive in the long term. In the short term, a firm can be solvent but not profitable. For a limited time, an unprofitable firm can convert assets to cash and remain solvent by borrowing, refinancing existing debt, selling inventory, liquidating capital assets,

increasing accounts payable, or depleting its capital base. These acts may improve the firm's solvency in the short run, but are likely to erode the firm's future profitability.

In contrast, a firm may be profitable and not solvent, in which case it cannot survive even in the short term. Once a firm fails to meet its cash flow obligations, even if it is profitable, in most cases it loses control over its assets. Therefore, short-term survival may require some firms to sacrifice profitability for solvency. Thus, financial managers must monitor both the firm's solvency and profitability. An appropriately constructed set of financial ratios will allow financial managers to monitor both the firm's profitability and solvency.

Financial ratios may also provide information about the liquidity of the firm, which is related to the firm's solvency because the firm's liquidity position tells us something about the firm's ability to meet unforeseen outcomes and survive. Also related to the firm's solvency and liquidity is the probability of achieving different rates of return. Measures of the probability of alternative rates of return are sometimes examined under the general heading of risk, a subject examined in Chapter 4.

## Strengths and Weaknesses Summary

How do we summarize our strengths and weaknesses analysis? One way is to assign a grade to each of the SPELL categories ranging from 5 (superior) to 1 (on life support). Clearly, the grades assigned are somewhat subjective, but perhaps useful, in summarizing a great deal of financial information. Then what? Do we assign equal weight to each of the SPELL categories depending on their relative importance? The answer to this question depends on the vision, goals, and objectives of the firm manager. To complete this discussion of how to assign weights to the SPELL categories, we treat them equally important in this example—although a strong case exists for assigning a greater weight to profitability measures. In Table 6.5 we summarize our strengths and weaknesses ratings.

**Table 6.5. Summary of HQN's 2018 Financial Strengths & Weaknesses**

| SPELL Category | weights | Grades: 5 (very strong) to 1 (very weak) |
|---|---|---|
| Solvency | .2 | 2.0 |
| Profitability | .2 | 3.0 |
| Efficiency | .2 | 4.0 |
| Liquidity | .2 | 3.0 |
| Leverage | .2 | 2.0 |
| Weighted Summary | | 2.8 |

So, what have we learned? We learned that a firm's SPELL ratios can be compared to finan-

cial ratios of similar firms to determine the firm's financial strengths and weaknesses. In the case of HQN, we assign to it a strengths and weaknesses score of 2.8 which is less than the median or average financial conditions of similar firms in its industry. Significant in arriving at an overall financial strengths and weaknesses score of 2.8 was HQN's high leverage that places it in a risky position and its weak solvency condition.

## Summary and Conclusions

When using financial ratios from one's own firm and comparing them with industry standard ratios, it is often useful to take notes or summarize the major points as you work through the ratio analysis. In our analysis of HQN, the firm is highly leveraged and is in a risky position. We might ask why is the firm relying so heavily on debt and why is its equity being withdrawn at such a high rate? The overhead expenses seem to be too high. Why? How can the situation be improved? Why are the firm's assets being depleted? What is the cause of the increasingly high level of inventory being held?

After gathering information on these questions and others, the firm's financial manager may produce a detailed strengths and weaknesses report. In the report, key financial management issues can be explored, and forecasts of future financial needs and situations can be made. Continued monitoring of the firm's financial statements and ratios will allow the firm's management to gain solid understanding of the relationship between the firm's operations and its financial performance and to recommend changes when required.

So, what have we learned? We learned that by using the information contained in its CFS, firms can construct financial ratios that provide five different views of the firm's financial condition: its solvency, its profitability, its efficiency, its liquidity, and its leverage. A logical next step is to a assign a weight to each of the firm's financial conditions reflected by its ratios after comparing them to industry standards. The overall weighted average reflects the firm's financial strengths and weaknesses and answers the question: what is the financial condition of the firm.

# Questions

When calculating 2018 ratios, please refer to Tables 5.1, 5.4A or 5.4B, and 5.6 in Chapter 5. When asked for industry standard comparisons, use industry measures provided in Table 6.4.

1. In this chapter we identified two kinds of ratios: percentages and rates. Please distinguish between rates and percentages.
2. Explain why financial statement data is made more useful by forming SPELL ratios?
3. Describe the kinds of questions related to the firm's financial strengths and weaknesses each of the SPELL ratios can help answer.
4. Calculate the 2018 SPELL ratios for Friendly Fruit Farm (FFF) described in Chapter 5.
5. Do FFF's DS and TIE ratios, both solvency ratios, tell consistent stories? Defend your answer.
6. Explain why a firm might be reluctant to meet its short-term liquidity needs by liquidating long-term assets.
7. Describe the connections between the m ratio and FFF's ROE.
8. What is the essential difference between ROA and ROE profit measures? What do they each measure?
9. What conditions guarantee that ROE > ROA or that ROA > ROE?
10. Explain the connections between efficiency and ROE or ROA measures.
11. Create an efficiency ratio for your class preparation efforts? (Hint: what are the inputs and what are the outputs?) What could you do to improve the efficiency of your class preparation efforts?
12. What might be implied by very high or very low ITO ratios?
13. Calculate ITO ratios using 2018 total revenue measures for FFF. Then compare your results with ITO ratios using accrued COGS. Explain the differences.
14. The optimum RTOT ratio seeks to balance the need to generate cash receipts by offering easy credit versus the need to meet liquidity need by limiting its accounts receivable. Looking at the financial statements for HQN, what is an ideal RTOT ratio (state a number)? Defend your ideal number RTOT number, and if it is different than HQN's actual number, what actions could you take to align HQN's actual RTOT to its ideal RTOT?
15. Explain why it is difficult to compare net working capital numbers between firms.
16. The DuPont equation allows us to decompose the ROE measure. Replace total revenue with COGS in equation (6.45) and recalculate the components of the revised DuPont equation. Interpret the results. Does the resulting equation still equal HQN's ROE?
17. Using FFF's QK ratios at the end of years 2017 and 2018, what strengths and weaknesses score would you assign to its liquidity?
18. Suppose FFF's long-term debt was 10% above the book value of their long-term assets and only 50% of the current value of their long-term assets. Calculate DE ratios using current and book values of their long-term assets. If FFF were applying for a loan, which DE ratios would they most likely present?
19. If ROA exceeds the average costs of the firm's liabilities, having higher DE ratios (greater leverage) increases profits for the firm. Why might lenders want lower DE ratios while borrowers may want higher DE ratios?

20. Compare firms with low ITO ratios such as jewelry stores with firms with high ITO ratios like grocery stores or gas stations. How might their profit margin requirements for success differ? Explain.
21. Using FFF's SPELL ratios and the industry standards used to evaluate HQN's strengths and weaknesses, write a brief report of FFF's financial strengths and weaknesses. Organize your report into the five SPELL categories: solvency, profitability, efficiency, liquidity, and leverage. Complete a table similar to Table 6.5 that was prepared for HQN. What is the summary measure of FFF's financial strengths and weaknesses?

# 7. System Analysis

**LINDON ROBISON**

*Learning goals.* After completing this chapter, you should be able to (1) define a system; (2) recognize system properties included in coordinated financial statements (CFS); (3) connect changes in exogenous variables and parameters determined outside the CFS system to changes in endogenous variables calculated inside the CFS system; (4) conduct scenario analysis by answering "what-if" and "how-much" kinds of questions; (5) endogenize exogenous variables to improve the credibility of opportunity and threat analysis; (6) simplify financial ratio analysis by exogenizing endogenous variables; and (7) identify trade-off and companion ratios using common size balance sheets and income statements.

*Learning objectives.* To achieve your learning goals, you should complete the following objectives:

- Learn what is a system
- Learn how CFS satisfy system requirements.
- Describe how (S)olvency, (P)rofitability, (E)fficiency,(L)iquidity, and (L)everage (SPELL) ratios answer the question: "what-is" the financial condition of the firm.
- Learn how to answer the question: what-if the value of an exogenous variable or parameter changes, then how will the values of endogenous variables change.
- Learn how to answer the question: how-much the value of an exogenous variable or parameter needs to change for the value of an endogenous variable to equal a specified value.
- Learn how to evaluate scenarios and evaluate the firm's strengths and weaknesses using what-if and how-much analysis.
- Learn how to endogenize exogenous variables within a CFS system to increase the credibility of opportunity and threat analysis.
- Learn how to create subsystems of the CFS system that describes a firm's rate of return on equity (ROE) and solvency by exogenizing certain endogenous variables.
- Learn how to find common size balance sheet ratios equal to balance sheet entries divided by total assets.
- Learn how to find common size income statement ratios equal to income statement entries divided by total revenue.
- Learn how to use common size balance sheets, income statements composed of common size ratios to examine financial trade-offs when conducting what-if and how much analysis.
- Learn how to use pro-forma common size statement to forecast future CFS values.

## Introduction

In what follows we define and distinguish between different kinds of systems. Then we make the point that CFS are a system. Indeed, we have already used CFS system properties to answer the question:

what-is the financial condition of the firm. We answered that question by using CFS data to find the firm's SPELL ratios. However, the value of information gained from SPELL ratios has its limits. Answering what-is kinds of questions is a static (timeless) analysis because it focuses on the current financial condition of the firm. We also need information that is forward looking such as knowing how the financial condition of the firm may change in response to changes in its external environment described by exogenous variables and parameters.

The CFS system allows us to examine alternative scenarios by allowing us to answer what-if questions: what if a change in the firm's exogenous variables occurs, how will its endogenous variables and SPELL ratios change. The CFS system also allows us to examine how-much questions: how-much an exogenous variable must change to produce a specified value for an endogenous variable. The CFS system allows us to change the relationship between exogenous and endogenous variables by endogenizing certain exogenous variables. The CFS system allows us to focus our analysis on key SPELL ratios by exogenizing certain endogenous variables. Finally, the CFS system allows us to create common size balance sheets and income statements that focus on common size ratios. These common size ratios are helpful because they provide comparisons of balance sheet and income statement entries relative to total assets and total revenue. As a result, the ratios can help describe the financial trade-offs facing the firm. To begin our applications of the CFS system, we must first describe the properties of a system.

## Understanding Systems

*What is a system*. A system is an interacting and interdependent group of items forming a unified whole serving a common purpose. Every system has boundaries that separate activities that occur within the system from those that occur outside of the system. There are several kinds of systems. An abstract system uses variables to represent tangible or intangible things and may or may not have a real-world counterpart. On the other hand, physical systems are generally concrete operational systems made up of people, materials, machines, energy, and other physical things. Physical systems are the systems that abstract systems may attempt to represent.

Finally, systems may be closed or open. Open systems allow for exogenous forces outside of the system to influence activities within the system. Closed systems are immune to exogenous forces. Finally, systems may be stochastic or nonstochastic. For stochastic systems, endogenous outcomes within the system and their exogenous causes are described with probabilities. Meanwhile, nonstochastic systems connect endogenous and exogenous variables and parameters with certain (nonprobabilistic) relationships.

## System Metaphors

A metaphor compares two ideas or objects that are dissimilar to each other in some ways and like each other in other ways. We introduce three metaphors to describe how changes in an exogenous variable or parameter—a shock—can change endogenous variables.

*Balloons.* One might compare the CFS to a balloon. If you squeeze one part of the balloon (an exogenous force), there will be an (endogenous) bulge somewhere else in the balloon. This action-reaction nature of a system (and balloons) leads to us examine shocks in pairs and answer the question: "what-if" a change in an exogenous variable occurs, "then" what happens to the endogenous variables of the system?

*Predicting the weather.* Predicting the financial future of the firm has characteristics in common with predicting the weather. Meteorologists look at where the weather fronts have been, the direction they have been traveling, and then predict where they will likely be in the future. To hedge their bets, they often predict future weather patterns with probabilities. Predicting the future financial condition of the firm also looks at the condition of the firm now, how it has changed over time, and then predicts with probabilities where it will be in the future.

*The detective.* Trying to describe how changes in an exogenous variable will affect endogenous variables is like a detective trying to put all the clues together to solve a case that explains who committed a crime. The detective observes a crime—an unusual condition different than what existed before the crime occurred. The financial manager observes changes in the firm's endogenous variables and attempts to link them to changes in one of the exogenous variables and parameters. Most importantly, a detective (and a financial manager) compares the firm's financial condition with industry standards or with other firms and asks: what is unusual, what is out of place?

## Understanding the CFS System

*CFS are a system.* The CFS are an abstract system whose variables and statements describe the financial condition of a firm using mathematical equations and numbers. The CFS are designed to represent the financial condition of the firm at the beginning and ending of a period with balance sheets and financial activities between the beginning and ending balance sheets using an AIS and a statement of cash flow (SCF). The CFS are an open system. They allow for an external environment represented by exogenous variables and parameters to influence activities within the firm represented by endogenous variables. Finally, for our purposes, we assume that the relationships between CFS and variable values included in the CFS system are deterministic.

*CFS and Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis.* Because CFS are a system, we can use them as our primary strengths, weaknesses, opportunities, and threats analysis tool. We summarize several reasons why the CFS system is important for financial managers conducting SWOT analysis:

- because it allows us to answer the question: what-is the financial condition of the firm reflected by its SPELL and common size ratios. Answering the what-is question is the primary means for conducting strengths and weakness analysis;
- because the relationships between CFS variables and financial statements are consistent (they don't change and cannot produce a contradiction), we can check the accuracy of our data by looking for unusual numbers in the statements. If we observe unrealistic results, they can only be attributed to data inaccuracies;
- because it allows us to conduct opportunities and threats analyses by asking what-if questions. What-if analysis considers a possible change (opportunity or threat) in the external environment of the firm and noting changes in the financial condition of the firm;
- because it allows us to ask how-much questions and determine how-much of an external change is needed to change a particular endogenous variable by a specific amount. Answering how-much questions allows us to find the required response to opportunities and threats to achieve a firm's goal;
- because it allows us to define subsystems to focus on parts of the system such as profitability and solvency;
- and, because it allows us to examine important financial trade-offs using common size balance sheets and income statements.

*Endogenous and exogenous variables and parameters.* To understand the CFS system, we must be able to distinguish between endogenous and exogenous variables and parameters. One way to distinguish between CFS endogenous and exogenous variables is to ask: was this variable calculated somewhere in the system? Or, was its value determined outside of the system? If the variable was calculated within the system, it is an endogenous variables. If the variable or parameter was determined outside of the system, it is an exogenous variable.

To illustrate, cash and marketable securities in the beginning period balance sheet is an exogenous variable. Its value was determined by activities in previous time periods. In contrast, ending period cash and marketable securities depend on their beginning period values and changes in the firm's cash position calculated in the SCF. Therefore, the firm's ending period cash and marketable securities is an endogenous variable.

Endogenous and exogenous variables and parameters also create interdependencies between CFS. In general, financial activities described by CFS link beginning and ending period balance sheet with an income statement and SCF. We illustrate these connections with two of several possible examples.

1) The difference in cash balances reported in the beginning and ending period balance sheets equals the change in cash position calculated in the SCF.

2) The difference in retained earnings reported in the beginning and ending period balance sheets equals the addition to retained earnings calculated in the firm's AIS.

*HQN exogenous variables and parameters.* We illustrate CFS exogenous variables and parameters using HQN's exogenous variables and parameters in Table 7.1. A special kind of exogenous variables are side-bar sums of exogenous variables. Because they are summed outside of CFS, side-bar calculations are

also exogenous variables. One reason we sum exogenous variables in side-bar calculations is to create categories that can be used to compare a firm's financial performance with similar firms, with the industry average in which it operates, and with its own performance over time. These comparisons could not occur unless financial data were organized into comparable categories. Another special kind of exogenous variables are parameters used to endogenize an exogenous variable such as the average tax rate.

**Table 7.1. Exogenous variables and parameters used to compute HQN's Coordinated Financial Statements (CFS)**
Open HQN Coordinated Financial Statement in MS Excel

| | A | B | C | E | F | H | I |
|---|---|---|---|---|---|---|---|
| 1 | **Balance Sheet** | | | **Statement of Cash Flow Exogenous** | | **Sidebar Calculations** | |
| 2 | Date | 12/31/17 | 12/31/18 | Cash Receipts | $38,990.00 | *Cash Receivables* | |
| 3 | Cash & Market Securities | $930 | | Cash COGS | $27,000 | Sales | $18,000 |
| 4 | Accounts Receivable | $1,640 | $1,200 | Cash OEs | $11,078 | Landscaping | $15,000 |
| 5 | Inventory | $3,750 | $5,200 | Interest Paid | $480 | Consultation | $5,990 |
| 6 | Notes Receivable | $0 | $0 | Taxes Paid | $38 | Total | $38,990 |
| 7 | Total Current Assets | | | | | | |
| 8 | Depreciable Assets | $2,990 | | Realized Capital Gains | $0 | *Cash COGS* | |
| 9 | Non-depreciable Assets | $690 | | Sale of Non-depreciable LTA | $0 | Fertilizer | $5,000 |
| 10 | Total Long-Term Assets | | | Purchase of Non-depreciable LTA | $0 | Maintenance | $7,000 |
| 11 | **TOTAL ASSETS** | | | Sale of Depreciable LTA | $30 | Labor | $8,000 |
| 12 | | | | Purchase of Depreciable LTA | $100. | Transportation | $5,000 |
| 13 | Notes Payable | $1,500 | $1,270 | Dividend/Owner Draw | $287 | Repairs | $2,000 |
| 14 | Current Portion LTD | $500 | $450 | | | Total | $27,000 |
| 15 | Accounts Payable | $3,000 | $4,000 | Average Tax Rate on ROA T* | 0.10 | | |
| 16 | Accrued Liabilities | $958 | $880 | Average Tax Rate on ROE T | 0.40 | *Cash OES* | |
| 17 | Total Current Liabilities | | | Average Interest Rate of Liabilities | 0.06 | Utilities | $6,000 |
| 18 | Non-Current LTD | $2,042 | $1,985 | | | Office Rent | $4,000 |
| 19 | **TOTAL LIABILITIES** | | | Depreciation | $350 | Cleaning | $1,078 |
| 20 | Contributed Capital | $1,900 | $1,900 | | | Total | $11,078 |
| 21 | Retained Earnings | $100 | | | | | |

| | A | B | C | E | F | H | I |
|---|---|---|---|---|---|---|---|
| 1 | **Balance Sheet** | | | **Statement of Cash Flow Exogenous** | | **Sidebar Calculations** | |
| 22 | **TOTAL EQUITY** | **$** | | | | | |
| 23 | **TOTAL LIABILITIES & EQUITY** | **$** | | | | | |

*Over-identified variables and systems.* Suppose that we use the system properties of the CFS to find ending period cash and marketable securities. Then suppose we observe ending cash and marketable securities reported in our check book or other financial reports. What happens if ending cash and marketable securities determined within the CFS differs from ending cash and marketable securities reported by our bank statement and other financial records are not the same?

The problem is that the ending cash and marketable securities value is over identified. It can be calculated as an endogenous variable within the CFS or observed externally as an exogenous variable. When the two values differ, we say the system is inaccurate because the two values for the over-identified variables don't agree. In such circumstances, the financial manager must employ his/her best effort to find the error in the data. Resolving data errors revealed by over-identified variables may be the most challenging task facing financial managers whose data is often incomplete and sometimes inaccurate. In some cases, the data errors revealed by over-identified variables provides financial managers opportunities to encourage the principals of the firm to reexamine their financial records and look for errors or missing data.

## What-Is Analysis and SPELL Ratios

*SPELL ratios and what-is analysis.* Chapter 6 described the firm's financial system using SPELL ratios. Alone, SPELL ratios help describe the financial condition of the firm and reveal its strengths and weaknesses. However, SPELL ratios are more useful when their interdependence are recognized. In other words, a change in the firm's solvency is likely to change the firm's liquidity. A change in the firm's efficiency is likely to change the firm's profitability. And the list of possible interdependencies continues. Since the variables in the financial system are interdependent, the SPELL ratios composed of system variables are also interdependent.

*Profitability and solvency ratios.* How do we proceed to examine the interdependencies of the firm? One approach is to focus on the firm's bottom line—its profitability and solvency ratios. A firm can exist for many reasons. It may satisfy the firm owners' desires to engage in a production activity. (For example, I just want to farm!) It may be organized to provide family members and others employment. It may exist to provide some public service. There are undoubtedly other reasons why firms exist. However, the firm financial manager is usually charged with only one mission—to ensure the firm's survival and its profitability. This requires a proper balance between the firm's return and its solvency.

In our view, solvency ratios described by the times interest earned (TIE) and debt-to-service (DSR) ratios and profitability ratios described by margin (m), return on equity (ROE), and return on asset (ROA) ratios are the most important SPELL ratios. However, efficiency, leverage, and liquidity ratios also matter to the firm because they influence its profitability measured by its ROE and ROA ratios and its solvency measured by its TIE and DSR ratios.

So, what have we learned? We have learned that since the CFS are a system, we can ask and answer questions related to changes in the values of exogenous variables and parameters and observe how these changes produce changes in the values of endogenous variables within the system. Furthermore, because the CFS are a system, they provides consistent relationships between CFS variables so that unusual values of endogenous variables may call attention to the accuracy of exogenous variables and parameters that determines its value. It may be helpful when considering the properties of a system to compare them to others systems described by a balloon or other activities that predict the weather based on known information or activities of a detective that looks for unusual values (clues) the solve the questions.

## What-if Analysis and SPELL Ratios

We emphasized earlier the interdependencies between endogenous and exogenous variables and parameters in the CFS system. Therefore, any change in an exogenous variable or parameter in one part of the CFS system will produce changes in endogenous variables in other parts of the system. Tracing the impact of a change in an exogenous variable on endogenous variables in the system is referred to here as what-if analysis.

What-if analysis may help the firm anticipate and plan for opportunities and threats. What-if analysis may also permit firm managers to virtually experiment with changes in exogenous variables before implementing an actual financial plan.

The first step in what-if analysis is to introduce the change in an exogenous variable. The second step is to recalculate the endogenous variables in the financial statements. The third step is to recalculate the SPELL ratios and compare them to the previous ratio values and to industry averages. Finally, the fourth step is to interpret the results described by changes in the firm's SPELL ratios. Fortunately, steps one, two, and three can be automated using Excel CFS spreadsheets described in an Appendix to this chapter.

*Describing the results of what-if analysis.* To help analyze the results of what-if analysis, we use an Excel spreadsheet that describes exogenous variables and the CFS. We illustrate how to use an Excel spreadsheet to describe what-if analysis using HQN's CFS. We represented HQN's CFS for years 2017 and 2018

in Table 6.1. We repeat it here as Table 7.2 for convenience. It represents the financial conditions of HQN before any changes in exogenous variables and parameters are considered.

