Corporate Financial Policy and R&D Management

Second Edition

JOHN B. GUERARD JR.

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Preface

In this monograph, the financial determinants of corporate research and development (R&D) and the impact of these expenditures on stockholder wealth are examined. The reader is introduced to financial statements and ratios for decision making. A discussion of the sources and uses of funds analysis leads to an econometric analysis of the interdependencies among the firm's financial decisions, including the dividend, capital investment, R&D, and new debt issuance decisions. The establishment of the R&D decision as a financial decision leads one to ask how the marketplace values and assesses the firm's R&D expenditures. A multifactor risk model analysis allows one to establish a statistically significant relationship between R&D expenditures and increases in stockholder wealth. R&D enhances stockholder wealth, particularly for larger capitalized firms.

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About the Author

John B. Guerard Jr. is faculty member in the finance and economics department at Rutgers Business School, where he teaches Advanced Financial Management and Investments. He serves on the Virtual Research team of GlobeFlex Capital Management, in San Diego, and consults to several other financial institutions, including a hedge fund. Mr. Guerard earned his AB in Economics, cum laude, at Duke University, an MA in Economics from the University of Virginia, an MSIM from the Georgia Institute of Technology, and his Ph.D. in Finance from the University of Texas, Austin. He served on the faculties at the University of Virginia and Lehigh University, and worked in the equity research departments at Drexel, Burnham and Lambert and Daiwa Securities Trust. Mr. Guerard was Director of Quantitative Research at Vantage Global Advisors, in New York City, when he was awarded the first Moskowitz Prize for outstanding research in socially responsible investing (SRI). He serves as an associate editor of the *International Journal of Forecasting* and the *Journal of Investing*. His articles have been published in *Management Science*, the *International Journal of Forecasting*, the *Journal of Forecasting*, *Research in Finance*, *European Journal of Operations Research*, *Journal of the Operational Research Society*, *Research Policy*, and the *Journal of Investing*. His research interests are in modeling R&D and financial decisions of firms, developing and estimating stock selection models, and estimating and forecasting time series models. He is the author, or co-author, of four textbooks. Mr. Guerard used the first edition of this monograph in his R&D Management and Corporate Financial Management class at the Executive Master in Engineering Management (EMTM) program, the University of Pennsylvania.

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CHAPTER 1

Corporate Financial Policy and R&D Management

The purpose of this book is to analyze the determinants of corporate research and development (R&D) expenditures in the United States during the 1952–2003 period and the impact that these expenditures have had on stockholder wealth. Our research began with a study of the interactions among the R&D, capital investment, dividend, and new debt financing decisions of major industrial corporations. We found significant interdependencies, such that one must use a simultaneous equations model to adequately analyze a firm's financial decision-making process. Even the presence of federal financing of R&D was insufficient to completely eliminate the potentially binding budget constraints on firms. A corporate planning model was developed and estimated by the authors. We found significant correlations between stock returns and our targeted variables.

Among our goals was to develop an econometric model to analyze the interdependencies of decisions in regard to research and development, investment, dividends, and new debt financing. The strategic decision makers of a firm seek to allocate resources in accordance with a set of seemingly incompatible objectives. Management attempts to manage dividends, capital expenditures, and R&D activities while minimizing reliance on external funding to generate future profits.

Each firm has a pool of resources, composed of net income, depreciation, and new debt issues, and this pool is reduced by dividend payments, investment in capital projects, and expenditures for R&D activities. Miller and Modigliani (1961) put forth the perfect markets hypothesis in regard to financial decisions, which holds that dividends are not influenced (limited) by investment decisions. There are no interdependencies between financial decisions in a perfect markets environment, except that new debt is issued to finance R&D, dividends, and investment.

The imperfect markets hypothesis concerning financial decisions holds that financial decisions are interdependent and that simultaneous equations must be used to efficiently estimate the equations. The interdependence hypothesis reflects the simultaneous-equation financial-decision modeling work of Dhrymes and Kurz (1967), Mueller (1967), Damon and Schramm (1972), McCabe (1979), Peterson and Benesh (1983), Jalilvand and Harris (1984), Switzer (1984), Guerard and Stone (1987), Guerard, Bean, and Andrews (1987), and Guerard and McCabe (1992). Higgins (1972), Fama (1974), and McDonald, Jacquillat, and Nussenbaum (1975) found little evidence of significant interdependencies among financial decisions.

The estimation of simultaneous equations for financial decision making is the primary modeling effort of Chapters 4, 5, and 6. In Chapter 4, we estimate a set of simultaneous equations for the largest securities in the United States during the 1952–2003 period. We review the federal financing impact on financial decisions during the 1975–1982 period. Recent restructuring has greatly changed the way many corporate officers think of new debt issuance.

Security valuation and portfolio construction is a major issue and is developed in Chapters 8, 9, and 10. Chapter 8 presents our valuation analysis, using historical fundamental data from Compustat and earnings forecast data from I/B/E/S. We find statistically significant stock selection models in the United States, Europe, and Japan, using both historical and earnings forecasting data that violate the efficient markets hypothesis, which holds that securities are equilibriumly priced. Chapter 9 extends the basic portfolio strategies discussed in Chapter 8 to include market-variance efficient portfolios, and we find a much greater use of earnings forecasts in the United States. We find that R&D enhances stockholder wealth in mean-variance efficient portfolios. Socially responsible investing is examined in Chapter 10, and we find no difference between socially screened and socially unscreened portfolios. One can be socially responsible and produce efficient portfolios. In Chapter 10, we look at the impact of socially responsible investment criteria, both concerns and strengths, on security total returns. It may be possible for management to increase its R&D activities, be recognized as a better firm in the socially responsible investment community, and see its stock price rise. A brief summary and set of conclusions are presented in Chapter 11.