**Table 7.2a. HQN's Coordinated Financial Statements (CFS).**

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | **BALANCE SHEET** | | | | **ACCRUAL INCOME STATEMENT** | | | **STATEMENT OF CASH FLOW** | |
| 2 | DATE | 12/31/ 2017 | 12/31/ 2018 | | DATE | 2018 | | DATE | 2018 |
| 3 | Cash and Marketable Securities | $930 | $600 | + | Cash Receipts | $38,990 | + | Cash Receipts | $38,990 |
| 4 | Accounts Receivable | $1,640 | $1,200 | + | Change in Accounts Receivable | ($440) | – | Cash Cost of Goods Sold | $27,000 |
| 5 | Inventory | $3,750 | $5,200 | + | Change in Inventories | $1,450 | – | Cash Overhead Expenses | $11,078 |
| 6 | Notes Receivable | $0 | $0 | + | Realized capital gains (losses) | $0 | – | Interest Paid | $480 |
| 7 | Total Current Assets | $6,320 | $7,000 | = | Total Revenue | $40,000 | – | Taxes | $68 |
| 8 | Depreciable Assets | $2,990 | $2,710 | | | | = | **Net Cash Flow from Operations** | $364 |
| 9 | Non-depreciable Assets | $690 | $690 | + | Cash Cost of Goods Sold | $27,000 | | | |
| 10 | Total Long-Term Assets | $3,680 | $3,400 | + | Change in Accounts. Payable | $1,000 | + | Realized Capital Gains and Depreciation Recapture | $0 |
| 11 | **TOTAL ASSETS** | $10,000 | $10,400 | + | Cash Overhead Expenses | $11,078 | + | Sales of Non-depreciable Assets | $0 |
| 12 | | | | + | Change in Accrued Liabilities | ($78) | – | Purchases of Non-depreciable Assets | $0 |
| 13 | Notes Payable | $1,500 | $1,270 | + | Depreciation | $350 | + | Sales of Depreciable Assets | $30 |
| 14 | Current Portion Long-Term Debt | $500 | $450 | = | Total Expenses | $39,350 | – | Assets | $100 |
| 15 | Accounts Payable | $3,000 | $4,000 | | | | = | **Net Cash Flow from Investment** | ($70) |
| 16 | Accrued Liabilities | $958 | $880 | | Earnings Before Interest and Taxes (EBIT) | $650 | | | |
| 17 | Total Current Liabilities | $5,958 | $6,600 | – | Less Interest Costs | $480 | + | Change in Non-current Long-term Debt | ($57) |
| 18 | Non-Current Long Term Debt | $2,042 | $1,985 | = | Earnings Before Taxes (EBT) | $170 | + | Change in Current Portion of Long-term Debt | ($50) |
| 19 | **TOTAL LIABILITIES** | $8,000 | $8,585 | – | Less Taxes | $68 | + | Change in Notes Payable | ($230) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 20 | Contributed Capital | $1,900 | $1,900 | = | Net Income After Taxes (NIAT) | $102 | – | Less Dividends and Owner Draw | $287 |
| 21 | Retained Earnings | $100 | ($85) | – | Less Dividends and Owner Draw | $287 | = | **Net Cash Flow from Financing** | ($624) |
| 22 | Total Equity | $2,000 | $1,815 | | Addition to Retained Earnings | ($185) | | | |
| 23 | **TOTAL LIABILITIES & EQUITY** | $10,000 | $10,400 | | | | = | **Change in Cash Position** | ($330) |

**Table 7.2b. HQN's Base SPELL ratios.**

| | A | B | C |
|---|---|---|---|
| 1 | | **12/31/2018** | **Industry** |
| 2 | **SOLVENCY RATIOS** | | |
| 3 | Times Interest Earned (TIE) | 1.35 | 2.5 |
| 4 | Debt Service Ratio (DSR) | 1.02 | 1.40 |
| 5 | **PROFITABILITY RATIOS** | | |
| 6 | Profit margin (m) | 0.43% | 1.03% |
| 7 | Return on assets (ROA) | 6.50% | 3.30% |
| 8 | After-tax ROA [ROA(1-T*)] | 5.82% | |
| 9 | Return on equity (ROE) | 8.50% | 10.70% |
| 10 | After-tax ROE [ROE(1-T)] | 5.10% | |
| 11 | E**FFICIENCY RATIOS** | | |
| 12 | Inventory Turnover (ITO) | 10.67 | 7.7 |
| 13 | ITOT (365/ITO) | 34.22 | 47.4 |
| 14 | Asset Turnover (ATO) | 4.00 | 3.2 |
| 15 | ATOT (365/ATO) | 91.25 | 114.1 |
| 16 | Receivable Turnover (RTO) | 24.39 | 11.41 |
| 17 | RTOT (365/RTO) | 14.97 | 32 |
| 18 | Payable Turnover (PTO) | 9.33 | 12.59 |
| 19 | PTOT (365/PTO) | 39.11 | 29.00 |
| 20 | **LIQUIDITY RATIOS** | | |
| 21 | Current ratio (CR) | 1.06 | 1.30 |
| 22 | Quick ratio (QR) | 0.43 | 0.70 |
| 23 | **LEVERAGE RATIOS** | | |
| 24 | Debt/Asset (D/A) | 0.80 | 0.91 |
| 25 | Debt/Equity (D/E) | 4.00 | 2.00 |
| 26 | Equity multiplier (A/E) | 5.00 | 2.20 |

Now consider what-if cash sales increased by $1,000. The first thing to observe is that increasing cash sales by $1,000 increased cash receipts by the same amount, from $38,990 to $39,990. We report the what-if analysis results in Table 7.3.

**Table 7.3a. HQN's Coordinated Financial Statements (CFS) after increasing sales by $1,000.**

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | **BALANCE SHEET** | | | | **ACCRUAL INCOME STATEMENT** | | | **STATEMENT OF CASH FLOW** | |
| 2 | DATE | 12/31/2017 | 12/31/ 2018 | | DATE | 2018 | | DATE | 2018 |
| 3 | Cash and Marketable Securities | $930 | $1,600 | + | Cash Receipts | $39,990 | + | Cash Receipts | $39,990 |
| 4 | Accounts Receivable | $1,640 | $1,200 | + | Change in Accounts Receivable | ($440) | – | Cash Cost of Goods Sold | $27,000 |
| 5 | Inventory | $3,750 | $5,200 | + | Change in Inventories | $1,450 | – | Cash Overhead Expenses | $11,078 |
| 6 | Notes Receivable | $0 | $0 | + | Realized capital gains (losses) | $0 | – | Interest Paid | $480 |
| 7 | Total Current Assets | $6,320 | $8,000 | = | Total Revenue | $41,000 | – | Taxes | $68 |
| 8 | Depreciable Assets | $2,990 | $2,710 | | | | = | **Net Cash Flow from Operations** | $1,364 |
| 9 | Non-depreciable Assets | $690 | $690 | + | Cash Cost of Goods Sold | $27,000 | | | |
| 10 | Total Long-Term Assets | $3,680 | $3,400 | + | Change in Accounts. Payable | $1,000 | + | Realized Capital Gains and Depreciation Recaputre | $0 |
| 11 | **TOTAL ASSETS** | $10,000 | $11,400 | + | Cash Overhead Expenses | $11,078 | + | Sales of Non-depreciable Assets | $0 |
| 12 | | | | + | Change in Accrued Liabilities | ($78) | – | Purchases of Non-depreciable Assets | $0 |
| 13 | Notes Payable | $1,500 | $1,270 | + | Depreciation | $350 | + | Sales of Depreciable Assets | $30 |
| 14 | Current Portion Long-Term Debt | $500 | $450 | = | Total Expenses | $39,350 | – | Assets | $100 |
| 15 | Accounts Payable | $3,000 | $4,000 | | | | = | **Net Cash Flow from Investment** | ($70) |
| 16 | Accrued Liabilities | $958 | $880 | | Earnings Before Interest and Taxes (EBIT) | $1,650 | | | |
| 17 | Total Current Liabilities | $5,958 | $6,600 | – | Less Interest Costs | $480 | + | Change in Non-current Lont-term Debt | ($57) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18 | Non-Current Long Term Debt | $2,042 | $1,985 | = | Earnings Before Taxes (EBT) | $1,170 | + | Change in Current Portion of Long-term Debt | ($50) |
| 19 | **TOTAL LIABILITIES** | $8,000 | $8,585 | – | Less Taxes | $68 | + | Chage in Notes Payable | ($230) |
| 20 | Contributed Capital | $1,900 | $1,900 | = | Net Income After Taxes (NIAT) | $1,102 | – | Less Dividends and Owner Draw | $287 |
| 21 | Retained Earnings | $100 | $915 | – | Less Dividends and Owner Draw | $287 | = | **Net Cash Flow from Financing** | ($624) |
| 22 | Total Equity | $2,000 | $2,815 | | Addition to Retained Earnings | $815 | | | |
| 23 | **TOTAL LIABILITIES & EQUITY** | $10,000 | $11,400 | | | | = | **Change in Cash Position** | $670 |

**Table 7.3b. HQN's Base SPELL ratios after increasing sales by $1,000.**

| | A | B | C |
|---|---|---|---|
| 1 | | **12/31/2018** | **Industry** |
| 2 | **SOLVENCY RATIOS** | | |
| 3 | Times Interest Earned (TIE) | 3.44 | 2.5 |
| 4 | Debt Service Ratio (DSR) | 2.04 | 1.40 |
| 5 | **PROFITABILITY RATIOS** | | |
| 6 | Profit margin (m) | 2.85% | 1.03% |
| 7 | Return on assets (ROA) | 16.50% | 3.30% |
| 8 | After-tax ROA [ROA(1-T*)] | 15.82% | |
| 9 | Return on equity (ROE) | 58.50% | 10.70% |
| 10 | After-tax ROE [ROE(1-T)] | 55.10% | |
| 11 | **EFFICIENCY RATIOS** | | |
| 12 | Inventory Turnover (ITO) | 10.93 | 7.7 |
| 13 | ITOT (365/ITO) | 33.38 | 47.4 |
| 14 | Asset Turnover (ATO) | 4.10 | 3.2 |
| 15 | ATOT (365/ATO) | 89.02 | 114.1 |
| 16 | Receivable Turnover (RTO) | 25.00 | 11.41 |
| 17 | RTOT (365/RTO) | 14.60 | 32 |
| 18 | Payable Turnover (PTO) | 9.33 | 12.59 |
| 19 | PTOT (365/PTO) | 39.11 | 29.00 |
| 20 | **LIQUIDITY RATIOS** | | |
| 21 | Current ratio (CR) | 1.06 | 1.30 |
| 22 | Quick ratio (QR) | 0.43 | 0.70 |
| 23 | **LEVERAGE RATIOS** | | |
| 24 | Debt/Asset (D/A) | 0.80 | 0.91 |
| 25 | Debt/Equity (D/E) | 4.00 | 2.00 |
| 26 | Equity multiplier (A/E) | 5.00 | 2.20 |

After an increase in sales and cash receipts of $1,000, earnings before interest and taxes (EBIT) and earnings before taxes (EBT) all increased by $1,000. Change in cash and marketable securities also increased by $1,000 as did additions to retained earnings. Importantly, ROE increased from 8.5% to 58.5% while ROA increased from 6.5% to 16.5%.

*Representing outcomes of what-if analysis using SPELL ratios.* While we can report the results of what-if analysis as numbers in CFS, these are difficult to compare with other firms. Instead, we present the results using SPELL ratios. We want to compare SPELL ratios before and after the change described in

the what-if analysis has occurred. The table that compares SPELL ratios before and after the change described in the what-if analysis has occurred is called an Activity table. An Activity table is described here and in the appendix to this chapter. An Activity table has four columns. The first column describes the SPELL ratios being compared. The second column describes the industry average SPELL ratios against which the firm can compare its own SPELL ratios. The third column describes the ratio's value recalculated as a result of the what-if analysis. And finally, the fourth column presents the firm's base—its SPELL ratios before the what-if changes were considered. We present an Activity table for HQN in Figure 7.4 that describes an in sales of $1,000. Note the changes in SPELL ratios ROE, ROA, TIE, and DSR. We present Activity Table 7.4 below. All the key ratios improve with an increase in sales.

**Table 7.4. HQN's Activity Table: SPELL ratios before and after a $1,000 increase in Cash Receipts**

| | A | B | C | D |
|---|---|---|---|---|
| 1 | Ratios | Industry Average | Activity Ratios | HQN Base |
| 2 | **Solvency** | | | |
| 3 | TIE | 2.50 | 3.44 | 1.35 |
| 4 | DSR | 1.40 | 2.04 | 1.02 |
| 5 | **Profitability** | | | |
| 6 | Profit margin (m) | 0.290 | 0.028 | 0.004 |
| 7 | ROA | 0.33 | 0.165 | 0.065 |
| 8 | ROE | 0.107 | 0.585 | 0.085 |
| 9 | **Efficiency** | | | |
| 10 | ITO | 7.7 | 10.93 | 10.67 |
| 11 | ITOT | 47.4 | 33.38 | 34.22 |
| 12 | ATO | 3.2 | 4.10 | 4.00 |
| 13 | ATOT | 114.1 | 89.02 | 91.25 |
| 14 | RTO | 11.41 | 25.00 | 24.39 |
| 15 | RTOT | 32 | 14.60 | 14.97 |
| 16 | PTO | 12.59 | 9.33 | 9.33 |
| 17 | PTOT | 29 | 39.11 | 39.12 |
| 18 | **Liquidity** | | | |
| 19 | Current Ratio | 1.30 | 1.06 | 1.06 |
| 20 | Quick Ratio | 0.70 | 0.43 | 0.43 |
| 21 | **Leverage** | | | |
| 22 | Debt/Assets | 0.91 | 0.80 | 0.80 |
| 23 | Debt/Equity | 2.00 | 4.00 | 4.00 |
| 24 | Asset/Equity | 2.20 | 5.00 | 5.00 |

## Endogenizing Exogenous Variables and Parameters

CFS systems are not unique because every financial system may define its endogenous and exogenous variables differently. As a result, each system may define its interdependencies differently, which in turn defines how consistency is achieved in the system. One way we can change the nature of a system is by endogenizing an exogenous variable.

*Endogenizing an exogenous variable.* System definitions of endogenous and exogenous variables and parameters are arbitrarily defined depending on data availability and analytic needs of the firm's financial manager. We illustrate next, using HQN data, how exogenous variables may be endogenized. In Figure 7.4, we described the what-if analysis of increasing sales by $1,000 which in turn increased cash receipts from $38,990 to $39,990. In this case, sales is considered an exogenous variable as is COGS. However, we should be concerned with the credibility of the results since we are confident that increasing sales will require an increase in COGS and possibly OEs, AR, interest, and taxes—to name a few exogenous variables affected by an increase in sales. The question is how-much do these other exogenous variables and parameters change and do they change in a systematic way with increases in sales?

To account for changes in exogenous variables and parameters expected with an increase in sales, we begin by considering how to internalize our exogenous variables and parameters when conducting what-if analysis. This is a critical task facing financial managers.

First consider the connection between current receipts and COGS. In 2018 cash COGS was 69% of original cash receipts ($27,000/$38,990). We might consider endogenizing cash COGS by replacing it with 69% of projected cash receipts. Then if cash receipts increase, so will COGS. We express the endogenized value of COGS below:

$$COGS = (.69)(CR) = (.69)(\$39,900) - \$27,351 \tag{7.1}$$

Taxes for the previous year were reported to be $68, but this amount assumes original EBT of $170 and an average tax rate of 40%. We endogenize taxes in HQN's income statement by replacing taxes in the exogenous variable page with the average tax rate parameter of 40% times projected EBT:

$$\text{Taxes} = (.4)(EBT) = (.4)(\$1,170) - \$468 \tag{7.2}$$

After endogenizing taxes and COGS, we resolve the HQN-CFS template and find new ratios for the "what-if" analysis and report the results in the Activity Table below.

**Table 7.5. HQN's Activity Table: What-if Analysis after Endogenizing COGS and the average tax rate**

| | A | B | C | D |
|---|---|---|---|---|
| 1 | Ratios | Industry Average | Activity Ratios | HQN Base |
| 2 | **Solvency** | | | |
| 3 | TIE | 2.50 | 2.20 | 1.35 |
| 4 | DSR | 1.40 | 1.44 | 1.02 |
| 5 | **Profitability** | | | |
| 6 | Profit margin (m) | 0.290 | 0.014 | 0.004 |
| 7 | ROA | 0.033 | 0.105 | 0.065 |
| 8 | ROE | 0.107 | 0.288 | 0.085 |
| 9 | **Efficiency** | | | |
| 10 | ITO | 7.7 | 10.93 | 10.67 |
| 11 | ITOT | 47.4 | 33.38 | 34.22 |
| 12 | ATO | 3.2 | 4.10 | 4.00 |
| 13 | ATOT | 114.1 | 89.02 | 91.25 |
| 14 | RTO | 11.41 | 25.00 | 24.39 |
| 15 | RTOT | 32 | 14.60 | 14.97 |
| 16 | PTO | 12.59 | 9.53 | 9.33 |
| 17 | PTOT | 29 | 38.30 | 39.12 |
| 18 | **Liquidity** | | | |
| 19 | Current Ratio | 1.30 | 1.06 | 1.06 |
| 20 | Quick Ratio | 0.70 | 0.43 | 0.43 |
| 21 | **Leverage** | | | |
| 22 | Debt/Assets | 0.91 | 0.80 | 0.80 |
| 23 | Debt/Equity | 2.00 | 4.00 | 4.00 |
| 24 | Asset/Equity | 2.20 | 5.00 | 5.00 |

The main result of endogenizing taxes and COGS was to reduce ROE from 16.5% to 10.57% and ROA from 58.5% to 28.85%.

So, what have we learned? We have learned what it means to endogenize exogenous variables and parameters. On occasion, we may have overidentified variables that provided a check on the accuracy of exogenous variables and parameters. However, overidentified variables means that we can arbitrarily decide if variables is to be treated as endogenous or

exogenous within the CFS system. One thing we also learned is that there may exist interdependencies in exogenous variables and parameters not captured in CFS systems that must be addressed when performing what-is analysis if our results are to be credible.

## What-If Analysis and Scenarios

What-if analysis often begins when the financial manager considers possible scenarios facing its firm. As the financial manager attempts to describe scenarios and consider possible responses, the manager may do so using what-if analysis after changing one or more exogenous variables. Following these changes in exogenous variables we may follow these changes throughout the CFS using what-if analysis. Consider several scenarios that a typical firm might face. Also consider several questions firm managers might want to answer about the scenario using what-if analysis.

*Scenario 1.* The firm has not been replacing its long-term assets. As a result, its cost of goods sold (COGS) has been increasing due to increased repairs and maintenance costs. What conditions may have prompted the firm to not replace its long-term assets. What are the consequences of this scenario on the financial condition of the firm reflected in its SPELL ratios?

*Scenario 2.* A financial manager is risk-averse and decides to increase the firm's current assets to reduce the risk of insolvency. What actions can the firm manager take to increase its level of current assets. What are the consequences of this scenario on the financial condition of the firm reflected in its SPELL ratios?

*Scenario 3.* Suppose the firm decides to increase the time it takes to repay its notes payable. What are the advantages/disadvantages of adopting such a strategy? What conditions facing the firm might prompt it to increase the time it takes to repay its notes payable? What are the consequences of this scenario on the financial condition of the firm reflected in its SPELL ratios?

*Scenario 4.* To boost its revenue, the firm offers easy credit terms to its customers. What are the implications for the firm? How would you expect the firm's credit policies to be reflected in the firm's financial statements? What are the consequences of this scenario on the financial condition of the firm reflected in its SPELL ratios?

*Scenario 5.* Market conditions have reduced the demand for the firm's products. As a result, cash receipts are falling. Unfortunately, most of the firm's overhead expenses (OE) are fixed and don't adjust to changing output levels. What are the consequences of this scenario on the financial condition of the firm reflected in its SPELL ratios?

*Scenario* 6. The firm's owners face serious medical costs and to pay for these, they must extract funds from the business. They want to know how to extract the required funds in such a way that least jeopardizes the firm's rate of return and solvency. What are the consequences of this scenario on the financial condition of the firm reflected in its SPELL ratios?

*Scenario* 7. The firm makes a major investment in long-term assets to improve its efficiency. One impact of the change is to reduce its taxes because of increased depreciation. The firm owners are interested in knowing what other changes in the firm's financial condition if it makes major investments in long-term assets. What are the consequences of this scenario on the financial condition of the firm reflected in its SPELL ratios?

*Scenario* 8. Hard economic times have reduced the firm's customers' ability to pay for their purchases in the usual amount of time. The firm wants to know how to respond to its decreased liquidity. What are the consequences of this scenario on the financial condition of the firm reflected in its SPELL ratios?

*Scenario* 9. Cash receipts have been inadequate for the firm to meet its notes payable and current long-term liabilities. As a result, it is forced to sell off some of its long-term assets at values less than reported on its balance sheet. The firm wants to know what other strategies it can adopt to meet its solvency demands. What are the consequences of this scenario on the financial condition of the firm reflected in its SPELL ratios?

*Scenario* 10. Reduced sales without changes in production levels have led to increased inventories. To meet its financial demands, the firm has restructured its debt, decreasing the current portion of the long-term debt. The firm wants to know how these changes will be reflected in its SPELL ratios.

*Scenario* 4 *analysis.* Performing what-if analysis for each scenario requires that we assume specific numbers for our exogenous variables. This approach is an alternative to endogenizing one or more of its exogenous variables. In our illustration assume that as a result of offering easy credit terms, cash receipts (CR) increased by 5% from $38,990 to $40,940. Then, because production has increased, assume that cash COGS increase by 8% from $27,000 to $29,160. There may be other changes in exogenous variables and parameters, but these are enough to illustrate how to conduct scenario analysis. After making the changes, we resolve the CFS template and report the consequences in Activity Table 7.6.

**Table 7.6. HQN's Activity Table: What If Analysis of Scenario 4.**

| | A | B | C | D |
|---|---|---|---|---|
| 1 | Ratios | Industry Average | Activity Ratios | HQN Base |
| 2 | **Solvency** | | | |
| 3 | TIE | 2.50 | 0.92 | 1.35 |
| 4 | DSR | 1.40 | 0.81 | 1.02 |
| 5 | **Profitability** | | | |
| 6 | Profit margin (m) | 0.290 | -0.001 | 0.004 |
| 7 | ROA | 0.033 | 0.044 | 0.065 |
| 8 | ROE | 0.107 | -0.020 | 0.085 |
| 9 | **Efficiency** | | | |
| 10 | ITO | 7.7 | 11.19 | 10.67 |
| 11 | ITOT | 47.4 | 32.63 | 34.22 |
| 12 | ATO | 3.2 | 4.20 | 4.00 |
| 13 | ATOT | 114.1 | 87.01 | 91.25 |
| 14 | RTO | 11.41 | 25.58 | 24.39 |
| 15 | RTOT | 32 | 14.27 | 14.97 |
| 16 | PTO | 12.59 | 10.05 | 9.33 |
| 17 | PTOT | 29 | 36.31 | 39.12 |
| 18 | **Liquidity** | | | |
| 19 | Current Ratio | 1.30 | 1.06 | 1.06 |
| 20 | Quick Ratio | 0.70 | 0.43 | 0.43 |
| 21 | **Leverage** | | | |
| 22 | Debt/Assets | 0.91 | 0.80 | 0.80 |
| 23 | Debt/Equity | 2.00 | 4.00 | 4.00 |
| 24 | Asset/Equity | 2.20 | 5.00 | 5.00 |

Note that increasing HQN's cash receipts by 5% and it COGS by 8% reduced its ROA from 6.5% to 4.4% and turned its ROE from 8.5% to a negative two percent.

## How Much Analysis and Goal Seek

CFS system's properties allow us to ask and answer important what-if kinds of questions by changing an exogenous variable or parameter and observing its effect on the endogenous variables of the system. Goal Seek is an important Excel function that allows us to ask and answer how-much kinds of

questions that take the form: how much of a change is required in an exogenous variable x for variable y to reach a specified value, a goal, equal to a? To illustrate using HQN data, suppose we asked: how much must HQN's CR increase for ROE to equal 9%?

To answer this question using an Excel spreadsheet that describes HQN's CFS, we press the [Data] tab and the [What-if Analysis] button. Finally, we press "Goal Seek" in the drop-down menu. Goal Seek asks us to supply three pieces of information: the cell where the goal value is located, the numeric value for the variable identified in the goal cell, and the cell location of the variable we wish to change to achieve our goal. The number we wish to change must be an exogenous variable. We want to change the endogenous variable ROE located in cell H50 to a value of 9% by changing cash sales of landscaping services an exogenous variable located in cell J4 located on the exogenous variables and parameters page. We record this information in the Goal Seek menu below.

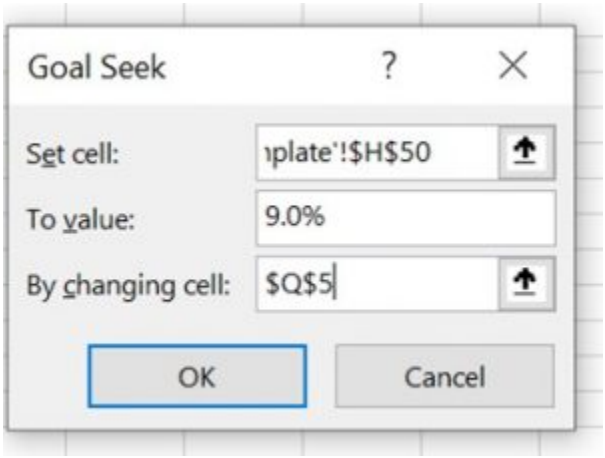



***Figure 7.1. Goal Seek Pop-up Menu***

Then we click [OK] and that find cash receipts from landscaping services must increase to $30,010 for HQN to earn an ROE of 9%. Furthermore, increasing cash receipts from landscaping services to $30,010 increases total cash receipts to $39,000. Changes in the endogenous variables included in system are described next in Activity Table 7.7.

**Table 7.7. HQN's Activity Table: Using Goal seek to find the increase in cash receipts required for ROE to equal 9.0%.**

| | A | B | C | D |
|---|---|---|---|---|
| 1 | Ratios | Industry Average | Activity Ratios | HQN Base |
| 2 | **Solvency** | | | |
| 3 | TIE | 2.50 | 1.38 | 1.35 |
| 4 | DSR | 1.40 | 1.03 | 1.02 |
| 5 | **Profitability** | | | |
| 6 | Profit margin (m) | 0.290 | 0.0045 | 0.0043 |
| 7 | ROA | 0.033 | 0.066 | 0.065 |
| 8 | ROE | 0.107 | 0.090 | 0.085 |
| 9 | **Efficiency** | | | |
| 10 | ITO | 7.7 | 10.67 | 10.67 |
| 11 | ITOT | 47.4 | 34.21 | 34.22 |
| 12 | ATO | 3.2 | 4.00 | 4.00 |
| 13 | ATOT | 114.1 | 91.23 | 91.25 |
| 14 | RTO | 11.41 | 24.40 | 24.39 |
| 15 | RTOT | 32 | 14.96 | 14.97 |
| 16 | PTO | 12.59 | 9.33 | 9.33 |
| 17 | PTOT | 29 | 39.11 | 39.12 |
| 18 | **Liquidity** | | | |
| 19 | Current Ratio | 1.30 | 1.06 | 1.06 |
| 20 | Quick Ratio | 0.70 | 0.43 | 0.43 |
| 21 | **Leverage** | | | |
| 22 | Debt/Assets | 0.91 | 0.80 | 0.80 |
| 23 | Debt/Equity | 2.00 | 4.00 | 4.00 |
| 24 | Asset/Equity | 2.20 | 5.00 | 5.00 |

Note that increasing CR from landscaping services to $39,000 increased of ROE to 9.00%. Of course, there were other consequences. ROA increased to 6.6%. The TIE solvency ratio increased slightly from 1.35 to 1.38. These and other changes we observe by comparing the activity and goal seek columns with the HQN base column.

## Creating Subsystems by Exogenizing Endogenous Variables

Sometimes, it is helpful to answer what-if and how-much questions in simpler terms. We can simplify our analysis by creating subsystems of CFS. Indeed, all systems are reduced versions of some larger system. One method for creating subsystems from larger systems is to exogenize some endogenous variables.

We can construct many subsystems. However, we focus on the two that matter most to the firm: those that describe the firm's ROE and those that describe its solvency. To illustrate, suppose we wanted to build a subsystem around the firm's ROE. We might begin by assuming that the firm sells each item of what it produces at an exogenously determined price p, whose marginal cost is c, whose fixed overhead expense is b, and whose interest costs are iD where i is the average cost of its debt and D is the sum of the firm's liabilities determined in the previous period. Finally, letting the number of physical units sold equal S, we define our ROE subsystem by assuming all other variables except ROE to be exogenous. To create an ROE subsystem, we first define EBT as:

$$EBT = (p - c)S - b - iD. \tag{7.3}$$

Now we can write the ROE subsystem as:

$$\begin{aligned} ROE &= \frac{EBT}{\text{Equity}} = \frac{(p-c)S - b - iD}{\text{Equity}} \\ &= \frac{EBT}{\text{Total Revenue}} \frac{\text{Total Revenue}}{\text{Assets}} \frac{\text{Assets}}{\text{Equity}} = m\, ATO\, EM \end{aligned} \tag{7.4}$$

Having defined an ROE subsystem, we are prepared to ask what-if questions such as: what would happen to the firm's ROE if we could increase the ATO by increasing cash receipts? Since our subsystem has defined all its interdependencies, we can find the answer to this what-if question by observing the change in the firm's ROE in response to changes in the system's exogenous variables and parameters. We illustrate this approach using HQN's data. Initially, HQN's ROE equals:

(7.5)

$$ROE = \frac{EBT}{\text{Equity}} = \frac{(p-c)S - b - iD}{\text{Equity}} = \frac{\$40,000 - \$39,350 - \$480}{\$2,000} = 8.5\%$$

Suppose the value of the exogenous variable cash receipts increased to $40,100? The results on the firm's ROE can be found to equal:

(7.6)

$$ROE = \frac{EBT}{\text{Equity}} = \frac{(p-c)S - b - iD}{\text{Equity}} = \frac{\$40,100 - \$39,350 - \$480}{\$2,000} = 13.5\%$$

Another subsystem might involve solvency and the TIE ratio. To analyze this subsystem, we begin with the EBT defined earlier and remove interest costs to obtain earnings before interest and taxes (EBIT) equal to:

(7.7) $$EBIT = (p-c)S - b$$

Next we write a DuPont type equation focused on TIE equal to:

(7.8)

$$TIE = \frac{EBIT}{\text{Interest}} = \frac{EBIT}{\text{Assets}}\frac{\text{Assets}}{\text{Interest}} = ROA\frac{(D+E)}{iD} = \frac{ROA}{i}\left(1 + \frac{1}{D/E}\right)$$

where D/E is the debt-equity leverage ratio. Having now defined a solvency subsystem reflected by the firm's TIE ratio, we can ask the following what-if question. What-if the firm increased its debt D? Then, what would be the effect on the firm's solvency? To answer this what-if question, we substitute the simplified EBIT formula into equation (7.8) to obtain:

(7.9) $$TIE = \frac{(p-c)S - b}{i}\left(1 + \frac{1}{D/E}\right)$$

To illustrate, we substitute HQN's data into equation (7.8) to find its initial TIE value. Making the substitution we find:

(7.10) $$TIE = \frac{ROA}{i}\left(1 + \frac{E}{D}\right) = \frac{6.5\%}{6\%}\left(1 + \frac{\$2,000}{\$8,000}\right) = 1.35$$

Now suppose we ask: what-if the firm's equity falls by $1,000? In response to this change in an exogenous variable, HQN's TIE ratio would decline to:

(7.11) $$TIE = \frac{ROA}{i}\left(1 + \frac{E}{D}\right) = \frac{6.5\%}{6\%}\left(1 + \frac{\$1,000}{\$8,000}\right) = 1.22$$

And what-if the firm's interest rate increased by one percent to 7.0%? Then its TIE ratio becomes:

$$TIE = \frac{ROA}{i}\left(1 + \frac{E}{D}\right) = \frac{6.5\%}{7\%}\left(1 + \frac{\$1,000}{\$8,000}\right) = 1.16 \tag{7.12}$$

It is important to recognize that the answers to our what-if questions provided by our subsystems are only approximations of what would happen if we considered the entire system. Nevertheless, the subsystem approach provides some useful intuitive explanations that may be disguised in a full system analysis.

> So, what have we learned? We learned that open systems like CFS require endogenous variables whose values are determined within the system and exogenous variables and parameters whose values are determined outside the system. However, systems are arbitrary constructs and we can create open subsystems including one that describes the firm's ROE and TIE ratios by arbitrarily exogenizing what were previously endogenously determined variables.

## Common Size Balance Sheets and Income Statements

When comparing a firm's financial condition with other firms, with itself over time, or with the average firm in the industry in which it operates, it is often useful to make comparisons using standardized measures such as SPELL ratios. But what if the comparisons we wish to make involves entries in the firm's financial statements, including balance sheets and income statements? To address the need for standardized measures of balance sheet and income statement entries, we express all items in the balance sheet as a percentage of total assets and all items in the income statement as a percentage of total revenue. We refer to the results as common size balance sheets and common size income statement ratios. Common size balance sheets and income statements are composed of common size ratios that sum to 100%.

*Common size balance sheet insights.* Consider what we can learn from common size balance sheets and their common size ratios. Suppose that a firm's cash and marketable securities was $100,000 at the end of 2017 and $110,000 at the end of 2018. In addition, suppose the firm's total assets were $2,000,000 at the end of 2017 and $3,000,000 at the end of 2018. The firm's cash and marketable securities increased by $10,000 over the year which might suggest the firm is now more liquid. However, the firm's cash and marketable securities must now support a larger amount of total assets. The common size cash and marketable securities ratio was 5% at the end of 2017 and only 3.67% at the end of 2018. Thus, the amount of cash and marketable securities available per dollar of assets decreased during the year. Stated differently, cash and marketable securities relative to total assets declined between 2017 and

2018 while increasing in absolute amounts. We report HQN common size balance sheets and ratios in Table 7.8.

**Table 7.8. Common Size Balance Sheets for HQN**

| | Year | | | |
|---|---|---|---|---|
| ASSETS | 2016 | 2017 | 2018 | Ind. Ave. |
| Cash and Marketable Securities | 12.13% | 9.30% | 5.77% | 6.3% |
| Accounts Receivable | 15.77% | 16.40% | 11.54% | 26.4% |
| Inventory | 31.85% | 37.50% | 50.00% | 25.6% |
| CURRENT ASSETS | 59.76% | 63.20% | 67.31% | 58.3% |
| Depreciable long-term assets | 33.06% | 29.90% | 26.92% | 35.7% |
| Non-depreciable long-term assets | 7.18% | 6.90% | 5.77% | 6.0% |
| LONG-TERM ASSETS | 40.24% | 36.80% | 32.69% | 41.7% |
| **TOTAL ASSETS** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| | | | | |
| LIABILITIES | | | | |
| Notes Payable | 14.15% | 15.00% | 12.21% | 13.9% |
| Current Portion LTD | 7.08% | 5.00% | 4.33% | 3.6% |
| Accounts Payable | 24.27% | 30.00% | 38.46% | 18.7% |
| Accrued Liabilities | 8.80% | 9.58% | 8.46% | 6.8% |
| CURRENT LIABILITIES | 54.30% | 59.58% | 63.46% | 43.0% |
| NON-CURRENT LONG-TERM DEBT | 25.88% | 20.42% | 19.09% | 13.4% |
| TOTAL LIABILITIES | 80.18% | 80.00% | 82.55% | 56.4% |
| Equity | 19.82% | 20.00% | 17.45% | 43.6% |
| TOTAL EQUITY | 19.82% | 20.00% | 17.45% | 43.6% |
| **TOTAL DEBT AND EQUITY** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |

*Common size balance sheets and what-is analysis.* HQN's common size balance sheet ratios can be examined by comparing them with other firms in the industry described in the last column of Table 7.8. Doing so provides information critical for what-is analysis. HQN's common size current asset ratio is above the industry average and rising primarily as a result of relatively high and increasing common size inventories ratio. Accounts receivable ratios are low compared to the industry's average as are long-term asset ratios. Current liabilities ratios are well above the industry average and rising mostly as a result of increasingly accounts payable ratios. Although falling, long-term debt ratios are still above the industry average; owner equity ratios are well below the average firm in the industry. Finding where one's firm differs from the industry or from other firms using common size balance sheets is one way for understanding what-is the financial condition of the firm.

*Common size income statements and what-is analysis.* HQN's common size income statement ratios can be examined by comparing them with other firms in the industry described in the last column of Table 7.9. HQN's COGS common size ratio in 2018 was close to the industry average. However, its overhead expenses ratio (OE) were much higher than the industry average in both 2017 and 2018. As a result, its EBIT ratios were much lower than the industry average. Furthermore, its interest costs ratios were almost double the industry average. HQN's high OE and high interest costs ratios relative to the industry average were somewhat mitigated by HQN's lower than industry ratios for depreciation and taxes. Still, HQN's net income after taxes (NIAT) ratio in 2018 was low compared to the industry average: 0.25% for HQN versus 2.28% for the industry.

Finding where one's firm differs from the industry or from other firms using common size income statements common size income statement ratios is one important way to determine what-is the financial condition of the firm.

**Table 7.9. HQN's Common Size Income Statement**

| | Year | | |
|---|---|---|---|
| | **2017** | **2018** | **Ind. Ave.** |
| Total Revenue | 100.00% | 100.00% | 100.00% |
| Cost of Goods Sold (COGS) | 67.37% | 70.00% | 71.40% |
| Overhead Expenses | 29.82% | 27.50% | 22.50% |
| Depreciation | 1.24% | 0.88% | 1.75% |
| EARNING BEFORE INTEREST AND TAXES (EBIT) | 1.57% | 1.62% | 4.35% |
| Interest | 1.22% | 1.20% | 0.55% |
| EARNINGS BEFORE TAXES (EBT) | 0.35% | 0.42% | 3.80% |
| Taxes | 0.17% | 0.17% | 1.52% |
| NET INCOME AFTER TAXES (NIAT) | 0.18% | 0.25% | 2.28% |

## What-if Analysis and Trade-offs

Common size statement ratios sum to 100%. This fact implies that we cannot increase one variable in the statements without decreasing the relative importance of other variables. This required trade-off in response to changes in exogenous variable provides us an important tool for conduction what-if analysis using common size statements. There are various ways we can describe these trade-offs.

*The squeeze versus the bulge.* One way to examine trade-offs in common size ratios is to assume the financial system has some characteristics similar to a balloon. If we squeeze a balloon, a corresponding bulge will occur—because balloons require equal pressure on its surface. This balloon-like characteristic is evident in common size financial statements because common size ratios must sum to 100%.

For example, suppose the firm wishes to increase its liquidity by increasing its accounts receivable ratio. However, increasing the accounts receivable and depreciable assets ratios will require that the long-term assets ratio decreases—and profitability and perhaps efficiency may suffer.

*CFS and trade-offs.* Trade-offs are obvious within common size statements. Some usual trade-offs are summarized in the table that follows. Consider the left-hand column as the "squeeze" and the right-hand column as the "bulge." However, the "squeeze" and "bulge" comparisons described below are only qualitative possibilities. To find out the quantitative connections, we must look at the change in common size ratios after a change in an exogenous variable or parameter has occurred.

**Table 7.10. The Squeeze vs. The Bulge**

| The Squeeze | The Bulge |
|---:|---|
| leverage ratio (D/E): High | rate of return on equity (ROE): High |
| cash receipts/inventory ratio (ITO): High | cash receipts/accounts receivable (RTO): Low |
| cash receipts/inventory ratio (ITO): Low | profit margin (m): Low |
| current assets/current liabilities ratio (CR): High | rate of return on equity (ROE): Low |
| cash receipts/assets ratio (ATO): High | operating and repair: High |
| COGS/notes payable (PTO): High | interest costs: High |

*Companion ratios.* We now conduct what-if analysis using common size ratios by looking for interesting things in pairs. To begin, look at HQN's common size inventories ratio: 50% in 2018 versus an industry average of 25.6%. We have found a squeeze. The bulge? Look at its accounts receivable ratio: 11.54% versus an industry standard of 26.4%. Does this suggest that the firm has adopted a stringent credit policy that has discouraged some customers by forcing them to pay in cash, reducing sales and increasing unsold inventories? Perhaps. It's an area the firm should explore. If HQN's stringent credit policy were indeed affecting cash receipts, then its inventory turnover ratio (ITO) would be affected. Compare, but this ratio isn't too far from the industry average: 10.67% versus the industry average of 7.7%. However, the ITO upper quartile for the industry is 14.9%, suggesting a large variability for the industry. So, the firm's credit policy is still a concern.

*Consider companion SPELL ratios.* HQN's debt to equity ratio is 4.0 in 2018 versus the industry average of 1.9. Unfortunately for HQN, a high leverage ratio hasn't increased profits or rates of return as much as might be expected because of its low efficiency. Continuing, if HQN has unusually high levels of debt relative to its equity, we should expect its interest payments to be above the industry average. They are 1.2% of cash receipts in 2018 versus an industry average of .55%. Already we are alarmed; high leverage is usually accompanied by high risk. One reason that high leverage implies high risk is that the firm's equity relative to its liability is small and not able to survive a market reversal. Is HQN's equity low relative to the industry? Very much so: 17.45% in 2018 versus the industry average of 43.6%.

## Common Size Statements and Forecasting

Using historical data, we attempt to look ahead to financial conditions the firm is likely to experience in the future. This effort is different than what-if analysis because we are predicting what-is likely to be the financial conditions of the firm in the future. Common size statements can sometimes be helpful when forecasting the future. We introduce the topic of forecasting here and in more detail in Chapter 11. In what follows we describe two forecasting method using common size statements. The first one is trend analysis. The second method is pro-forma analysis.

*Trend analysis.* Consider the common size balance sheets reported earlier in Table 7.8. Trend analysis begins by looking for significant changes or trends in the asset or liability ratios. Current asset ratios have increased over the three-year period mostly due to increases in inventory levels. Cash and marketable securities common ratios declined during the three years for the same reason—current assets being tied up in inventory. Long-term assets have fallen primarily as a result of declining values of the firm's property, plant, and equipment. The worrisome result of this trend is that it may project increased maintenance costs associated with aging machinery.

On the debt side of the balance sheet, current liabilities ratios have increased during the three-year period mostly as a result of increases in accounts payable ratios. Long-term debt ratios have declined, and owner equity ratios have remained relatively constant. The question associated with these trends is, can increasing dependence on notes payable be sustained? Are there less expensive sources of financing available?

Examining HQN's common size income statement, reported in Table 7.9, we see that both EBIT and NIAT ratios increased in 2018. Comparing HQN's income statement ratios with other firms in the industry, we note that HQN's EBIT and NIAT ratios were low compared to industry averages, primarily as a result of relatively high overhead expenses and interest expenses ratios. High OE, COGS, and interest costs ratios have reduced HQN's taxes ratio. Trends in both common size balance sheets and income statements can be used to predict their future value, assuming the trends continue; or, they may be used to identify barriers to the trends continuing.

*Pro forma financial statements.* Pro forma income statements and balance sheets are forecasts of what these statements will look like in the future and provide essential planning information. There are several ways to construct pro forma statements. The usual technique is to select a key variable and predict its future value. Then assume constant SPELL ratios which include the key variable and solve for other values using other ratios. We demonstrate this approach in what follows.

Assume that HQN wants to achieve a projected level of cash receipts. Also assume that SPELL ratios will remain constant even in the face of projected total revenue increases. Specifically, assume that next year's projected total revenue for HQN will equal $42,000, an increase of 5%. What does this imply for HQN's level of inventory? From HQN's SPELL ratios, we see that the inventory turnover ratio was 10.67%. Assuming this year's ratios will not change next year, we can use the projected level of cash receipts to forecast the pro forma levels of inventories (INV). The first step in these types of problems is to write out the definition of each ratio and their assumed values:

$$ITO = \frac{\text{Total Revenue}}{INV} = \frac{\$40,000}{\$3,750} = 10.67\% \tag{7.13}$$

From the inventory turnover (ITO) equation we find:

$$INV = \frac{\text{Total Revenue}}{ITO} \tag{7.14}$$

Next, we use the projected cash receipts level of $42,000 and divide by ITO to find projected HQN's inventory in 2019:

$$INV = \frac{\text{Total Revenue}}{ITO} = \frac{\$42,000}{10.4\%} = \$4,038.46 \tag{7.15}$$

We observe an interesting result. Inventories increased by 5% to $4,038.46, the same percentage increases as was projected in total revenue. This result, of equal percentage increases, occurs whenever the ratio is held fixed. When one number of the ratio is increased by some percent, the other number in the ratio must increase by the same percent. To illustrate, consider the $m$ ratio:

$$m = \frac{EBIT}{\text{Total Revenue}} = \frac{\$170}{\$40,000} = 0.00425 \tag{7.16}$$

If the $m$ ratio is constant and cash receipts increases to $42,000, then EBIT will increase by 5% to $178.50. Again, the technique is to assume that the historical financial relationships will hold in the future and then project the future value of one variable, usually cash receipts. This allows us to calculate the projected values of the remaining financial variables based on the historical financial relationships. Of course, we could create pro forma income statements and balance sheets by increasing all the variables by some common percent, or just the exogenous variables by the common percent. However, increasing all the exogenous variables by a common percent is confusing, and it is highly unrealistic. That explains why what-if analysis is often applied to the firm's CFS.

## Summary and Conclusions

We began this chapter by describing the CFS as a system in which changes in one part of the system affect other parts of the system. We answered the question, what-is the financial condition of the firm by computing SPELL ratios using CFS data and comparing these with industry averages of similar firms. Because SPELL ratios are computed using CFS data, they reflect the interdependencies inherent in the CFS.

While SPELL ratios can describe what-is the firm's strengths and weaknesses, they can also answer what-if and how-much kinds of questions by changing CFS exogenous variables that reflect scenarios the financial managers may face—and recomputing the SPELL ratios. Comparing SPELL ratios before and after the changes in exogenous variables and parameters allows us to examine the firm's strengths and weaknesses. We also answered how-much questions with the help of Excel's goal seek. How-much questions help us find the requirements for reaching specific financial goals.

What-is analysis assumes relationships among exogenous variables are fixed. However, when we change an exogenous variable required by what-if and how-much analysis, we may need to consider interdependencies between exogenous variables. We demonstrated this interdependencies when we considered an increase in cash sales that would require an increase in COGS and taxes. As a result, to improve the credibility of our scenario analysis using what-if and how-much, we may need to endogenize certain exogenous variables.

We faced the fact that the world is a complicated system and we can sometimes gain insights about it by creating subsystems that assume or define some endogenous variables as exogenous variables and parameters. In effect, we create subsystems from systems by reducing the number of endogenous variables and increasing the number of exogenous variables and parameters—allowing us to describe a subsystem within a system with a reduced number of endogenous variables.

We found our subsystems to be useful because they allow us to understand the connections between some of the most important parts of the financial system such as a firm's rates of return and solvency. While there are many subsystems we could create and examine, we emphasized the firm's TIE ratio and its ROE ratios that reflect a firm's solvency and rate of return on equity. We expressed our subsystems using DuPont type equations.

Another important set of ratios we considered was common size ratios. We found common size ratios by dividing CFS balance sheet entries by total assets and CFS income statement entries by total revenue. As a result, common size balance sheet ratios and common size income statement ratios sum to 100%. They reflect what-is the financial condition of the firm by comparing the relative important of each balance sheet and income statement entry to total assets or total revenue.

That common size ratios in balance and income statements sum to 100% facilitates a special kind of what-if analysis: the analysis of trade-offs in the relative importance of common size ratios. We perform trade-off analysis by changing an exogenous variable and recalculating common size ratios and noting the changes in relative importance of each ratio relative to total assets or total revenue.

Finally, we facilitated what-is, what-if, and how much analysis using CFS and common size statements entered into Excel spreadsheets described in the appendix to this chapter.

# Questions

1. Describe a system that is different than the CFS system described in this chapter.
2. Refer to Table 7.1 that lists exogenous variables and parameters. Since determining which variables are endogenous and exogenous is somewhat arbitrary, especially when some variables are overidentified, describe factors that influence which variables are exogenous in any particular CFS.
3. SPELL and common size ratios can be used to describe what-is the financial condition of the firm. What-if and how-much analysis examine possible scenarios, counter-factual conditions that differ from the actual condition of the firm. Explain the benefits and limitations of what-is versus what-if analysis.
4. Explain why it may be necessary to endogenize some exogenous variables and parameters when conducting what-if and how-much analysis to improve credibility. Explain why it may be necessary to exogenize some endogenous variables when the goal is to provide a simpler view of the firm. Give examples from the text of endogenizing some exogenous variables and exogenizing some endogenous variables.
5. Choose three of the ten scenarios described in the text. Then perform what-if analysis using the Excel CFS template described in the appendix to this chapter. Describe what changes in exogenous variables or what exogenous variables should be endogenized to improve the credibility of the analysis. Recognize that some scenario analyses may require more than one exogenous variable be changed. Finally, write a brief opportunities and threats report about how the conditions described in the scenario would change the firm's opportunities and threats.
6. Compare HQN's 2017 and 2018 common size balance sheet in Table 7.8 with the industry average. Based on these comparisons, describe what is the financial condition of the firm. How does what-is analysis using common size balance sheets and income ratios differ from conducting what-is using SPELL ratios.
7. Refer to Table 7.8 that describe HQN's common size balance sheets at the end of years 2016, 2017, and 2018. Notice that cash and marketable securities were well above the industry average in 2016 and then declined in both 2017 and 2018 to percentages below the industry average.
8. Common size statement are interdependent. And increase in one common size ratio requires corresponding decreases in other ratios. By referring to other ratios in the common size balance sheet, explain what changes in the firm likely account for HQN's decline in liquidity reflected by a decrease in the relative importance of cash and marketable securities.
9. Refer to Table 7.8 and observe that HQN's current liabilities increased from 59.58% in 2017 to 63.46% in 2018. In all years, current liabilities were well above the industry average of 43%. If high levels of current liabilities in HQN's balance sheets (the squeeze), what is other ratios are below the industry average that would be the companion ratio (the bulge). Is this change a strength or weakness for HQN?
10. Focusing on HQN's common size income statement in Table 7.9, observe that overhead expenses were increasing between 2017 and 2018 while depreciation was low. Are the two connected? Can you connect this change to changes in the firm's long-term assets in the common size balance sheets?

11. The common size income statement's base is cash receipts. Recalculate the common size income statements for 2017 and 2018 using COGS as the new base. What is the effect of changing the base in the calculation of the common size income statement?
12. In Table 7.9, NIAT is especially low compared to the industry average. Can you explain why?
13. Compute a pro forma income statement for HQN for 2019. Assume cash receipts equals $42,000 and the relationships described by the common size income statement for 2018 are maintained.

## Appendix to System Analysis

Coordinated financial statements (CFS) and ratios. This appendix operationalizes the calculation of CFS using HQN data reported in Chapter 5, calculates SPELL ratios derived in Chapter 6, and common size ratios derived in this chapter. CFS include interdependent beginning and ending period balance sheets linked with income and cash flow statements. CFS for HQN described in Chapter 5 and HQN SPELL ratios described in Chapter 6 are reported below. Open the HQN Coordinated Financial Statement template in MS Excel.

***Table 7.A1. HQN Coordinated Financial Statement Template***

Exogenous and endogenous data. Data included in CFS and used to find SPELL ratios can be separated into endogenous and exogenous variables and parameters. Exogenous variables and parameters and their values are determined outside of CFS. These are used to find the values of endogenous variables whose values are calculated within CFS. It is somewhat arbitrary which variables are endogenous and endogenous. The distinction depends on what data are available outside of CFS and which data must be calculated. A third data category included in CFS are repeated values of endogenous and exogenous variables and parameters that are reported in more than one location. For example, cash receipts are calculated using exogenous data that are summed and then reported in the statement of cash flow and the income statement. Table 7.A2 below describes exogenous data included in CFS.

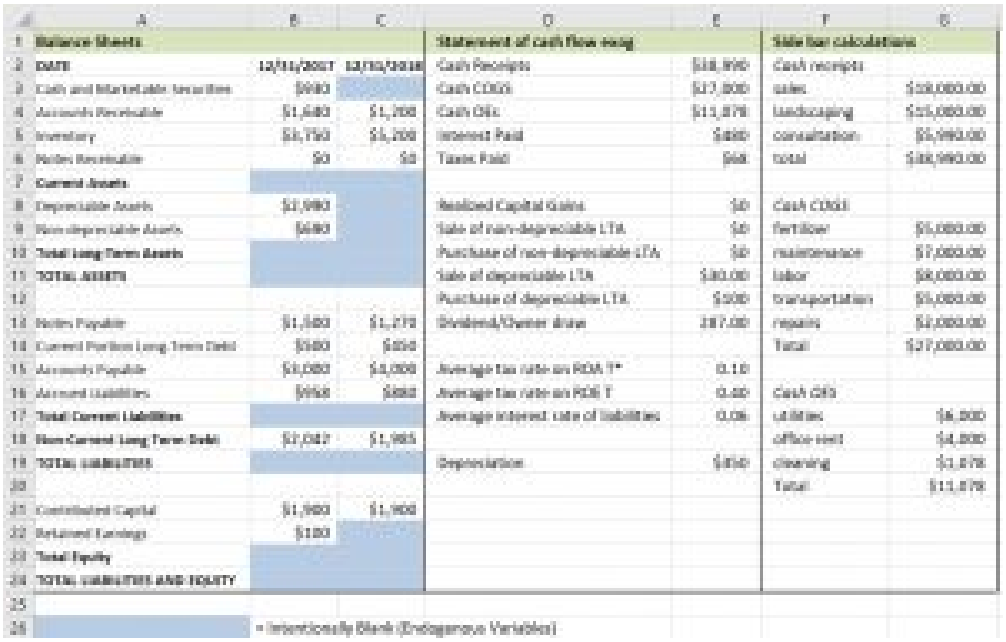


***Table 7.A2. Exogenous Variables***

Exogenous data reported in Table 7.A2 can be separated into three categories. The first category includes exogenous data included in beginning and ending balance sheets. The second category includes exogenous data included in the statement of cash flow, and the third category includes exogenous data used for side-bar calculations required to combine multiple entries of similar data into a single category that can be used to facilitate comparisons between firms, a firm and the industry in which it operates, and the same firm over time. Side-bar calculated sums are treated as exogenous data in CFS. There is no exogenous data included in income statements in Table 7.A2 since it is created using data transferred from the balance sheets or statement of cash flow or calculated. Exogenous data reported in Table 7.A2 are collected from outside of CFS from such sources as tax records, records of financial transactions including purchases and sales of depreciable and non-depreciable assets, and operating data include product sales receipts and records operating expenses.

Whenever there is a question about a datum source in the CFS, one need only hover the cursor over the cell in question. If the source refers one back to the exogenous data sheet, the variables is an exogenous variable including side bar calculations. If the cell begins with an "=" sign indicating a calculation, the datum is an endogenous variable. If the cell indicates another cell location within the CFS, the data is being transferred from another location and may be either an exogenous or endogenous variable.

*SPELL ratios*. SPELL ratios included in the CFS were described in Chapter 6. Figure 7.A1 reports two categories of SPELL ratios. The first category describes exogenously determined values that report industry standard ratios. The second SPELL ratios category describes endogenously determined values that reflect the financial condition of the firm being examine. Comparing the two categories of SPELL

ratios helps financial managers determine the financial condition of the firm. The formula for each financial ratio reported in the CFS for the firm being examined can be discovered by hovering over the cell containing the ratio of interest. For example, hovering over the ROE cell, we find the ratio is calculated as: J21/C28. Then referring to the CFS, we find J21 equals Earnings Before Taxes of $170 divided by C28 equal to total equity at the beginning of the period of $2,000. ROE then is found as the ratio $170/$2000=8.5%.

*What-if analysis.* One of the many advantages of using an Excel spreadsheet to describe CFS and SPELL ratios is the ability to considers the consequences of changes in exogenous variables and parameters on the value of endogenous variables. We describe the consequences of change(s) in the value of exogenous variable(s) on endogenously determined SPELL ratios and report the results in Table 7.A3.

**Table 7.A3. HQN's Activity Table: What-if Analysis Before Changes**

| | A | B | C | D |
|---|---|---|---|---|
| 1 | Ratios | Industry Average | Activity Ratios | HQN Base |
| 2 | **Solvency** | | | |
| 3 | TIE | 2.50 | 1.35 | 1.35 |
| 4 | DSR | 1.40 | 1.02 | 1.02 |
| 5 | **Profitability** | | | |
| 6 | Profit margin (m) | 0.290 | 0.004 | 0.004 |
| 7 | ROA | 0.033 | 0.065 | 0.065 |
| 8 | ROE | 0.107 | 0.085 | 0.085 |
| 9 | **Efficiency** | | | |
| 10 | ITO | 7.70 | 10.67 | 10.67 |
| 11 | ITOT | 47.40 | 34.22 | 34.22 |
| 12 | ATO | 3.20 | 4.00 | 4.00 |
| 13 | ATOT | 114.10 | 91.25 | 91.25 |
| 14 | RTO | 11.41 | 24.39 | 24.39 |
| 15 | RTOT | 32.00 | 14.97 | 14.97 |
| 16 | PTO | 12.59 | 9.33 | 9.33 |
| 17 | PTOT | 29.00 | 39.12 | 39.12 |
| 18 | **Liquidity** | | | |
| 19 | Current Ratio | 1.30 | 1.06 | 1.06 |
| 20 | Quick Ratio | 0.70 | 0.43 | 0.43 |
| 21 | **Leverage** | | | |
| 22 | Debt/Assets | 0.91 | 0.80 | 0.80 |
| 23 | Debt/Equity | 2.00 | 4.00 | 4.00 |
| 24 | Asset/Equity | 2.20 | 5.00 | 5.00 |

The first column in Table 7.A3 describes the financial ratio being reported. The second column describes the average ratio value for the industry to which the firm belongs. Ratios in this column provides the firm a standard against which it can compare itself. The third column describes the value of the firm's SPELL ratios after the change in the exogenous variable has occurred. We refer to this column as the activity column. Finally, the fourth column describes the value of the ratios before the change in the exogenous variable has occurred. We label this column base values. Of course, what-if analysis can accommodate more than one exogenous variable change. For example, the scenarios described in Chapter 7 may require several changes in exogenous variables and parameters to be adequately described.

For Table 7.A3, the activity column and the base column are equal since no change in an exogenous variable or parameter has been introduced. Now introduce a change. Suppose that cash sales increased from $18,000 to $18,100. We describe the consequences of this change in an exogenous variable will influence HQN's SPELL ratios in Table 7.A4. While several SPELL ratios change, the most important change increased ROA from 6.5% to 7.5% and increased the ROE ratio from 8.5% to 13.5%. Since the activity column is updated after each "what-if" analysis, it may be convenient to copy each "what-if" table and record it in a separate Excel page.

**Table 7.A4. HQN's Activity Table: What If Analysis: Increasing Cash Sales to $18,100.**

| | A | B | C | D |
|---|---|---|---|---|
| 1 | Ratios | Industry Average | Activity Ratios | HQN Base |
| 2 | **Solvency** | | | |
| 3 | TIE | 2.500 | 1.563 | 1.354 |
| 4 | DSR | 1.400 | 1.122 | 1.020 |
| 5 | **Profitability** | | | |
| 6 | Profit margin (m) | 0.290 | 0.007 | 0.004 |
| 7 | ROA | 0.033 | 0.075 | 0.065 |
| 8 | ROE | 0.107 | 0.135 | 0.085 |
| 9 | **Efficiency** | | | |
| 10 | ITO | 7.700 | 10.693 | 10.667 |
| 11 | ITOT | 47.400 | 34.133 | 34.219 |
| 12 | ATO | 3.200 | 4.010 | 4.000 |
| 13 | ATOT | 114.100 | 91.022 | 91.250 |
| 14 | RTO | 11.410 | 24.451 | 24.390 |
| 15 | RTOT | 32.000 | 14.928 | 14.965 |
| 16 | PTO | 12.590 | 9.333 | 9.330 |
| 17 | PTOT | 29.000 | 39.107 | 39.120 |
| 18 | **Liquidity** | | | |
| 19 | Current Ratio | 1.300 | 1.061 | 1.061 |
| 20 | Quick Ratio | 0.700 | 0.431 | 0.431 |
| 21 | **Leverage** | | | |
| 22 | Debt/Assets | 0.910 | 0.800 | 0.800 |
| 23 | Debt/Equity | 2.000 | 4.000 | 4.000 |
| 24 | Asset/Equity | 2.200 | 5.000 | 5.000 |

*Goal seek and "how-much" analysis.* Finally, we introduce "Goal Seek", an Excel function that allows us to ask the question: how-much of a change in exogenous variable X is required for an endogenous variable Y to equal a specified value? We refer to this analysis as how-much analysis. The details of how to use Goal Seek and how-much analysis were described in Chapter 7. The main point here is that Goal Seek and how much analysis, like what-if analysis, analyzes the consequences of a change in an exogenous variable on an endogenous variable. The difference is that the size of the change in the exogenous variables is determined by a separate analysis that uses goal seek. The values of SPELL ratios after introducing a change in an exogenous variable whose amount was determined by goal seek is reported in the what-if table, Table 7.A3. For example, suppose we are interested in discovering how-much of a change in labor costs is required to increase ROE to 9.0%. Using goal-seek, we find that decreasing

labor costs to $7990 will increase ROE to 9%. Other changes associated with decreasing labor costs to $7,990 are reported in Table 7.A5.

**Table 7.A5. HQN's Activity Table: Goal Seek Reducing Labor Costs to $7,990 Increases ROE to 9%**

| | A | B | C | D |
|---|---|---|---|---|
| 1 | Ratios | Industry Average | Activity Ratios | HQN Base |
| 2 | **Solvency** | | | |
| 3 | TIE | 2.500 | 1.375 | 1.354 |
| 4 | DSR | 1.400 | 1.031 | 1.020 |
| 5 | **Profitability** | | | |
| 6 | Profit margin (m) | 0.290 | 0.005 | 0.004 |
| 7 | ROA | 0.033 | 0.066 | 0.065 |
| 8 | ROE | 0.107 | 0.090 | 0.085 |
| 9 | **Efficiency** | | | |
| 10 | ITO | 7.700 | 10.667 | 10.667 |
| 11 | ITOT | 47.400 | 34.219 | 34.219 |
| 12 | ATO | 3.200 | 4.000 | 4.000 |
| 13 | ATOT | 114.100 | 91.250 | 91.250 |
| 14 | RTO | 11.410 | 24.390 | 24.390 |
| 15 | RTOT | 32.000 | 14.965 | 14.965 |
| 16 | PTO | 12.590 | 9.330 | 9.330 |
| 17 | PTOT | 29.000 | 39.121 | 39.120 |
| 18 | **Liquidity** | | | |
| 19 | Current Ratio | 1.300 | 1.061 | 1.061 |
| 20 | Quick Ratio | 0.700 | 0.431 | 0.431 |
| 21 | **Leverage** | | | |
| 22 | Debt/Assets | 0.910 | 0.800 | 0.800 |
| 23 | Debt/Equity | 2.000 | 4.000 | 4.000 |
| 24 | Asset/Equity | 2.200 | 5.000 | 5.000 |

*Common size statements and "what-is" analysis.* Common size statements introduced in this chapter are an important financial analysis tool that can be used for what-is, what-if, and how-much analysis. Entries in common size statements are ratios like the SPELL ratios but differ because they sum to 100% and therefore emphasis trade-offs between elements of common size balance sheets and income statements. The only point that distinguishes SPELL ratios from common size ratios is that the latter set of ratios care created using the same base for balance sheet and income statement ratios, total assets versus total revenue. Common size ratios using CFS base numbers provide the basis for what-is

analysis. Conducting what-if and how-much analysis using CFS after changes in exogenous variables provide the basis for common size statement what-if and how-much analysis. We include an Excel template that describes common size balance sheets in Figure 7.A6. The activity column headed 12/31/2018 reflects a what-if analysis that examines an increase in sales of $1,000.

**Table 7.A6. HQN Common size balance sheets for December 31, 2017 and 2018.**

| | Activity | | Activity | | |
|---|---|---|---|---|---|
| ASSETS | 12/31/2017 | base 2017 | 12/31/2018 | base 2018 | Ind. Ave. |
| Cash and Marketable Securities | 9.30% | 9.30% | 7.93% | 5.77% | 6.30% |
| Accounts Receivable | 16.40% | 16.40% | 11.27% | 11.54% | 26.40% |
| Inventory | 37.50% | 37.50% | 48.85% | 50.00% | 25.60% |
| CURRENT ASSETS | 63.20% | 63.20% | 68.06% | 67.31% | 58.30% |
| Depreciable long-term assets | 29.90% | 29.90% | 25.46% | 26.06% | 35.70% |
| Non-depreciable long-term assets | 6.90% | 6.90% | 6.48% | 6.63% | 6.00% |
| LONG-TERM ASSETS | 36.80% | 36.80% | 31.94% | 32.69% | 41.70% |
| **TOTAL ASSETS** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| | | | | | |
| LIABILITIES | | | | | |
| Notes Payable | 15.00% | 15.00% | 11.93% | 12.21% | 13.90% |
| Current Portion LTD | 5.00% | 5.00% | 4.23% | 4.33% | 3.60% |
| Accounts Payable | 30.00% | 30.00% | 37.58% | 38.46% | 8.70% |
| Accrued Liabilities | 9.58% | 9.58% | 8.27% | 8.46% | 6.80% |
| CURRENT LIABILITIES | 59.58% | 59.58% | 62.01% | 63.46% | 43.00% |
| NON-CURRENT LONG-TERM DEBT | 20.42% | 20.42% | 18.65% | 19.09% | 13.40% |
| TOTAL LIABILITIES | 80.00% | 80.00% | 80.65% | 82.55% | 56.40% |
| TOTAL EQUITY | 20.00% | 20.00% | 19.35% | 17.45% | 43.60% |
| **TOTAL DEBT AND EQUITY** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |

Finally, we include a common size income statement in Table 7.A7. Note that we have few industry averages to compare the AIS entries, partly because there is less standardization for income statements than for balance sheets.

**Table 7.A7. HQN's Common size income statement for 2018 reflecting an increase in sales of $1,000.**

| Date | | AIS Activity | Activity 2018 | Base 2018 | Industry Average |
|---|---|---|---|---|---|
| + | Cash Receipts | $39,990 | 97.54% | 97.48% | |
| + | Change in Accounts Receivable | ($440) | -1.07% | -1.10% | |
| + | Change in Inventories | $1,450 | 3.54% | 3.63% | |
| + | Realized Capital Gains (Losses | $0 | 0.00% | 0.00% | |
| = | **Total Revenue** | $41,000 | 100.00% | 100.00% | 100.00% |
| + | Cash Cost of Goods Sold | $27,593 | 67.30% | 67.50% | 71.40% |
| + | Change in Accounts Payable | $1,000 | 2.44% | 2.50% | |
| + | Cash Overhead Expenses | $11,078 | 27.02% | 27.70% | 22.50% |
| + | Change in Accrued Liabilities | ($78) | -0.19% | -0.20% | |
| + | Depreciation | $350 | 0.85% | 0.88% | 1.75% |
| = | **Total Expenses** | $39,943 | 97.42% | 98.38% | |
| | **Earnings Before Interest and Taxes (EBIT)** | $1,057 | 2.58% | 1.63% | 4.35% |
| – | Less Interest Costs | $480 | 1.17% | 1.20% | 0.55% |
| = | **Earnings Before Taxes (EBT)** | $577 | 1.41% | 0.43% | 3.80% |
| – | Less Taxes | $231 | 0.54% | 0.17% | 1.52% |
| = | **Net Income After Taxes (NIAT)** | $346 | 0.84% | 0.26% | 3.80% |
| – | Less Dividends and Owner Draw | $287 | 0.70% | 0.72% | |
| = | **Addition to Retained Earnings** | $59 | 0.14% | -0.46% | |

PART III

# PART III: PRESENT VALUE MODELS

# 8. Present Value Models & Accrual Income Statements

LINDON ROBISON

*Learning goals.* After completing this chapter, you should be able to: (1) construct present value (PV) models that are multi-period extensions of accrual income statements (AIS); (2) demonstrate how to properly represent the financial characteristics of an investment using PV models; (3) distinguish between PV models by associating them with AIS earnings and rates of return; and (4) clarify the conditions required for earnings and rates of return on assets and equity to provide consistent rankings. These contributions are intended to help financial managers make better investment decisions.

*Learning objectives.* To reach your learning goals, you should complete the following objectives:

- Describe the similarities and differences between AIS and PV models.
- Demonstrate that before and after-tax rates of return on assets (ROA) and equity (ROE) derived from AIS are equivalent to before and after-tax internal rate of return on assets ($IRR^A$) and equity ($IRR^E$) derived from multi-period IRR models.
- Demonstrate that net present value (NPV) models can be viewed as multi-period present value extensions of EBIT, EBT, and NIAT earning measures.
- Solve NPV and IRR models using a generalized Excel template.
- Identify the conditions required for consistent earnings and rates of return on assets and equity rankings.

## Introduction

[1]

The development of PV models has a long history. Some of that history is reviewed by Robison and Barry (2020). Relevant to this chapter is work by Osborn (2010), Graham and Harvey (2001), Scott and Petty (1984), and a host of other authors have focused on the possible inconsistency between NPV and IRR rankings and how to resolve the possible conflict. One resolution to the ranking conflict focused on reinvesting cash flow, producing a new class of PV models that Lin (1976) and others have referred to as modified PV models. Related to modified PV models, Beaves (1988) and Shull (1994) describe implicit

1. The material in this chapter was adapted from Robison, L.J. and P.J. Barry (2020). "Accrual Income Statements and Present Value Models." Agricultural Finance Review.

and explicit reinvestment rates. Magni (2013) proposed a weighted average IRR to resolve PV and IRR inconsistencies. Robison, Barry, and Myers (2015) listed homogeneous size conditions that would guarantee IRR and NPV ranking consistency.

Recent studies have connected PV models to other disciplines. Magni (2020) linked PV models to accounting, finance, and engineering. Robison and Barry (2020) connected AIS accounting measures to PV models by noting the need to account for changes in operating accounts and liquidations of capital accounts in PV models. This chapter emphasizes that by paying attention to AIS and PV model connections we can develop more accurate and transparent PV models and better understand the possible conflict in rankings, depending on whether the focus is on assets or equity.

## AIS and PV Models

*Accrual Income Statements*. AIS measure asset and equity earnings before and after taxes are paid. In addition, when combined with balance sheet data, AIS earning measures can estimate return on assets (ROA), equity (ROE), and after-tax return on equity (ROE(1–T)) where T is the average tax rate. AIS measure revenues and expenses when transactions occur rather than relying exclusively on when cash payments are processed or received (see Harsh, Connor, and Schwab (1981; Lazarus (1987)). To achieve this end, AIS include changes in operating and capital accounts that do not produce cash flow.

*PV models defined.* This paper defines PV models as multiperiod extensions of AIS. This definition applies because AIS earnings and rates of return have their corresponding measures in PV models. AIS derived ROA, ROE, and ROE(1-T) correspond to PV model derived $IRR^{A}$, $IRR^{E}$, and $IRR^{E(1-T)}$. Likewise AIS EBIT, EBT, and NIAT measures correspond to NPV for asset earnings ($NPV^{A}$), equity earnings ($NPV^{E}$), and after-tax equity earnings ($NPV^{E(1-T)}$).

*AIS and PV model differences.* Despite the correspondence between AIS and PV models, there are some important differences. Consider two. First, AIS are constructed to measure a firm's financial performance. As a result, they are often ex-post in their focus. PV models consider the financial advisability of an investment whose profitability depends on future cash flows. As a result, PV models are often ex-ante in their focus.

Second, AIS can be constructed to measure rates of return and earnings on assets and equity before and after taxes are paid in one period. PV models can be constructed to measure rates of return and earnings on assets and equity before and after tax are paid for investments that generate returns for several periods. As a result, AIS report earnings at the end of the first period. PV models report the present value of cash flow earned over several periods and the liquidated value of operating and capital accounts at the end of the analysis.

*Details included in AIS and PV models.* AIS and PV models correspond to and are consistent with each other. This consistency requires that we include the same detail and distinctions in PV models as we include in AIS. This requirement implies that we first need to determine if we are investigating

return on assets or equity. Second, we need to account for changes in accounts receivable, inventories, accounts payable, accrued liabilities and capital accounts in both AIS as well as in PV models. Finally, to calculate rates of return on assets and equity requires asset and equity balances besides earnings data. AIS require beginning assets and equity data from balance sheets. PV models also require assets and equity data to determine how investments are supported.

> So, what have we learned? PV models are multi-period generalizations of AIS whose future cash flows are evaluated as though they were received in the present period. As a result, we need to be prepared to construct PV models with the same detail included in an AIS. If we fail to include these details, we may misrepresent the present value of the investment's earnings and rates of return.

## AIS Earnings and Rates of Return on Assets and Equity

*Earnings on assets*. AIS earnings on beginning assets equals:

- the difference between cash receipts and the sum of cash cost of goods sold (COGS) and cash overhead expenses (OE), and
- changes in the value of the firm's operating and capital accounts.

A *numerical example*. We illustrate how to find AIS earnings and rates of return on assets using data that describes the fictional firm Hi-Quality Nursery (HQN) described in Chapter 5. We report the AIS for HQN in Table 8.1.

**Table 8.1. HQN's 2018 Accrual Income Statement**

| | **2018** |
|---|---|
| + Cash Receipts | $38,990 |
| + Change in Accounts Receivable | ($440) |
| + Change in Inventories | $1,450 |
| + Realized capital gains (losses) | $0 |
| **Total Revenue** | $40,000 |
| + Cash Cost of Goods Sold | $27,000 |
| + Change in Accounts Payable | $1,000 |
| + Cash Overhead Expenses | $11,078 |
| + Change in Accrued Liabilities | ($78) |
| + Depreciation | $350 |
| **Total Expenses** | $39,350 |
| **Earnings Before Interest and Taxes (EBIT)** | $650 |
| – Less Interest Costs | $480 |
| **Earnings Before Taxes (EBT)** | $170 |
| – Less Taxes | $68 |
| **Net Income After Taxes (NIAT)** | $102 |
| – Less Dividends and Owner Draw | $287 |
| Addition to Retained Earnings | ($185) |

The AIS reported in Table 8.1 organizes cash flow and changes in operating and capital accounts into total revenue and total expenses and reports the difference as EBIT. The HQN EBIT calculation is summarized in equation (8.1). Total revenue equals cash receipts (CR), plus the change in accounts receivable (ΔAR), plus the change in inventory (ΔInv), plus realized capital gains (losses) (RCG). Total expenses equal the sum of cash COGS, plus the change in accounts payable (ΔAP), plus the change in cash overhead expenses (ΔOE), plus the change in accrued liabilities (ΔAL), plus the change in the book value of capital assets or depreciation (Dep). EBIT represents HQN's earnings from its beginning assets that include assets supported by its liabilities or debt.

$$\begin{aligned} EBIT &= \text{total revenue} - \text{total expense} \\ &= (CR + \Delta AR + \Delta Inv + RCG) \\ &\quad - (COGS + \Delta AP + OE + \Delta AL + Dep) \\ &= \$40,000 - \$39,350 = \$650 \end{aligned} \tag{8.1}$$

*Rates of return on assets.* We find HQN's ROA by dividing HQN's EBIT of $650 by its beginning assets ($A_0$) of $10,000 reported in Table 8.2. HQN's ROA equals:

$$ROA = \frac{EBIT}{A_0} = \frac{\$650}{\$10,000} = 6.5\% \tag{8.2}$$

**Table 8.2. HQN's Beginning and Ending Balance Sheets**

| **DATE** | 12/31/2017 | 12/31/2018 |
|---|---|---|
| Cash and Marketable Securities | $930 | $600 |
| Accounts Receivable | $1,640 | $1,200 |
| Inventory | $3,750 | $5,200 |
| Notes Receivable | $0 | $0 |
| **Total Current Assets** | $6,320 | $7,000 |
| Depreciable Assets | $2,990 | $2,710 |
| Non-depreciable Assets | $690 | $690 |
| **Total Long-Term Assets** | $3,680 | $3,400 |
| **TOTAL ASSETS** | $10,000 | $10,400 |
| Notes Payable | $1,500 | $1,270 |
| Current Portion Long-Term Debt | $500 | $450 |
| Accounts Payable | $3,000 | $4,000 |
| Accrued Liabilities | $958 | $880 |
| **Total Current Liabilities** | $5,958 | $6,600 |
| **Non-Current Long-Term Debt** | $2,042 | $1,985 |
| **Total Liabilities** | $8,000 | $8,585 |
| Contributed Capital | $1,900 | $1,900 |
| Retained Earnings | $100 | ($85) |
| **Total Equity** | $2,000 | $1,815 |
| **TOTAL LIABILITIES AND EQUITY** | $10,000 | $10,400 |

*Earnings and rate of return on equity.* We find HQN's earnings on its beginning equity by subtracting from EBIT interest costs (Int) that represent payments for the use of debt and other liabilities and refer to the result as EBT, earnings after interest and before taxes are paid. We find ROE for HQN by dividing EBT by the firm's beginning equity ($E_0$) of $2,000 reported in Table 8.2. HQN's ROE equals:

$$ROE = \frac{EBIT - Int}{E_0} = \frac{EBT}{E_0} = \frac{\$170}{\$2,000} = 8.5\% \tag{8.3}$$

*Earnings and changes in beginning assets and equity.* EBIT and EBT earnings on the firm's beginning assets and equity respectively. These earnings estimates may not equal the actual changes in assets and equity between periods reported in HQN's balance sheets. To explain, the change in equity between periods reported in Table 8.2 equals ($185), ($1815 – $2,000). However, this value is not equal to EBT of $170 estimated from HQN's AIS in Table 8.1. The difference between the change in equity and EBT can be attributed to sum of taxes paid equal to $68 and owner draw equal to $287. If we subtract taxes and owner draw from EBT, we find the change in equity between periods of ($185) equal to the actual change in equity reported in Table 8.2.

(8.4)
$$\Delta \text{Equity} = EBT - \text{taxes} - \text{owner draw} = \$170 - \$68 - \$287 = (\$185)$$

Table 8.3 reports a change in HQN's assets of $400, ($10,400 – $10,000). Meanwhile, HQN's AIS reports EBIT equal to $650. We can explain part of the difference between EBIT and the actual change in assets by accounting for interest and taxes paid and owner draw. These describe how operating activities can explain the difference between beginning and ending assets. Then if we add the effect of increased liabilities of $585, ($8585 – $8000), and the corresponding increase in assets, we explain the discrepancy. We summarize these results in the Table 8.3.

**Table 8.3. HQN's EBIT and Change in Assets**

| | | |
|---|---|---|
| | EBIT | $650 |
| – | Interest paid | $480 |
| – | Taxes paid | $68 |
| – | Owner draw | $287 |
| = | Change in retained earnings | ($185) |
| + | Changes in total liabilities | $585 |
| = | Change in total assets | $400 |

The main point is that while rates of return on assets and equity reflect some changes in beginning assets and equity—they do not necessarily equal the differences between beginning and ending assets and equity reported in balance sheets. Therefore, we cannot measure rates of return on assets and equity as percentage changes in ending and beginning assets and equity reported in balance sheets.

> So, what have we learned? We have learned that EBIT and EBT estimate earnings on beginning assets and equity respectively. EBIT and EBT should be used rather than changes in assets and equity to estimate asset and equity earnings because some changes in assets and equity may be unrelated to investment earnings. We estimate of ROA and ROE by dividing EBIT by $A_0$ and EBT by $E_0$ respectively.

# AIS and IRR Models

*IRR model definition.* To build an IRR model, we reorganize an AIS into cash flow and changes in operating and capital accounts. This reorganization allows us to extend an AIS into an $n$ period IRR model by separating $n$ periods of cash flow from the liquidation of operating and capital accounts in the $n^{th}$ period.

Table 8.4 divides cash flow into cash receipts (CR) and cash expenses (CE). CR include cash sales from operations, reductions in accounts receivable ($\Delta AR < 0$), reductions in inventories held for sale ($\Delta Inv < 0$) and realized capital gains (RCG). CE include cash COGS, cash OEs, reductions in accounts payable ($\Delta AP < 0$), and reductions in accrued liabilities ($\Delta AL < 0$).

**Table 8.4. HQN 2018 Cash Flow (Cash Receipts minus Cash Expenses)**

| | | |
|---|---|---|
| + | Cash Receipts from Operations | $38,990 |
| + | Realized Capital Gains (RCG) | $0 |
| = | Cash Receipts (CR) | $38,990 |
| + | Cash Cost of Goods Sold (COGS) | $27,000 |
| + | Cash Operating Expenses (OE) | $11,078 |
| = | Cash Expenses (CE) | $11,078 |
| | CR − CE | $912 |

Table 8.5 records changes in operating accounts and depreciation. Changes in operating accounts include $\Delta AR$, $\Delta Inv$, $\Delta AP$, and $\Delta OE$. Note that we include negative changes in operating accounts that produce CR and CE cash flow. We include changes in operating accounts regardless of their sign in Table 8.5 to assure that we are measuring returns and expenses when they occur.

**Table 8.5. HQN 2018 Changes in Operating and Capital Accounts**

| | | |
|---|---|---|
| + | Change in accounts receivable ($\Delta AR$) | ($440) |
| + | Change in inventories ($\Delta Inv$) | $1450 |
| − | Change in accounts payable ($\Delta AP$) | $1,000 |
| − | Change in accrued liabilities ($\Delta AL$) | ($78) |
| = | Changes in operating accounts | $88 |
| − | Depreciation (Dep) | $350 |
| = | Changes in capital accounts | $350 |
| = | Changes in operating and capital accounts | ($262) |

To summarize the calculations included in Tables 8.4 and 8.5 we express HQN's EBIT as the sum of cash flow and changes in operating and capital accounts:

$$
\begin{aligned}
EBIT &= (CR - CE) + (\Delta AR + \Delta INV - \Delta AP - \Delta AL - Dep) \\
&= \$912 + (\$262) = \$650
\end{aligned}
\tag{8.5}
$$

Notice that the sum of cash flow (CR – CE) recorded in Table 8.4 of $912 plus changes in operating and capital accounts (ΔAR + ΔINV – ΔAP – ΔAL – Dep) recorded in Table 8.5 of ($262) equal EBIT of $650 reported in Table 8.1. Were the capital assets sold and their liquidation value not equal to their book value, the difference in capital accounts would be recorded as realized capital gains or losses (RCG) and included in our cash flow measure.

Finally, the EBIT estimate of change in assets minus interest costs equals EBT, the estimate of HQN's change in equity:

$$EBT = EBIT - Int = \$650 - \$480 = \$170 \tag{8.6}$$

> So, what have we learned? Total revenue in AIS include the difference between CR and CE and changes in operating and capital accounts plus RCG. CR includes cash sales plus reductions in AR (ΔAR<0) and Inv (ΔInv<0) accounts. Cash expenses include cash COGS and OEs and reductions in AP (ΔAP<0) and AL (ΔAL<0) accounts. Changes in operating account include changes between the ending and beginning AR, Inv, AP, and AL accounts over the life of the analysis. When we do not intend to liquidate capital assets at the end of the analysis, we value them at their book value rather than their market value.

## AIS and IRR$^{A}$ Models

*Single period IRR$^{A}$ models.* We found ROA and ROE from an AIS by dividing EBIT and EBT by beginning assets $A_0$ and equity $E_0$ respectively. We follow a similar procedure when we build PV models. We must account for the beginning value of assets and equity as well as relevant changes in their ending values, including only those changes that affect EBIT or EBT. We are not interested in explaining total changes in equity and assets over the periods of analysis, but only those changes that we can attribute to operating, investing, and financing activities. To that end, we rearrange equation (8.2) and write:

$$A_0 ROA = EBIT \tag{8.7}$$

Now suppose that we add $A_0$ to both sides of equation (8.7) and after factoring, divide both sides of equation (8.7) by (1 + ROA) to obtain:

(8.8)

$$A_0 = \frac{A_0 + EBIT}{(1 + ROA)}$$
$$= \frac{A_0 + (CR_1 - CE_1) + (\Delta AR_1 + \Delta Inv_1 - \Delta AP_1 - \Delta AL_1 - Dep_1)}{(1 + ROA)}$$

We simplify equation (8.8) by substituting for $A_0$, the value of capital accounts $V_0$ plus the value of current asset accounts $AR_0$ and $Inv_0$ plus beginning cash balance $Csh_0$.

(8.9)

$$A_0 = \frac{V_0 + AR_0 + Inv_0 + Csh_0 + (CR_1 - CE_1) + (\Delta AR_1 + \Delta Inv_1 - \Delta AP_1 - \Delta AL_1 - Dep_1}{(1 + ROA)}$$

We simplify equation (8.8) still more by recognizing that the value of capital assets $V_0$ less depreciation, $Dep_1$, equals the book value of capital assets $V_1^{book}$ at the end of the period. However, if the capital assets are actually liquidated, then the liquidation value of capital assets can be written as $V_1^{liquidation} = V_0^{book} - Dep_1 + RCG$. Furthermore, $AR_0 + \Delta AR_1 = AR_1$, and $Inv_0 + \Delta Inv_1 = Inv_1$. Now we can rewrite equation (8.9) as:

(8.10)

$$A_0 = \frac{(V_1^{liquidation} + AR_1 + Inv_1 + Csh_0 + (CR_1 - CE_1) - (\Delta AP_1 + \Delta AL_1)}{(1 + ROA)}$$

To write the multi-period equivalent of equation (8.10), we allow time subscripts to range from $t = 1, \ldots, n$ periods. To convert cash flow and liquidated values of noncash operating and capital accounts to their present value, we discount them by (1 + ROA). However, the discount rate in the multi-period equation is not the ROA derived from the one-period AIS but $IRR^A$, a multi-period average internal rate of return on assets, that we substitute for ROA. We summarize our results in equation (8.11):

(8.11)

$$
\begin{aligned}
A_0 &= V_0 + AR_0 + Inv_0 + Csh_0 \\
&= \frac{CR_1 - CE_1}{(1 + IRR^A)} + \cdots + \frac{CR_n - CE_n}{(1 + IRR^A)^n} \\
&+ \frac{V_n^{liquidation} + AR_n + Inv_n + Csh_0 - (AP_n - AP_0) - (AL_n - AL_0)}{(1 + IRR^A)^n}
\end{aligned}
$$

To demonstrate equation (8.11) with data from HQN, we set $n$=1, replace $IRR^A$ with ROA and write:

(8.12)

$$
\begin{aligned}
A_0 &= \frac{CR_1 - CE_1}{(1 + ROA)} \\
&+ \frac{V_1^{liquidation} + (AR_1 + Inv_1 + Csh_0) - (AP_1 - AP_0) - (AL_1 - AL_0)}{(1 + ROA)} \\
&= \frac{\$38,990 - \$38,078}{(1.065)} \\
&+ \frac{(\$3,400 - \$70) + (\$1,200 + \$5,200 + \$930) - \$1000 - \$78)}{(1.065)} \\
&= \frac{\$10,650}{1.065} = \$10,000
\end{aligned}
$$

To explain equation (8.12), we compare the result with HQN's AIS. We observe $CR_1$ less $CE_1$ produces \$38,990 – \$38,078 = \$912 (see Table 8.1). Ending period long-term assets (LTA) equal \$3,400 (see Table 8.2) from which we subtract purchases minus sales of LTA equal to \$100 – \$30 = \$70. Ending account balances AR1 + Inv1 equal \$1,200 + \$5,200, and the beginning cash balance is \$930. Next, we subtract changes in accounts payable of \$1,000 and changes in accrued liabilities of (\$78).

# AIS and IRR$^{E}$ Models

We computed ROE by subtracting from EBIT interest paid for the use of debt and divided the result by beginning equity, $E_0$. To find the multi-period IRR for equity, IRR$^{E}$, we subtract in each period $t$ interest cost $iD_{t-1}$ where $D_{t-1}$ equals the firm's debt at the end of the previous period and $i$ equals the average cost of debt. To find the amount of equity invested, we subtract from initial assets initial debt $D_0$. Outstanding debt during the period of analysis collects interest. No changes in debt occur in the last period and debt at the end of the $t$–1$^{st}$ period, $D_{n-1}$, is retired in the last period. Revising equation (8.10) to account for interest costs and debt and replacing ROE with IRR$^{E}$, we can find the multi-period equivalent of ROE, IRR$^{E}$. We write:

(8.13)

$$
\begin{aligned}
E + 0 &= V_0 + AR_0 + Inv_0 + Csh_0 - D_0 \\
&= \frac{(CR_1 - CE_1 - iD_0)}{(1 + IRR^E)} + \cdots + \frac{(CR_n - CE_n - iD_{n-1})}{(1 + IRR^E)^n} \\
&+ \frac{V_n^{liquidation} + AR_n + Inv_n + Csh_0 - (AP_n - AP_0) - (AL_n - AL_0) - D_0}{(1 + IRR^E)^n}
\end{aligned}
$$

To illustrate equation (8.13) with data from HQN, we set $n$ = 1, replace IRR$^{E}$ with ROE and write:

(8.14)

$$
\begin{aligned}
E_0 &= \frac{CR_1 - CE_1 - iD_0}{(1 + ROE)} \\
&+ \frac{V_1^{liquidation} + AR_1 + Inv_1 + Csh_0 - (AP_1 - AP_0) - (AL_1 - AL_0) - D_0}{(1 + ROE)} \\
&= \frac{\$38,990 - \$38,078 - \$480}{(1.085)} \\
&+ \frac{(\$3,400 - \$70) + \$1,200 + \$5,200 + \$930}{(1.085)} \\
&- \frac{\$1,000 + (\$78) + \$8,000}{(1.085)} \\
&= \frac{\$2,170}{1.085} = \$2,000
\end{aligned}
$$

So, what have we learned? We have learned that the multi-period $IRR^A$ and $IRR^E$ models described in equations (8.11) and (8.13) follow AIS construction principles. Investing and

borrowing recorded in AIS occur at the beginning of the period. Liquidation of investments and repayments occur at the end of the period. When we extend single period AIS to multi-period PV models, we must allow for multi-period repayments and borrowings and investing and disinvesting. We can easily extend equations (8.11) and (8.13) to account for these possibilities. However, wanting to maintain the focus of this paper on AIS and PV model connections, we omit these complications for now.

## AIS Earnings and NPV Models

In the previous sections we derived multi-period $IRR^A$ and $IRR^E$ that correspond to ROA and ROE derived from a one period AIS and beginning assets and equity. Now we introduce multi-period NPV models that correspond to one period AIS earnings, EBIT, EBT, and NIAT. We begin by emphasizing the main difference between IRR and NPV models. IRR models find the rate of return earned by the investment or equity supporting the investment. NPV models measure the earnings realized by transferring funds from a defending investment, the investment in place, to a challenging investment, the investment being considered to replace the defending investment. Thus, NPV models convert multi-period future cash flow and changes in operating and capital accounts from a challenging investment for present dollars at the rate of one plus the defender's IRR, (1 + IRR).

*EBIT and* $NPV^A$ *earnings on assets.* We write NPV for asset earnings by rearranging equation (8.10) and by reinterpreting $IRR^A$ as the internal rate of return on a defending investment.

(8.15)

$$NPV^A = -A_0 + \frac{CR_1 - CE_1}{(1+IRR^A)} + \cdots + \frac{CR_n - CE_n}{(1+IRR^A)^n} + \frac{V_n^{liquidation} + AR_n + Inv_n + Csh_0 - (AP_n - AP_0) - (AL_n - AL_0)}{(1+IRR^A)^n}$$

To demonstrate equation (8.15) with HQN data, we set $n = 1$, replace $IRR^A$ with ROA, and write:

(8.16)

$$
\begin{aligned}
NPV^A &= -A_0 + \frac{CR_1 - CE_1}{(1+ROA)} \\
&+ \frac{V_1^{liquidation} + AR_1 + Inv_1 + Csh_0 - (AP_1 - AP_0) - (AL_1 - AL_0)}{(1+ROA)} \\
&= -\$10,000 + \frac{\$38,990 - \$38,078}{(1.065)} \\
&+ \frac{(\$3,400 - \$70) + \$1,200 + \$5,200 + \$930}{(1.065)} \\
&- \frac{\$1,000 + (\$78)}{(1.065)} = -\$10,000 + \frac{\$10,650}{1.065} = \$0
\end{aligned}
$$

Notice that the $NPV^A$ after exchanging funds from a defender with an identical challenger is zero. But if we found NPV at the end of one period, $(IRR^A)(A_0)$, the product would equal EBIT: (.065)($10,000) = $650 (see equation 8.5). These results emphasize that one important difference between AIS and NPV earnings is that AIS value earnings at the end of the period while PV models value earnings in the present. NPVs value earnings in the present because the present is where we live and make decisions. It should be obviously that if the defender's IRR were not equal to the challenger's IRR, then $NPV^A$ would not equal zero. For example, suppose that in equation (8.15), the defender's IRR were 6%. Then $NPV^A$ would equal $47.17.

*EBT and NPVE earnings on equity.* We write the NPV for equity earnings by rearranging equation (8.14) and by recognizing that $IRR^E$ is the internal rate of return on equity for a defending investment.

(8.17)

$$
\begin{aligned}
NPV^E &= -(A_0 - D_0) \\
&= -(V_0 + AR_0 + Inv_0 + Csh_0) + D_0 \\
&+ \frac{(CR_1 - CE_1 - iD_0)}{(1 + IRR^E)} + \cdots + \frac{(CR_n - CE_n - iD_{n-1})}{(1 + IRR^E)^n} \\
&+ \frac{V_n^{liquidation} + AR_n + Inv_n + Csh_0 - (AP_n - AP_0) - (AL_n - AL_0) - D_0}{(1 + IRR^E)^n}
\end{aligned}
$$

To illustrate equation (8.17) with data from HQN, we set $n$=1, replace $IRR^E$ with ROE, and write:

(8.18)

$$
\begin{aligned}
NPV^E &= -E_0 + \frac{CR_1 - CE_1 - iD_0}{(1+ROE)} \\
&+ \frac{V_1^{liquidation} + AR_1 + Inv_1 + Csh_0 - (AP_1 - AP_0) - (AL_1 - AL_0) - D_0}{(1+ROE)} \\
&= -\$2,000 + \frac{\$38,990 - \$38,078 - \$480}{(1.085)} \\
&+ \frac{(\$3,400 - \$70) + \$6,400 + \$930}{(1.085)} \\
&- \frac{\$1,000 + (\$78) + \$8,000)}{(1.085)} \\
&= -\$2,000 + \frac{\$2,170}{1.085} = \$0
\end{aligned}
$$

Like the results obtained for $NPV^A$, $NPV^E$ from exchanging funds from a defender with an identical challenger is zero. But if we found $NPV^E$ at the end of one period, $(IRR^E)x(E_0)$, the product would equal EBT: (.085)x($2,0000) = $170 (see equation 8.6). It should be obvious that if the defender's IRR were not equal to the challenger's IRR, that $NPV^E$ would not equal zero. For example, suppose that in equation (8.18), the defender's IRR were 8%. Then $NPV^E$ would equal $9.26.

So, what have we learned? We have learned that EBIT corresponds to $NPV^A$. EBT corresponds to $NPV^E$. We have also learned that IRR and NPV models are distinguished by their reinvestment rate assumptions. IRR models assume that cash flow is reinvested in the challenger and earn the challenger's IRR. NPV models assume that cash flow is reinvested in the defender and earn the defender's IRR. Because cash flow in IRR models is discounted and reinvested at the same rate, NPVs or IRR earnings either from assets or equity are always zero.

## After-tax ROE and ROA

PV models often focus on after-tax cash flow because it represents what firms/investors keep after paying all their expenses including taxes. In what follows we present tax obligations in a simplified form to illustrate their impact on earnings and rates of return. Our goal is to find the average tax rate T that adjusts ROE to ROE(1–T) and T* that adjusts ROA to ROA(1–T*). We do not try to duplicate the complicated processes followed by taxing authorities to find T and T*. Instead we suggest that the firm pays an average tax rate T or T* on EBT and EBIT respectively.

AIS report taxes paid by the firm and subtracts them from EBT to obtain NIAT. We calculate interest costs by multiplying the average interest rate $i$ times beginning period debt $D_{t-1}$ ($iD_{t-1}$) and subtract them from earnings to reduce tax obligations. As a result, NIAT represents changes in equity after both interest and taxes have been paid. In 2018, HQN paid $68 in taxes. To find the average tax rate HQN paid on its changes in equity we set taxes equal to the average tax rate T times EBT:

$$\text{Taxes} = (T)(EBT) = \$68 \tag{8.19}$$

Solving for the average tax rate T that HQN paid on its earnings we find:

$$T = \frac{\text{Taxes}}{EBT} = \frac{\$68}{\$170} = 40\% \tag{8.20}$$

Finally, we adjust ROE for taxes and find HQN's after-tax ROE to be:

$$ROE(1-T) = \frac{NIAT}{E_0} = \frac{\$102}{\$2,000} = 5.1\% \tag{8.21}$$

*AIS and After-tax ROAs.* An AIS computes taxes paid by the firm on its return to equity but not on its return to assets. They record only one value for taxes paid and these estimates account for tax saving

resulting from interest payments. As a result, we cannot use the average tax rate T calculated for taxes paid on equity earnings to adjust ROA for taxes. To find the average tax rate T* that adjusts ROA to ROA(1 – T*), we calculate taxes "as if" there were no interest costs to reduce the average tax rate to T*. We find ROA(1 – T*) in equation (8.16) as:

$$ROA(1-T*) = \frac{(EBIT - \text{Taxes})}{A_0} = \frac{(\$650 - \$68)}{\$10,000} = 5.8\% \tag{8.22}$$

Solving for T* we find:

$$T* = 1 - \frac{(EBIT - \text{Taxes})}{EBIT} = 1 - \frac{(\$650 - \$68)}{\$650} = 10.5\% \tag{8.23}$$

Equation (8.23) emphasizes an important point: adjusting ROE and ROA for taxes nearly always requires different average tax rates. The only time that T = T* is when interest costs are zero. In that case, we can easily demonstrate that T* = T since EBIT = EBT:

$$T = T* = \frac{\text{Taxes}}{EBIT} = \frac{\text{Taxes}}{EBT} = 10.5\% \tag{8.24}$$

## After-tax Multiperiod IRR$^{E(1-T)}$ Model

We are now prepared to introduce taxes into the IRR$^E$ model described in equation (8.13). We begin by solving for NIAT in equation (8.21) and replacing ROE(1-T) with IRR$^E$(1 – T):

$$NIAT = E_0 ROE(1-T) = E_0 IRR^E(1-T) \tag{8.25}$$

Next, we write NIAT as EBIT adjusted for both interest costs and taxes:

$$NIAT = (EBIT - Int)(1-T) \tag{8.26}$$

Then, we substitute for EBIT the right-hand side of equation (8.5) and for NIAT, the right-hand side of equation (8.25) and add time subscripts. The result is equation (8.27).

$$\begin{aligned} & E_0 ROE(1-T) \\ & = [(CR_1 - CE_1 - Int_1) \\ & + (\Delta AR_1 + \Delta Inv_1 - \Delta AP_1 - \Delta AL_1 - Dep_1)](1-T) \end{aligned} \tag{8.27}$$

Finally, we add $E_0$ to both sides of equation (8.27) and after factoring [1 + ROE(1 – T)] and dividing both sides of equation (8.27) by the factor, we obtain:

(8.28)

$$E_0 = \frac{E_0 + [(CR_1 - CE_1 - Int_1) + (\Delta AR_1 + \Delta Inv_1 - \Delta AP_1 - \Delta AL_1 - Dep_1)](1-T)}{[1 + ROE(1-T)]}$$

Replacing $E_0$ with $Csh_0 + AR_0 + Inv_0 + V_0 - D_0$ in the numerator of (8.28), we can write:

(8.29)

$$E_0 = \frac{Csh_0 + AR_0 + Inv_0 + V_0 - D_0 + [(CR_1 - CE_1 - Int_1)}{[1 + ROE(1-T)]} + \frac{(\Delta AR_1 + \Delta Inv_1 - \Delta AP_1 - \Delta AL_1 - Dep_1)](1-T)}{[1 + ROE(1-T)]}$$

Finally, we simplify equation (8.29) by recognizing that

(8.30) $$V_0 - Dep_1(1-T) = V_1^{book} + TDep_1,$$

(8.31) $$Int_1 = iD_0, \text{and}$$

(8.32) $$AR_0 + Inv_0 + (\Delta AR_1 + \Delta Inv_1)(1-T) = T(AR_0 + Inv_0) + (1-T)(AR_1 + Inv_1).$$

These simplifications allow us to rewrite equation (8.29) as:

(8.33)

$$E_0 = \frac{Csh_0 - D_0 + T(AR_0 + Inv_0) + (1-T)(AR_1 + Inv_1) + V_1^{book} + TDep_1}{[1 + ROE(1-T)]} + \frac{[(CR_1 - CE_1 - iD_0) - (\Delta AP_1 + \Delta AL_1)](1-T)}{[1 + ROE(1-T)]}$$

To verify our results, we substitute HQN numerical values into equation (8.33) and find:

(8.34)

$$E_0 = \frac{\$930 - \$8,000 + [.4(\$1,640 + \$3,750)]}{(1.051)} + \frac{[.6(\$1,200 + \$5,200)] + (\$3,400 - \$70) + [.6(\$350)]}{(1.051)} + \frac{[(\$38,990 - \$38,078 - \$480) - (\$1,000 - \$78)].6}{(1.051)} = \$2,000$$

To write the multi-period equivalent of equation (8.34) we discount n periods of operating income and in the nth period we liquidate operating and capital accounts and replace ROE(1 – T) with $IRR^E(1 - T)$.

$$
\begin{aligned}
E_0 = & \frac{(CR_1 - CE_1 - iD_0)(1-T) + TDep_1}{[1 + IRR^E(1-T)]} \\
& + \cdots + \frac{(CR_n - CE_n - iD_{n-1})(1-T) + TDep_n}{[1 + IRR^E(1-T)]^n} \\
& + \frac{Csh_0 - D_0 + T(AR_0 + Inv_0) + (1-T)(AR_n + Inv_n)}{[1 + IRR^E(1-T)]^n} \\
& + \frac{V_n^{book} - (AP_n - AP_0 + AL_n - AL_0)(1-T)}{[1 + IRR^E(1-T)]^n}
\end{aligned}
\tag{8.35}
$$

*Capital gains (losses) and taxes.* At the end of the analysis, PV models value their capital assets at their book value, or if they liquidate them, they value them at their liquidation value $V_n^{liquidation}$. For tax purposes, if the difference between the liquidation and book value of capital assets is positive, ($V_n^{liquidation} - V_n^{book}$) > 0, the firm or the investment has realized capital gains whose after-tax value is (1 – T)($V_n^{liquidation} - V_n^{book}$) > 0. On the other hand, if the difference is negative ($V_n^{liquidation} - V_n^{book}$) < 0, then the firm has realized a capital loss and earned tax credits whose after-tax value loss is (1 – T)($V_n^{liquidation} - V_n^{book}$) < 0. To simplify the tax discussion, we ignore the tax rate differences between income, capital gains, and depreciation recapture and apply only one tax rate T, the average of all tax rates. Finally, to adjust capital accounts for taxes, we replace $V_n^{book}$ in equation (8.28) with what follows:

$$
(1-T)(V_n^{liquidation} - V_n^{book}) + V_n^{book} = (1-T)V_n^{liquidation} + TV_n^{book} \tag{8.36}
$$

Now we can write the after-tax IRRE model for changes in equity consistent with AIS construction principles.

(8.37)

$$
\begin{aligned}
E_0 = & \frac{(CE_1 - CE_1 - iD_0)(1-T) + TDep_1}{[1 + IRR^E(1-T)]} \\
& + \cdots + \frac{(CR_n - CE_n - iD_{n-1})(1-T) + TDep_n}{[1 + IRR^E(1-T)]^n} \\
& + \frac{Csh_0 - D_0 + T(AR_0 + Inv_0) + (1-T)(AR_n + Inv_n)}{[1 + IRR^E(1-T)]^n} \\
& + \frac{(1-T)V_n^{liquidation} + TV_n^{book} - (AP_n - AP_0 + AL_n - AL_0)(1-T)}{[1 + IRR^E(1-T)]^n}
\end{aligned}
$$

So, what have we learned? We have learned that taxes are intended to be charged on earnings including the cost (interest) of using borrowed funds that support the investment. While most expenses are incurred in exchanges for nondurable goods that are used up in the period's production, capital investments are only used up over several periods. To account for the periodic costs of using capital assets, we include depreciation as a cost when finding earnings and rates of return. We also use depreciation to generate tax savings.

# After-tax Multi-period $IRR^A(1-T^*)$ Model

There is no explicit measure for T* that can be used to find ROA(1 – T*). This peculiar result occurs because taxes must account for interest costs that we do not consider when finding EBIT. Yet, many applied IRR models solve for after-tax return on assets that assume we can measure ROA(1 – T*). Still, we can find such a measure from an AIS allowing us to write:

(8.38)

$$
\begin{aligned}
A_0 = & \frac{(CR_1 - CE_1)(1-T*) + T * Dep_1}{[1 + IRR^A(1-T*)]} \\
& + \cdots + \frac{(CR_n - CE_n)(1-T*) + T * Dep_n}{[1 + IRR^A(1-T*)]^n} \\
& + \frac{Csh_0 + T * Accts_0 + (1-T*)Accts_n}{[1 + IRR^A(1-T*)]^n} \\
& + \frac{(1-T*)V_n^{liquidation} + T * V_n^{book} - (AP_n - AP_0 + AL_n - AL_0)(1-T*)}{[1 + IRR^A(1-T*)]^n}
\end{aligned}
$$

The main difference between equations (8.37) and (8.38) is that T is replaced with T*, interest charges are not subtracted from periodic cash flow, and initial liabilities are no longer subtracted. All these changes are required so that earnings can be attributed to beginning assets rather than beginning equity.

Although there is no explicit AIS measure corresponding to equation (8.38), we do know the value of beginning assets $A_0$ and $IRR^A$ (1 – T*) so we can write the one period HQN numerical equivalent of (8.38) assuming capital assets are valued at their book value:

$$
\begin{aligned}
A_0 &= \frac{Csh_0 + T * Accts_0 + (1 - T*)Accts_1 + V_1^{book} + T * Dep_1}{[1 + ROA(1 - T*)]} \\
&+ \frac{[(CR_1 - CE_1) - (\Delta AP_1 + \Delta AL_1)](1 - T*)}{[1 + ROA(1 - T*)]} \\
&= \frac{\$930 + \$565.95 + \$5,728 + \$3,330 + \$36.75}{(1.058)} \\
&+ \frac{[(\$38,990 - \$38,078) - (\$1,000 - \$78)].895}{(1.058)} \\
&= \$10,000
\end{aligned} \tag{8.39}
$$

So, what have we learned? We have learned that AIS do not find after-tax earnings on assets because tax laws account for interest payments which are not considered on returns to assets. Still, it is popular to find after-tax rates of return and earnings on assets which requires a special calculation to find the equivalent average after-tax rate.

## Rates of Return on Assets and Equity

Miller and Bradford (2000) reviewed and compared rates of return on assets and equity. We agree with their conclusion that the two measures should be viewed as complementary. To describe the relationship between ROE and ROA, we begin with equations (8.2) and (8.3) that employ AIS definitions of ROA and ROE. From these two equations we deduce the rates of return identity:

(8.40)

$$
ROE = \frac{EBIT - Int}{E_0} = \frac{(ROA)(A_0) - (i)(D_0)}{E_0} = \frac{(ROA - i)D_0}{E_0} + ROA
$$

Note that in equation (8.40) if $i$ = ROA or if $D_0 = 0$ then ROE = ROA. Note also that ROE and ROA are positively related. Furthermore, if we solve for ROA as a function of ROE, we find the familiar weighted cost of capital (WCC) equation that we illustrate using HQN data:

$$\begin{aligned} ROA &= ROE\left(\frac{E_0}{A_0}\right) + i\left(\frac{D_0}{A_0}\right) \\ &= 8.5\%\left(\frac{\$2,000}{\$10,000}\right) + 6\%\left(\frac{\$8,000}{\$10,000}\right) = 6.5\% \end{aligned} \tag{8.41}$$

Of course, we are less confident about the relationships in equations (8.40) and (8.41) when measured in multi-period settings where ROA is replaced with $IRR^A$ and ROE is replaced with $IRR^E$ and interest rates and asset and debt levels may vary over time.

We emphasize that both ROA and ROE provide interesting and important information. Financial managers should be interested in what firms and investments can earn independent of how they are financed. Then, if the difference between return on assets and the cost of debt matters, as it should, ROE provides important information for choosing between alternative financing options.

> So, what have we learned? We have learned that by adjusting liabilities, interest costs, and tax rates, we can derive PV earning measures corresponding to NIAT, EBIT, and EBT measures calculated in AIS. This provides us an interesting interpretation of PV models. Discounting after-tax multi-period earnings on equity provides a measure corresponding the present value of future NIAT calculations. Discounting before-tax multi-period earnings on assets provides a measure corresponding the present value of future EBIT calculations. Finally, discounting before-tax multi-period earnings on equity provides a measure corresponding the present value of future EBT calculations

## Conflicting Asset and Equity Earnings and Rates of Return Rankings

Suppose we are comparing two mutually exclusive challengers, 1 and 2, funded by the same defender and earning rates of return on invested assets of $ROA^1 > ROA^2$. Do these results imply that $ROE^1 > ROE^2$? That NPV earnings from assets invested in challengers 1 and 2 satisfy $NPV^{A1} > NPV^{A2}$? Or, that NPV earnings from equity invested in challengers 1 and 2 satisfy $NPV^{E1} > NPV^{E2}$?

The answer is that earnings and rates of return on assets and equity are consistent only under limited conditions. These include, $A_0$ and $E_0$ must satisfy homogeneity of size conditions and the average interest cost $i$ must be the same for both investments. We demonstrate that if the homogeneity and average interest rate conditions are satisfied, then $ROA^1 > ROA^2$ implies $ROE^1 > ROE^2$, $NPV^{A2} > NPV^{A1}$, and $NPV^{E1} > NPV^{E2}$. To begin, recall equation (8.41) that allows us to write:

(8.42)

$$\begin{aligned} ROA^1 - ROA^2 &= ROE^1 \left(\frac{E_0}{A_0}\right) + i\left(\frac{D_0}{A_0}\right) - ROE^2 \left(\frac{E_0}{A_0}\right) + i\left(\frac{D_0}{A_0}\right) \\ &= (ROE^1 - ROE^2)\left(\frac{E_0}{A_0}\right) \end{aligned}$$

Therefore, if $ROA^1 > ROA^2$, then $ROE^1 > ROE^2$. Next, if $ROA^1 > ROA^2$, then from equation (8.2), it follows that $EBIT^1 > EBIT^2$ and $NPV^{A1} > NPV^{A2}$ since:

(8.43)
$$NPV^{A1} - NPV^{A2} = \frac{EBIT^1 - EBIT^2}{(1 + ROA)} > 0$$

Finally, if $EBIT^1 > EBIT^2$ and interest costs are the same for both investments, then $EBT^1 > EBT^2$ and $NPV^{E1} > NPV^{E2}$ since:

(8.44)
$$NPV^{E1} - NPV^{E2} = \frac{EBIT^1 - EBIT^2}{(1 + ROE)}$$

Conflicting rankings may occur when interest rates or debt levels financing the two challengers differ. To illustrate, suppose we decided to rank challengers 1 and 2 that satisfied homogeneity of size conditions for assets and equity and whose ROA1 and ROA2 were equal. Now assume that interest costs for the two investments differed. Then we would rank the two investments based on their asset earnings and rates of return as equal. But for rankings based on equity earnings and rates of return, the investment with the lower interest cost would be preferred. The consequence is that asset-based rankings would be equal and equity-based rankings would be unequal and asset and equity-based rankings would be inconsistent.

To make clear that asset and equity earnings and rates of return may produce conflicting rankings, consider HQN's one-period ROA of 6.5% ($650/$10,000) and its one-period ROE of 8.5% ($170/$2,000) respectively. Let HQN's beginning assets and EBIT describe both investments 1 and 2. Now suppose

that interest costs for investments 1 and 2 differed. For example, let the average interest rate charged on investment 1 be 6% and 0% for investment 2. As a result, the $IRR^E$ and $NPV^E$ rankings would no longer be consistent with IRRA and $NPV^A$ rankings for investments 1 and 2. We summarize these results in Table 8.6.

**Table 8.6. HQN's Inconsistent rankings based on asset and equity earnings and rates of return.**

| | Investment 1 | Investment 2 |
|---|---|---|
| Asset earnings and rates of return (rankings) | | |
| $NPV^A$ (rankings) | EBIT=$650 (1) | >EBIT=$650 (1) |
| $IRR^A$ (rankings) | $650/$10,000=6.5% (1) | >$650/$10,000=6.5% (1) |
| Equity earnings and rates of return (rankings) | | |
| $NPV^E$ (rankings) | EBT=$170 (2) | EBT=$650 (1) |
| $IRR^E$ (rankings) | $170/$2,000=8.5% (2) | $650/$2,000=32.5% (1) |

One can imagine other less extreme cases in which asset and equity rankings could be inconsistent simply because interest cost influence earnings and rates of return on equity but not for assets.

So, what have we learned? We have learned that earnings and rates of return measures for assets and equity need not provide consistent rankings. As a result, financial managers must carefully whether investment decisions should depend on asset or equity earnings. At the heart of this decision is the importance of debt and interest charges in making investment decisions.

## Summary and Conclusions

We now make explicit the main point of this paper. PV models should be constructed as multi-period extensions of AIS. Otherwise, they may misrepresent the financial characteristics of investments and may lead to less than optimal investment decisions. Furthermore, different AIS earnings and rates of return help us distinguish between different NPV models and IRR. These distinctions are important since asset and earning measures on assets and equity may lead to different recommendations.

We emphasize that AIS help us recognize the conditions required for asset and equity earnings and rates of return rankings to be consistent. These insights that we learn from AIS and multi-period extensions of AIS, we believe will help financial managers better understand, build, and interpret PV models. However, these results, also task financial managers with the responsibility to carefully decide whether to base their recommendation on asset or equity earnings and rates of return.

Using the PV models developed in this paper, we can imagine financial managers building Excel templates or similar computerized support systems to solve applied investment problems that include more details than we were able to include in our demonstrations. These details may include more complete description of taxes and allow more investments and disinvestments to occur during the analysis. We wish you all success in this effort—to develop and apply PV models that represent multi-period extensions of AIS.

## Questions

1. How does this chapter define present value models?
2. Describe two similarities and distinctions between AIS and PV models.
3. Discuss the following statement. AIS find earnings at the end of the period. PV models value earnings in present dollar equivalents.
4. AIS EBIT and EBT measure earnings on beginning assets and equity respectively. Do these measures equal the actual change in beginning assets and equity? If not, explain why not?
5. Please consider the following statement. AIS value cash flows and liquidation of operating and capital accounts at the end of one period. IRR models find the present value of cash flow earnings over several periods and the liquidation of operating and capital account that occurs in the last period. Explain why this difference between AIS and PV models is required. (Hint: why do we limit AIS earning measures to one period while PV models find the present value of investment earnings over several periods.
6. What is the main difference between $IRR^A$ models and $IRR^E$ models?
7. One important difference between IRR models and NPV models is their reinvestment rate assumptions. Please describe the reinvestment rate assumptions for IRR and NPV models. What is the NPV value for IRR models?
8. The cost of operating inputs is included in PV models in the period in which they are paid for with cash. Explain how depreciation estimates the cost of using up capital inputs.
9. Explain the difference between the average tax rate used to find the after-tax rate of return on equity versus the average tax rate used to find the after-tax rate of return on assets. Also explain why AIS compute earnings on assets (EBIT), equity (EBT), and after-tax earnings on equity (NIAT)–but do not calculate after-tax earnings on assets?
10. Using the rate of return identify find ROE if ROA=7%, beginning assets are $10,000, the average interest rate is 6%, and liabilities are 75% of assets.
11. List sufficient conditions that guarantee that earnings and rates of return on asset will generate the same rankings as earnings and rates of return on equity.

12. If earnings and rates of return on assets and equity provided conflicting rankings, which earnings and rates of return measures would you rely on to choose your investment, on assets or on equity? Defend your preference for either asset or equity rankings.
13. Use the template described in the appendix to this chapter to find NPV on assets for the following investment.

## Appendix to Present Value Models & Accrual Income Statements

Open Green & White Services Excel PV Template

A *generalized NPV equation*. This appendix operationalizes the concepts presented in this chapter by presenting a generalized present value (PV) template. The PV template corresponds to an accrual income statement (AIS) that measures after-tax returns on equity described in equation (8.37). To solve equation (8.37) for NPVE(1–T) using a generalized PV template, we replace beginning equity $E_0$ with beginning assets $A_0$ minus beginning liabilities D0 and discount future cash flow using the defender's after-tax internal rate of return on equity IRRE(1–T) and by subtracting equity ($A_0 - D_0$) from both sides of the equation. We rewrite the results as:

(8.A1)

$$
\begin{aligned}
NPV^{E(1-T)} = &-(A_0 - D_0) + \frac{(CR_1 - CE_1 - iD_0)(1-T) + TDep_1}{[1 + IRR^E(1-T)]} \\
&+ \cdots + \frac{(CR_n - CE_n - iD_{n-1})(1-T) + TDep_n}{[1 + IRR^E(1-T)]^n} \\
&+ \frac{Csh_0 - D_0 + TAccts_0 + (1-T)Accts_n}{[1 + IRR^E(1-T)]^n} \\
&+ \frac{(1-T)V_n^{liquidation} + TV_n^{book} - [AP_n - AP_0 + AL_n - AL_0](1-T)}{[1 + IRR^E(1-T)]^n}
\end{aligned}
$$

A generalized PV template for finding rolling earnings and rates of return on equity. We now introduce the generalized NPV template corresponding to equation (8.A1). To demonstrate the template, we use data from the Green and White Services investment problem to be introduced in Chapter 10 and represent the defender by solving HQN's ROE, ROA, T, and T*.

**Table 8.A1. A generalized PV model template with rollin**

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Year | Assets | Debt Capital | Capital Accounts Liquidation Value | Capital Accounts book value | Depreciation (Dep=ΔE) | Asset Operating accounts (AR+INV) | Sales | Cash Receipts (CR=H+ΔG) | Liability Operating Accounts (AP+AL) | Expenses (COGS + OE) |
| 2 | 0 | $40000 | $32000 | $40000 | $40000 | | | | | | |
| 3 | 1 | $0 | $27200 | $30000 | $30000 | $10000 | $1000 | $20000 | $19000 | $0 | $9000 |
| 4 | 2 | $0 | $22200 | $15000 | $15000 | $15000 | $1200 | $30200 | $30000 | $0 | $13500 |
| 5 | 3 | $0 | $17200 | $5000 | $5000 | $10000 | $800 | $35600 | $36000 | $0 | $16500 |
| 6 | 4 | $0 | $12200 | $0 | $0 | $5000 | $400 | $39600 | $40000 | $0 | $18000 |

Defender data obtained from HQN is represented in Table 8.A2 below.

**Table 8.A2. Defender's $IRR^E$, average tax rate T paid on its equity earnings, and average interest "i" rate paid on its liabilities.**

| | A | B |
|---|---|---|
| 1 | $IRR^E$ | 0.085 |
| 2 | T | 0.4 |
| 3 | $IRR^E(1-T)$ | 0.051 |
| 4 | average interest rate i | 0.06 |

Finally, we present in Table 8.A3 GWS equity generated after-tax cash flow during its four years of operation and corresponding after-tax internal rates of return.

**Table 8.A3. GWS equity generated after-tax cash flow during its four years of operations and corresponding after-tax internal rates of return.**

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Economic Life | 1 year | 2 years | 3 years | 4 years |
| 2 | | -$8,000.00 | -$8,000.00 | -$8,000.00 | -$8,000.00 |
| 3 | | $7,448.00 | $4,048.00 | $4,048.00 | $4,048.00 |
| 4 | | -6.90% | $3,440.80 | $9,920.80 | $9,920.80 |
| 5 | | | 3.03% | -$1,819.20 | $9,900.80 |
| 6 | | | | 31.67% | -$2,379.20 |
| 7 | | | | | 64.79% |

The results of Table 8.A3 should remind us of the nature of the IRR calculation. After having calculated an investment's IRR in year t, any positive cash flow in later periods, will increase the investment's IRR. In the case of GWS, cash flow differ in the last year but still add to the calculated IRR value.

*Detailed description of Table* 8.A1. The column headings in Table 8.A1 describe exogenous and endogenous variables used to find rolling (every year) NPV and annuity equivalent (AE) estimates and correspond to variables in equation (8.A1). Highlighted data are exogenous often obtained from coordinated financial statements or projected. Data not highlighted are endogenous or calculated. Projecting values in Table 8.A1 is a subject to which we will return in Chapter 11. Now we will describe in more detail the values in Table 8.A1 and their correspondence to variables in equation (8.A1). Columns are indicated by highlighted letters in column titles.

- Column A indicates the period t at the end of which financial activity occurs and values are recorded.
- Column B line 4 lists total investment amount $A_0$ including beginning cash $C_0$, beginning accounts receivable and inventories ($AR_0$ + $Inv_0$), plus capital investments $V_0$.
- Column C line 4 lists beginning current liabilities and noncurrent long-term liabilities $D_0$ supporting the firm's assets on which interest is paid. Subsequent values in Column C list the amount of outstanding liabilities in each period.
- Column D lists the liquidation value of capital investments. Since Table 8.A1 calculates rolling after-tax estimates of NPV, AE, and IRR, we are required to estimate the liquidated value of the investment in each period.
- Column E lists the book value of capital investments determined by the initial purchase price and depreciation percentages reported by taxing authorities.
- Column F calculates depreciation equal to the change in the investment's book value.

- Column G lists the value of accounts receivable $AR_t$ and inventory $Inv_t$ at the end of period $t$.
- Column H lists total sales during period $t$.
- Column I calculates cash receipts $CR_t$ in period $t$ by adjusting total sales for changes in inventories and accounts receivable.
- Column J lists the value of accounts payable $AP_t$ and accrued liabilities $AL_t$ at the end of period $t$.
- Column K lists expenses in period $t$ equal to the cost of goods $COGS_t$ plus overhead expenses $OE_t$.
- Column L calculates cash expenses $CE_t$ in period $t$ adjusted for changes in accounts payable and accrued liabilities.
- Column M calculates interest costs $iD_{t-1}$ by multiplying periodic liabilities at the end of the previous period $D_{t-1}$ by the average interest rate $i$.
- Column N calculates tax savings from depreciation equal to the average tax rate time depreciation in the previous period
- Column O calculates after-tax cash flow from operations in period $t$, equal to $(CR_t - CE_t - iD_{t-1})(1-T) + TDep_{t-1} + \Delta D_t)$. Note that the change in outstanding debt is included because of its impact on cash flow.
- Column P calculates cash flow from after-tax liquidation of changes in asset operating accounts $(AR_n + Inv_n - AR_0 - Inv_0)(1 - T)$.
- Column Q calculates cash flow from after-tax liquidation of changes in liability operating account $(AP_n - AP_0 + AL_n - AL_0)(1 - T)$.
- Column R calculates the cash flow from after-tax liquidation of capital and asset and liability operating accounts.
- Column S sums cash flow from after-tax liquidations plus operating cash flow in the last period, required for finding rolling NPV, AE, and IRR values.
- Column T calculates rolling after-tax NPVs as though the investment ended in each year using Excel NPV equation by finding the NPV from operations and liquidations.
- Column U calculates rolling after-tax AEs associated with the after-tax NPVs for each period using Excel PMT function by finding the payment whose present value equals after-tax NPV for the corresponding period.
- Column V calculates rolling after-tax IRRs for each year using Excel IRR function. To find the annual IRRs we calculate the after-tax cash flow for each possible age of the investment reported in Table 8.A2.

*Adjusting the PV template to calculate after-tax earnings and rates of return on assets.* AIS statements compute earnings before interest and taxes (EBIT), earnings before taxes (EBT), and net income after taxes (NIAT). Table 8.A1 finds the PV model equivalent of NIAT. However, there is no AIS equivalent earnings measure that corresponds to after-tax NPV measures reported in Table 8.A4. This is because taxes paid are reduced by interest costs. However, in this chapter, Chapter 8, we found a method for finding the equivalent average tax rate paid on earnings from assets that enabled us to find rolling after-tax NPVs, AEs, and IRRs for assets.

To adjust equation 8.A1 to find the after-tax earnings and rates of return for assets, we set $D_0$ equal to zero, we replace the defender's after-tax IRR for equity $IRR^E(1-T)$ with the defender's after-tax return

on assets $IRR^A(1–T^*)$, and we replace the average tax rate T on equity with the average tax rate T* on assets. The revised after-tax NPV calculation for assets is reported as equation 8.A2:

(8.A2)

$$
\begin{aligned}
NPV^{A(1-T*)} &= -A_0 + \frac{(CR_1 - CE_1)(1-T*) + T*Dep_1}{[1+IRR^A(1-T*)]} \\
&+ \cdots + \frac{(CR_n - CE_n)(1-T*) + T*Dep_n)}{[1+IRR^A(1-T*)]^n} \\
&+ \frac{Csh_0 + T*Accts_0 + (1-T*)Accts_n}{[1+IRR^A(1-T*)]^n} \\
&+ \frac{(1-T*)V_n^{liquidation} + T*V_n^{book} - [AP_n - AP_0 + AL_n - AL_0](1-T*)}{[1+IRR^A(1-T*)]^n}
\end{aligned}
$$

The PV template equivalent to equation 8.A2 is reported in Table 8.A4.

**Table 8.A4. A generalized PV model template with rollin**

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Year | Assets | Debt Capital | Capital Accounts Liquidation Value | Capital Accounts book value | Depreciation (Dep=ΔE) | Asset Operating accounts (AR+INV) | Sales | Cash Receipts (CR=H+ΔG) | Liability Operating Accounts (AP+AL) | Expenses (COGS + OE) |
| 2 | 0 | $40000 | $0 | $40000 | $40000 | | | | | | |
| 3 | 1 | $0 | $0 | $30000 | $30000 | $10000 | $1000 | $20000 | $19000 | $0 | $9000 |
| 4 | 2 | $0 | $0 | $15000 | $15000 | $15000 | $1200 | $30200 | $30000 | $0 | $13500 |
| 5 | 3 | $0 | $0 | $5000 | $5000 | $10000 | $800 | $35600 | $36000 | $0 | $16500 |
| 6 | 4 | $0 | $0 | $0 | $0 | $5000 | $400 | $39600 | $40000 | $0 | $18000 |

Defender data obtained from HQN is represented in Table 8.A5 below.

**Table 8.A5. Defender's $IRR^A$, average tax rate T* paid on its assets earnings and average interest i (although irrelevant for the calculations in Table 8.A4).**

| | A | B |
|---|---|---|
| 1 | $IRR^A$ | 0.065 |
| 2 | T* | 0.105 |
| 3 | IRRA(1-T*) | 0.0582 |
| 4 | average interest rate $i$ | 0.06 |

Finally, we present GWS asset generated after-tax cash flow during its four years of operation and corresponding after-tax internal rates of return.

**Table 8.A6. GWS asset generated after-tax cash flow during its four years of operations and corresponding after-tax internal rates of return.**

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Economic Life | 1 year | 2 years | 3 years | 4 years |
| 2 | | -$40,000.00 | -$40,000.00 | -$40,000.00 | -$40,000.00 |
| 3 | | $40,600.00 | $10,000.00 | $10,000.00 | $10,000.00 |
| 4 | | 1.50% | $31,620.00 | $15,900.00 | $15,900.00 |
| 5 | | | 3.03% | $21,180.00 | $15,700.00 |
| 6 | | | | 7.63% | $15,440.00 |
| 7 | | | | | 14.85% |

So, what have we learned? This appendix demonstrated how the PV equations consistent with AIS earnings and rates of return can be operationalized using Excel formulas. The corresponding PV templates demonstrated here could be found at links to this chapter. In general, the templates employ the same level of aggregation as employed when calculating AIS statements. This level of aggregation can be adapted depending on the user's needs. However, it should be kept in mind that financial ratios used to compare firms within the industry also employ the level of aggregation employed here.

# 9. Present Value Models

LINDON ROBISON

*Learning goals.* At the end of this chapter, you should be able to: (1) organize present value (PV) models by the questions they answer; (2) organize PV models by their unknown endogenous variables; and (3) solve practical PV problems using appropriate PV models.

*Learning objectives.* To reach your learning goals, you should complete the following objectives:

- Distinguish between different kinds of PV models including:
  - net present value (NPV),
  - internal rate of return (IRR),
  - maximum (minimum) bid (sell),
  - annuity equivalent (AE),
  - loan formula,
  - optimal term,
  - replacement,
  - incremental,
  - capitalized value,
  - break-even,
  - payback.
- Describe the unknown endogenous variable that defines PV models.
- Describe the kinds of questions different PV models can answer.
- Use Excel financial formulas to solve the different kinds of PV models described in this chapter.

## Introduction

Earlier we defined a PV model as a multi-period extension of an accrual income statement (AIS) that values future cash flow as though they were received in the present. Just as AISs find different earnings and rates of return measures, different PV models find different earnings and rates of return measures—and more. In addition, each type of PV model is designed to answer different kinds of questions.

## Kinds of PV Models

*Comparative advantage.* Picture yourself traveling across the country driving a luxury car or a tractor. Alternatively, picture yourself pulling a plow with a luxury car or a tractor. While both a luxury car

and a tractor can provide transportation and pulling services, they are not equally suited for the two assignments.

Economists use the words comparative advantage to describe activities a firm can perform but with unequal efficiency. Luxury cars are perfectly suited for traveling across country but not for pulling a plow. A tractor is well designed for pulling a plow but not for long-distance travel.

Similarly, there are several different kinds of PV models. Each model has a comparative advantage for answering different questions. In what follows we examine some of the most important PV models and the questions they can be used to answer.

*The distinction between PV models.* PV models are single equation models especially designed to find one unknown variable. Different kinds of PV models distinguish themselves from each other by the one unknown variable they are designed to find. The questions we wish to answer determine which PV model and unknown variable we wish to find. In what follows we identify and discuss the following PV models: NPV, IRR, maximum (minimum) bid (sell), annuity equivalent (AE), break-even, optimal life and replacement, and payback. We also describe the question each one is designed to answer. We emphasize that each PV model solves for one unknown variable that identifies the PV model type.

## Net Present Value Models

NPV models solve for the difference between the present value of the challenger and the defender's earnings. These earnings differences can be positive or negative. Positive (negative) NPV earnings support the conclusion that the challenging (defending) investment earns more in present value dollars than does the defender (challenger). Comparisons of more than one challenger against the same defender must calculate the challengers' NPVs and compare them.

The important difference between NPV models and AIS profit calculations is that AIS calculations may include non-cash returns and expenses such as increases in inventory and depreciation. The numbers that enter NPV models besides the discount rate and the exponents on the discount rate are cash flow. The exception is the liquidation value of the investment at the end of its economic life that is treated as though it were converted to cash.

*An illustration of an NPV calculation.* Suppose an investment in a challenger requires an outflow of $V_0$ dollars and generates a positive cash flow of $R_1$ dollars one period later plus the investment's liquidation value $S_1$. For now, assume that the exchange rate between present defender dollars and future challenger dollars is $r$ percent and represents the opportunity cost of sacrificing the defender to invest in the challenger. To determine if the benefits of the challenger outweigh the opportunity costs of disinvesting in the defender, we find the NPV defined as:

$$NPV = -V_0 + \frac{R_1 + S_1}{(1+r)} \tag{9.1}$$

Suppose a challenging investment costs \$100 and returns $R_1$ = \$100 and $S_1$ = \$20 in period one while the defending investment earns $r$ equal to 10%. Then the NPV of this investment would be:

$$NPV = -100 + \frac{\$100 + \$20}{1.1} = \$9.09 \tag{9.2}$$

For this investment, NPV is positive, and present profits from the challenger outweigh the present loss in profits from sacrificing the defender. Another way to describe this result is that the challenger earned a higher rate of return than the defender. How much more? The exchange rate for the challenger is (\$100 + \$20)/\$100 = 1.20 compared to \$110/\$100 = 1.10 for the defender.

But what does it mean to say that the challenger earned a higher rate of return than the defender? An investment is a commitment one makes to a project. If the project pays more than the rate of return on the defender, then the investment's NPV is positive. In our example the project pays at the rate of 20%. In NPV models, think of the discount rate as the rate earned by the defending investment. And if NPV is positive, the challenger will earn a rate of return higher than could be earned by continuing to invest in the defender.

Of course, investments can be much more complicated than described above. For example, an investment may generate (positive and negative) cash flows for n periods ($R_1$, $R_2$, ⋯, $R_n$) rather than just one period. Furthermore, most capital assets generate a positive or negative liquidation value ($S_n$) at the end of its economic life which should be accounted for explicitly.

*An Excel template solution.* Suppose a firm can invest $V_0$ = \$1,000 present dollars in exchange for three future period dollars $R_1$ = \$200, $R_2$ = \$250, $R_3$ = \$350, and salvage value $V_3$ = \$950. Also assume that the defender exchanges dollars between time period at the rate of (1.08). Excel finds the NPV of the investment just described using its NPV equation described below in Table 9.1 equal to \$431.50. To make the Excel solution transparent, the function $f_x$= NPV(B1,B3:B4,(B5+B6))−B2 describes the cell location of the variables included in the solution. Meanwhile, an explanatory equation containing variable names is listed to the right of the NPV equation, =PV(r,$V_0$,$R_1$,$R_2$,$R_3$+$V_3$) . We follow this pattern in describing future Excel solutions.

**Table 9.1. An Excel Template Used to Find an NVP**
Open Table 9.1 in Microsoft Excel.

| B7 | | fx | =NPV(B1,B3:B4,(B5+B6))-B2 |
|---|---|---|---|
| | **A** | **B** | **C** |
| 1 | rate | 0.08 | |
| 2 | $V_0$ | $1000 | |
| 3 | $R_1$ | $200 | |
| 4 | $R_2$ | $250 | |
| 5 | $R_3$ | $350 | |
| 6 | $V_3$ | $950 | |
| 7 | NPV | $431.50 | =NPV(r,$V_0$,$R_1$,$R_2$,$R_3$+$V_3$)-$V_0$ |

## Internal Rate of Return (IRR) Models

Assume that an investment's acquisition, salvage, and cash flow are known and that we want to determine the rate of increase in the investment's beginning equity or assets from operations and investment activities. Compared to equation (9.2), NPV is zero and $r$ is replaced with IRR. We write:

$$V_0 = \frac{R_1 + S_1}{(1 + IRR)} \tag{9.3}$$

Next we solve for the IRR in equation (9.3) and find:

$$IRR = \frac{R_1 + S_1}{V_0} - 1 \tag{9.4}$$

The unknown variable in equation (9.3) describes the rate of return on the challenger. NPV is known to be zero since there is no comparison between the challenger and a defender. We are not comparing two investments as was the case of NPV models. We are only interested in finding the rate of return for a single investment. Of course, an investment's IRR can be compared to the IRRs of other investments or can be used to discount another challenging investment's cash flow, in which case it is referred to as the opportunity cost of capital or the discount rate. In such a model, the IRR will be equal to the defender's rate of return on equity ($IRR^E$) or its rate of return on its assets ($ROA^A$) depending on the focus of the PV model. Consider the PV equation below.

*An Excel template solution.* Suppose a firm can invest V0 = $1,000 present dollars in exchange for future dollars R1 = $200, R2 = $250, R3 = $350, and salvage value V3 = $950. The firm's financial manager wants to know what is the investment's internal rate of return? Excel find the IRR of the investment just

described using its IRR equation described below in Table 9.2 equal to 24.28%. Note that the template requires that cash flow in each period are summed.

**Table 9.2. An Excel Template Used to Find an IRR.**
Open Table 9.2 in Microsoft Excel.

| B5 | | fx | =IRR(B1:B4) |
|---|---|---|---|
| | **A** | **B** | **C** |
| 1 | $-V_0$ | -$1,000 | |
| 2 | $R_1$ | $200 | |
| 3 | $R_2$ | $250 | |
| 4 | $R_3 + V_3$ | $1,300 | |
| 5 | IRR | 24.28% | =IRR($V_0$,$R_1$,$R_2$,$R_3$+$V_3$) |

More complicated IRR models. Suppose that we wanted to find the IRR for an n period PV model such as the one written below:

$$V_0 = \frac{R_1}{(1+IRR)} + \cdots + \frac{R_n}{(1+IRR)^n} \tag{9.5}$$

Equation (9.5) is an $n^{th}$ degree polynomial with multiple possible solutions. But we need only one. To reduce equation (9.5) to a single IRR solution, it has become standard to specify a reinvestment rate r and compound cash flow to the last period allowing us to write:

$$V_0 = \frac{(1+r)^{n-1}R_1 + \cdots + (1+r)R_{n-1} + R_n}{(1+IRR)^n} \tag{9.6}$$

From equation (9.6) we find the solution for IRR equal to:

$$IRR = \left[\frac{(1+r)^{n-1}R_1 + \cdots + (1+r)R_{n-1} + R_n}{V_0}\right]^{(1/n)} \tag{9.7}$$

## Break-Even Models

Fundamental to PV models is the concept of break-even. Break-even refers to an equality between rates of return and earnings between a defending investment and a challenging investment. If the break-even solution compares the present earnings on the defender and challenger and if the NPV

was positive (negative), the NPV could be reduced (increased) by changing the price of the challenger. Alternatively, we could find the break-even rates of return on the defender and challenger by altering the defender's IRR or changing any of the challenger's cash flow including salvage values, tax rates, and any periodic cash flow. We will discuss several break-even models in what follows, beginning with maximum (minimum) bid (sell).

## Maximum Bid (Minimum Sell) Models

Different kinds of investment questions create the need for different kinds of PV models. The maximum bid (minimum sell) model assumes the defender's IRR *r* and the challenger's cash flow are known. The models then solve for the purchase (sell) price of an investment that equates NPV to zero. In a maximum bid (minimum sell) price model, the solution is the maximum price the buyer (seller) can offer and still earn the defender's IRR. To repeat, from the buyer's perspective, the solution is the most that can be offered and still earn the IRR rate r on the challenger. Or, from the seller's perspective, the minimum sell price is the lowest price a seller can accept in exchange for the cash flow stream generated by the investment and still earn the IRR rate r earned on the challenger.

To illustrate, begin by assuming that *r*, the IRR of the defender, is known as well as the cash flow that can be earned by the challenger. Now find the challenger's maximum bid price, $V_0^B$ (minimum sell price $V_0^S$) by setting NPV equal to zero and finding the maximum bid V0B (minimum sell V0S) price. We write the maximum bid (minimum sell) price as:

$$V_0^B(V_0^S) = \frac{R_1 + S_1}{(1+r)} \tag{9.8}$$

*An Excel template solution for a Maximum (Minimum) bid (sell) model.* Suppose a firm can invest $V_0$ = \$1,000 present dollars in exchange for future dollars $R_1$ = \$200, $R_2$ = \$250, $R_3$ = \$350, and salvage value $V_3$ = \$950. Also assume that the defender exchanges present dollars for future challenger dollars at the rate of (1.08). Excel finds the NPV of the investment just described using its NPV equation described below in Table 9.3 equal to \$431.50. To find the maximum bid (minimum sell) price, we sum the $V_0$ and NPV. The solution is described in Table 9.3.

**Table 9.3. An Excel Template Used to Find an NPV and a Maximum Bid (Minimum Sell) Price**
Open Table 9.3 in Microsoft Excel.

| B8 | | fx | =B7+B2 |
|---|---|---|---|
| | **A** | **B** | **C** |
| 1 | r | 0.08 | |
| 2 | $V_0$ | $1,000 | |
| 3 | $R_1$ | $200 | |
| 4 | $R_2$ | $250 | |
| 5 | $R_3$ | $350 | |
| 6 | $V_3$ | $950 | |
| 7 | NPV | $431.50 | |
| 8 | max bid | $1,431.50 | =$V_0$ + NPV |

## Break-even Cash Flow Models

Assume that the investor knows the investment's cost $V_0$, its liquidation value $S_1$, and the IRR of the defender $r$ but doesn't know the challenger's cash flow $R_1$ that would be required for the investment to earn an IRR equal to the defender's. The firm can find the cash flow amount required to break-even earnings by setting NPV to zero and solving for $R_1$ in equation (9.1) as follows:

$$R_1 = (1 + r)V_0 - S_1 \tag{9.9}$$

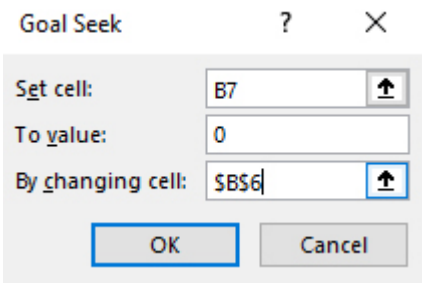
If $r$ were 10%, and if the liquidation value were zero, and the initial investment were $100, then the break-even cash flow would be $100(1.1) = $110, the amount the investment would be required to earn to break-even. Break-even here has a specific meaning which is for the challenger to earn the defender's IRR.

*An Excel template solution for a Break-Even cash flow model.* Suppose a firm can invest $V_0$ = $1,000 present dollars in exchange for future dollars $R_1$ = $200, $R_2$ = $250, $R_3$ = $350, and salvage value $V_3$ = $950. Also assume that the defender exchanges dollars between time period at the rate of (1.08). The financial manager wants to know the salvage value that would allow the challenger to break even—to earn the defender's IRR of 8 percent. To find the break-even salvage value solution, we introduce Excel's goal seek solution described in the Excel appendix to this book.

We begin with the solution in Table 9.3. Then Goal Seek asks, if we require the value in cell B7, the investment's NPV, to be set equal to zero, how much would we need to change the investment's salvage value in cell B6 (the salvage value $V_3$)?

**Table 9.4. Using Excel's Goal Seek to Find the Break-Even Salvage Value**
Open Table 9.4 in Microsoft Excel.

| B7 | | fx | =NPV(B1,B3:B4,(B5+B6))-B2 |
|---|---|---|---|
| | **A** | **B** | **C** |
| 1 | r | 0.08 | |
| 2 | $V_0$ | $1,000 | |
| 3 | $R_1$ | $200 | |
| 4 | $R_2$ | $250 | |
| 5 | $R_3$ | $350 | |
| 6 | $V_3$ | $950 | |
| 7 | NPV | $431.50 | =NPV(r,$V_0$,$R_1$,$R_2$,$R_3$+$V_3$)-$V_0$ |
| 8 | max bid | $1,431.50 | =$V_0$ + NPV |




We report the goal seek solution in Table 9.5. We find that the salvage value could fall from $950 to $406.43 and still break-even, i.e., the challenger could earn the defender's IRR of 8 percent and an NPV equal to zero.

**Table 9.5. An Excel Template that Uses Goal Seek to Find the Break-Even Salvage Value**
Open Table 9.5 in Microsoft Excel.

| | **A** | **B** |
|---|---|---|
| 1 | r | 0.08 |
| 2 | $V_0$ | $1,000 |
| 3 | $R_1$ | $200 |
| 4 | $R_2$ | $250 |
| 5 | $R_3$ | $350 |
| 6 | $V_3$ | $406.43 |
| 7 | NPV | $0.00 |

## Annuity Equivalent (AE) Models

An annuity is a financial product sold by financial institutions. The essence of an annuity is this: an individual or firm pays into a fund that is invested and grows until some point when the investment is paid back to the investor as a constant stream of payments for a specified period. In this book we define a related concept, an annuity equivalent. An annuity equivalent is a constant stream of payments whose present value is equivalent to some other stream of payments that may not be constant. The annuity equivalent model finds an annuity associated with an investment. An annuity is like a time adjusted average. Suppose we wished to find the annuity equivalent associated with the generalized NPV model below:

$$\begin{aligned} NPV &= -V_0 + \frac{R_1}{(1+r)} + \frac{R_2}{(1+r)^2} + \cdots + \frac{R_n + S_n}{(1+r)^n} \\ &= \frac{R}{(1+r)} + \frac{R}{(1+r)^2} + \cdots + \frac{R}{(1+r)^n} \end{aligned} \tag{9.10}$$

The value for $R$ in equation (9.10) is the annuity equivalent (AE) cash flow. The discounted PV of the constant cash flow $R$ yields an amount equal to NPV.

*An Excel template solution for an* AE *model.* Suppose a firm can invest $V_0$ = \$1,000 present dollars in exchange for future dollars $R_1$ = \$200, $R_2$ = \$250, $R_3$ = \$350, and salvage value $V_3$ = \$950. Also assume that the defender exchanges dollars between time period at the rate of 8 percent. Under this scenario, the firm estimates its NPV to equal \$431.50. The financial manager wants to know what is the AE for an NPV of \$431.50 over 4 years? The AE solution for this investment over 4 periods is \$130.28, negative since it represents funds being withdrawn from the investment. We find AE using Excel's PMT function.

**Table 9.6. Finding an Annuity Equivalent for an NPV over 4 years.**
Open Table 9.6 in Microsoft Excel.

| B9 | | fx | =PMT(B1,B8,B7) |
|---|---|---|---|
| | **A** | **B** | **C** |
| 1 | r | 0.08 | |
| 2 | $V_0$ | $1,000 | |
| 3 | $R_1$ | $200 | |
| 4 | $R_2$ | $250 | |
| 5 | $R_3$ | $350 | |
| 6 | $V_3$ | $950 | |
| 7 | NPV | $431.50 | |
| 8 | n | 4 | |
| 9 | AE | ($130.28) | =PMT(r,n,NPV) |

The PMT solution informs us that an NPV of $431.50 could pay $130.28 for four years in the future before exhausting its value.

## Capitalization Formulas

Long-lived assets, often non-depreciable, require a special PV model. Long-lived assets will be discussed in more detail in Chapter 14 on investment terms. But for now, consider the following. Suppose that we can considered the future cash flow of a long-lived asset to be represented by the annuity equivalent model described in equation (9.10). Now let $n$, the term of the investment, get very large. Then the present value of the present value of the AE can be written as:

$$\begin{aligned} \lim_{n\to\infty} NPV_n &= -V_0 + \frac{R_1}{(1+r)} + \frac{R_2}{(1+r)^2} + \cdots + \frac{R_n + S_n}{(1+r)^n} \\ &= \frac{R}{(1+r)} + \frac{R}{(1+r)^2} + \cdots + \frac{R}{(1+r)^n} = \frac{R}{r} \end{aligned} \tag{9.11}$$

The capitalization formula, like all PV models that depends on future forecasts, is an approximation. In this case the approximation improves with increases in $n$. To illustrate suppose that we found the PV for $n$ = 30, $r$ = 8%, and AE = $130.28. The Excel solution is PV(.08,20,130.28) = $1,466.66. The capitalization approximation is $130.28/.08 = $1628.50. If $n$ increases to 40, PV equals $1,553.54.

## Optimal Life Models

Optimal life models ask what is the optimal life of this investment? We may want to ask if the NPV of the investment in equation (9.9) would be increased if the economic life of the investment were increased to the ($n$ + 1) period or reduced to the ($n$ – 1) period. The optimal life model in continuous time can be written as:

$$NPV = -V_0 + \int_0^n R(t)e^{-rt}dt + S_n e^{-rn} \tag{9.12}$$

Where $R(t)$ equals the cash flow in the $t^{th}$ period and $S_n$ is the salvage value in the $n^{th}$ period. The optimal solution has a specific meaning in the context of the optimal life model. It is that value of n that maximizes the NPV. Formally, the solution employs the calculus to optimize the NPV. In the discrete time model which is most often employed in practice, the optimal value is found through trial and error or through repeated calculations of alternative values for $n$.

A related optimal life model asks: what is the optimal value of $n$ that maximizes NPV if there are replacements for the investment? In this case, NPV is the sum of NPVs from individual investments. Such a replacement model will be described in more detail in Chapter 14.

## The Payback Model

While PV models are generally carefully deduced and the data required to solve them is explicit, sometimes decision makers just want a "ball-park" estimate of the desirability of a financial strategy. In such cases, decision makers are willing to sacrifice rigor and precision for approximations. When this is the case, the payback model is often employed. To obtain an approximation, it assumes the discount rate in PV models is zero. In other words, the payback model assumes that present and future dollars are valued the same—a very unrealistic assumption. Then the payback model calculates the number of periods required to earn the investment's present value. The number of periods required to earn the investment's value is the payback period, the criterion used to rank investments. All cash flow after the payback period is assumed to have no influence on the criterion. To illustrate, $n$ is the payback period in the payback model that follows.

$$V_0 = R_1 + R_2 + \cdots + R_n \tag{9.13}$$

And if periodic cash flows are constant we can express the payback period as:

$$\text{Payback period} = \frac{(\text{initial investment})}{(\text{periodic cash flows})} \tag{9.14}$$

To illustrate, consider an initial outflow of $5,000 with $1,000 cash inflows per month. In this case, the payback period would be 5 months. If the cash inflows were paid annually, then the result would be 5 years. More generally, cash flows will not equal one another. If $10,000 is the initial outflow investment, and the cash inflows are $1,000 in year one, $6,000 in year two, $3,000 in year three, and $5,000 in year four, then the payback period would be three years, as the first three years are equal to the initial outflow.

Despite its popularity, the payback model is not recommended for several reasons. Mainly, ignoring the time value of money basically treats an inter temporal investment as though it were a static profit problem. Furthermore, it treats cash flow earned after the payback period as not important. In sum, in many respects, the pay-back method inadequately accounts for important details of the investment problem.

## Present Value Models and Rates of Return

So far, the opportunity cost of capital has been introduced without specifying whose capital is being invested. Is it equity capital, debt capital, or a combination of debt and equity capital? Or does it matter? The short answer is that it does matter as we demonstrated in Chapter 8. If the focus is on the return on equity, then the discount rate represents the return on equity ROE in a one-period model and $IRR^E$ in a multi-period model. When focused on the rate of return on equity, interest costs on debt are subtracted from the cash flow included in the model. If the focus is on the return on assets ROA in a one-period model and $IRR^A$ in a multi-period problem, then the cost of the investment is subtracted at the beginning of the model and earnings reflect a return to the assets, and interest costs are irrelevant since the asset is treated as though it were purchased at the beginning of the investment.

The difference between the two approaches matter because most firms rely on a combination of debt and equity to fund assets. Reduced to its essence, the issue is whether the opportunity cost of capital reflects the rate of return on the firm's assets or equity. Both approaches apply under different circumstances. For example, interest costs may be subsidized so that ROE estimates may be distorted compared to what they would be if the firm paid the market rate of interest. In this case, a return to asset approach may be appropriate. In other circumstances, the firm may indeed want to know their earnings and rate of return independent of contributions from debt capital. In this case, a return on equity approach may be appropriate. We now describe the two approaches in more detail using a one-period model to make the results transparent.

*Internal rate of return on assets* (ROA). In the return to asset model, we charge the entire investment at the beginning of the period and include its liquidation value as a return at the end of the period. This approach ignores the fact that investments may be financed and paid for over the life of the investment and charging for the investment at the beginning of the project doesn't accurately reflect its cash flow. However, in the ROA approach, we ignore financing because our interest is in the productive capacity of the long-term asset, independent of the terms under which it can be financed. The advantage of the

ROA approach is that the analysis considers the rate of return on the entire investment made at the beginning of the period. The NPV for the ROA approach for a single period can be expressed as:

$$NPV = -V_0 + \frac{R_1 + S_1}{1 + ROA} \tag{9.15}$$

Note that in equation (9.15), if NPV = 0, as it would in an IRR model, then (1 + ROA)$V_0$ is equal to $R_1$ + $S_1$. If we replace $V_0$ with $E_0 + D$, we can write $R_1 + S_1 = (1 + ROA)(E_0 + D)$. This fact will be helpful as we connect ROA and ROE measures.

We illustrate how to find ROA in a simple one-period example. Suppose the firm's defender is a $1,000, non-depreciable investment that will earn $100 for one period and then will be liquidated at its acquisition price. We find the ROA associated with $1,000 of assets invested in the defender by setting its NPV equal to zero in equation (9.15) and solve for ROA.

$$\begin{aligned} ROA &= \frac{R_1 + S_1}{V_0} \\ &= \frac{\$1,100 - \$1,000}{\$1,000} = 10\% \end{aligned} \tag{9.16}$$

*Internal rate of return on equity* (ROE). In the ROE approach, the analysis depends on how the asset is financed. In this approach, the cost of interest and debt payments are subtracted explicitly. Moreover, the initial investment is equal to the amount of equity invested since the debt is paid directly to whoever supplies the investment. However, the debt $D$ plus average interest costs charged at interest rate $i$ ($iD$) are subtracted at the end of the period. The NPV for the one-period ROE model is expressed as

$$NPV = -E_0 + \frac{R_1 + S_1 - (1 + i)D_0}{1 + ROE} \tag{9.17}$$

Now reconsider the same example, except that the $500, or half of the defender, is financed at 9%. The other half of the investment, $500, is financed by the firm's equity. We continue to assume that, after one period, the investment is liquidated for its acquisition value, the loan of $500 is repaid, and the firm recovers its investment of $500. The firm also earns in one period, $100, the same as before. But now it pays a rental fee for the use of the loan's funds of 9% times $500, or $45. By setting the NPV model of the defender in equation (9.17) equal to zero, we can find its ROE associated with the firm's equity ($IRR^E$) in the project equal to.

$$
\begin{aligned}
ROE &= \frac{(R_1 + S_1) - (1+i)D_0 - E_0}{V_0} \\
&= \frac{\$1,100 - \$45 - \$500}{\$500} = 11\%
\end{aligned}
\tag{9.18}
$$

We find the defender's ROE to equal 11%. In this case, the firm gained access to the use of an asset because of financing. The gains from a lender providing the firm access to $500 of debt capital to acquire a $1,000 investment using only $500 of its own money increased its earnings on its equity from 10% to 11%. Meanwhile the investment as a whole continued to earn only 10%. The value of the financing increased the rate of return on equity by 1%.

For a variety of reasons, financial managers may prefer to represent the defender's rate of return using ROA. However, this same manager must be careful to make sure that the cash flow associated with the challengers are consistent and measure cash flow earned by assets. On the other hand, if the defender's rate of return is represented by its ROE, then debt and interest costs should be accounted for explicitly.

In practice, most PV modelers appear to prefer the ROA approach, even though both approaches are valid and provide unique information. Nevertheless, the dominance of the ROA approach has resulted in the identification of ROAs as simply the IRR of the investment, a practice we will also adopt in the remainder of this book.

> So, what have we learned? We have learned that single equation PV models can solve for at most one unknown variable that defines what kind of PV model is represented. You will be asked to summarize the different kinds of PV models, the unknown variable that defines the PV model, and the kinds of questions each model is designed to answer in the chapter questions section.

## Summary and Conclusions

This chapter reviewed several different kinds of PV models. They differ because they are designed to answer different kinds of questions. Some PV models, NPV and IRR, help us rank alternative investments. Others like AE models can be used to find the optimal time for replacing an investment—or what our periodic loan payments will be. And still other PV models like the maximum bid (minimum sell) models help us know the maximum (minimum) we can offer to purchase (sell) an investment and

still earn the defender's IRR. Finally, still other PV models such as capitalization formulas and payback models offer at most a rule of thumb for evaluating and making investment decisions.

## Questions

1. PV models can be identified by the questions they are designed to answer. Please complete the table below by identifying the unknown variable and the question the solution to the unknown variables is designed to answer:

| Question you want to answer | Unknown Variable | Appropriate PV Model to Answer your Question |
|---|---|---|
| What is the rate of return I can expect from my equity invested in a lawn care business? | | |
| What will be my loan payment for a $10,000 loan to be repaid in 10 annual installments at an interest rate of 6%? | | |
| How much will the value of my assets change if I disinvest $50,000 from a defender and reinvest the funds in a challenger, assuming my defender is earning an IRR of 9%? | | |
| What is the most I can pay for a challenging investment and break-even or earn my defender's IRR? | | |
| I own an aging orchard. I need to know the optimal time to replace my orchard with new tree varieties. | | |
| I am considering the purchase of beef feeder operation. I want to know the value of the operation realizing that I will earn returns on many beef-feeder cohorts. | | |
| If the discount rate is zero, how many periods will be required to recover my original investment. | | |

2. Compare the implied reinvestment rates for NPV and IRR models.
3. IRR models measure an investment's internal rate of return. NPV models measure the difference in present earnings between the defender and the challenger. Both NPV and IRR models can be used to rank investments. Would you expect them to ranking investments consistently? Defend your answer.
4. To find the present value of a stream of future income for a long-lived asset, I capitalize the constant or first period's cash flow. What are the key assumptions employed that permit us to use the capitalization formula?
5. Suppose you found the maximum bid price for a purchase you are considering. How would you

use this information in your negotiations with the seller?

6. Suppose that you found that an investment's AE reached its maximum at year 10 while its NPV reached its maximum at 15 years. How would you use these results to determine the optimal life of the investment?
7. When finding the ROE, we explicitly accounted for the debt used to finance the investment. However, when finding the ROA measure, we did not account for the debt used to finance the investment. Explain the difference between the two approaches. Which one would you recommend?
8. Provide numerical PV models in which you find an investment's IRR and NPVs using $IRR^A$ and $IRR^E$.
9. Most of the time, we don't identify discount rates in PV models as being either a ROE or a ROA. Instead we seem to prefer to identify the defender's ROA with the letter "r". Why do we tend to prefer ROA to ROE measures? Can you describe a case when it would be important to evaluate the projects using the defender's ROE instead of its ROA?
10. Assume you were considering one investment that could be financed from two different financial institutions. Thus, the only difference between the projects were their cash flow associated with their use of debt capital. How would you proceed to rank the two investments?

# 10. Incremental Investments

LINDON ROBISON

Learning goals. After completing this chapter, you should be able to: (1) distinguish between incremental and stand-alone investments; (2) understand how time and use costs determine the optimal service extraction rate from investments; and (3) find earnings and rates of return on incremental investments.

Learning objectives. To achieve your learning goals, you should complete the following objectives:

- Learn how to distinguish between incremental and stand-alone investments.
- Learn how an investment's liquidation and acquisition values determine its fixity.
- Learn how an investment's time and use costs determine its optimal service extraction rates.
- Learn how to find contributions from incremental investments by finding changes in the firm's cash receipts (CR), cash cost of goods sold (COGS), cash overhead expenses (OE), and change in operating and capital asset accounts.
- Learn how to use Excel templates to find net present value (NPV), annuity equivalent (AE), and internal rate of return (IRR) measures earned by incremental investments.

## Introduction

Think of two kinds of investments. The first one is a stand-alone investment—possibly including other supporting capital investments and nondurable inputs. The second kind of investment is an incremental one. We consider incremental investments when we want to add to or replace an investment that is part of an existing production unit. Firms that extract services from durables, especially those that depreciate, must some time replace or refurbish them, and the decision depends on what happens to the difference in NPV of the firm's cash flow before and after the incremental investment.

Whether we invest in an incremental investment or disinvest in an existing investment depends on its asset's fixity. A fixed investment is one already owned by the firm and unlikely to be removed from service. Glenn Johnson described the conditions required for an investment to be fixed; namely, that the investment's acquisition value ($V_0$) and liquidation value ($V_0^{liquidation}$) bound its value in use ($V_0^{use}$). In other words, an investment is fixed or unlikely to be removed from service if: $V_0^{liquidation} < V_0^{use} < V_0$. Because the investment's value in use is less than what it would cost to acquire another one and because its liquidation value is less than what it is earning—the firm has no incentive to invest or disinvest in them. An investment with a zero or negative liquidation value is one likely fixed if it contributes something positive to the firm.

We summarize the collective contributions of the firm's capital assets during a single period as earnings in an accrual income statement (AIS). Then we calculate AIS earning as a percentage of the firm's