CHAPTER 2

An Introduction to Financial Statements

In this chapter, we introduce the reader to the balance sheet, income statement, statement of shareholders' equity, and sources and uses of funds statement. We illustrate the financial statement analysis using a health care, R&D-intensive firm in New Jersey, Johnson & Johnson. Financial data can be used to value the firm's equity, deriving the fair market value of the company stock, or accessing its financial health in terms of potential bankruptcy. We show financial Johnson & Johnson balance sheets, income statements, and sources and uses of funds for the 1999–2003 period using AOL Personal Finance data and calculate ratios concerning balance sheet and income statement data for the 1970–2003 period using the Wharton Research Data Services (WRDS) data. This chapter is designed to serve two modest purposes: to acquaint the student with accounting and financial terminology and concepts used throughout the book, and to explain the three important accounting statements on an introductory level: balance sheet, income statement, and statement of cash flows.

THE BALANCE SHEET

The balance sheet is the financial picture of the firm at a point of time. The assets of the firm are its resources. Assets include cash, receivables, inventory, and plant and equipment. Assets are used to produce goods and services, and generate profits and cash flow. The liabilities of the firm represent what the firm owes its creditors and its stockholders' claims. The difference between the liabilities and the assets is the net worth, stockholders' equity which represents the owners' investment in the firm. The liabilities plus the net worth of the firm must equal the sum of the firm's assets. The balance sheet presents the equation that the sum of the assets equals the sum of liabilities and equity.

The balance sheet is constructed on the basis of formal rules and may not necessarily represent the market value of the firm as a growing concern, or its liquidation value if the component parts were sold off one by one. The balance sheet represents the financial position exactly at the close of trading on the date of the balance sheet. The assets and liabilities shown are those the accountants have ascertained to exist at that point in time. The accountant's prime functions are to keep legal claims straight, present the data as consistently as possible, and stay as close as possible to objectively determined costs.

We might note at this point an insight provided by the balance sheet equation. The equation states: Total assets must equal total liabilities plus ownership capital. Therefore, if the firm increases its total assets, it follows that the liability and/or ownership accounts must also increase to balance the rise in assets. The firm may increase the amount it owes its suppliers, borrow from the banks, float a new bond issue, increase its net worth by floating additional common stock, or retain additional earnings in the business. The problem of whether to acquire additional assets and the related question of choosing the best source out of which to finance the additional assets are a central area of financial decision making.

Let us describe the various major accounts presented in the balance sheet. In order that the reader may follow the discussion more readily, we present the balance sheet of Johnson & Johnson. The reader can find company balance sheets on many online sources, such as America Online (AOL) Personal Finance Research for five years, or for 10 years in the Standard & Poor's (S&P) *Stock Guide* or company annual reports. We also show balance sheet variables for Johnson & Johnson in Table 2.1 for the 1999–2003 period, drawing data from the AOL Personal Finance Research web site. We could find reported balance sheets for 10 years in the Johnson & Johnson annual report for 2003. A longer history of balance sheet variables, covering the 1950–2003 period, can be found on the Wharton Research Data Services (WRDS) Compustat database.

Assets

The assets that the nonfinancial firm may acquire or own are usually broken down into two major categories: current assets and fixed assets. The current assets and the fixed assets are usually much larger than the other assets.

Current Assets The current assets consist of cash, accounts receivable, and inventory, as well as items that in the normal course of business will be turned into cash within one year. One generally assumes that accounts receivable, inventory, and prepaid items will be used up, or converted into cash, within one year. The three largest accounts making up the current assets are usually in cash, receivables, and inventories. Cash is the sum of the cash on hand and the deposits in the bank. Accounts receivable are amounts due the firm from customers who have bought on credit. They are often segregated into accounts receivable and notes receivable. An account receivable is the usual way credit is given in American business practice. It simply means that the buyer of the goods is charged for the purchases on the books of the seller. If a note receivable is used, the purchaser of the goods has signed a promissory note in favor of the seller. A note, except in certain lines of business where they are customary, is generally required only of customers with weaker credit ratings or those who are already overdue on their accounts.

An account called reserve for bad debts or allowance for doubtful accounts is generally subtracted from the receivables account, a so-called contra-asset. This is called a valuation reserve; it is an attempt to estimate the amount of receivables that may turn out to be uncollectible. The receivables account minus this reserve, the net receivables, is counted as an asset on the balance sheet. Loans to officers or employees or advances to subsidiaries are generally included in the other assets. Also, except for financial firms—banks and finance companies—items such as accrued interest receivable are usually not included with the other receivables.

Inventories are items making up the finished stock in trade of the business, as well as the raw materials that a manufacturing firm will use in its production process to create finished products. In an industrial firm the inventory consists basically of finished goods—that is, items that the company does not have to process further. In manufacturing companies the inventory divides into three categories: raw materials, goods-in-process, and finished goods. If we consider the current assets from the "flow of funds" aspect, that is, how close they are to being turned into cash, then cash will be listed first. Receivables—sales made but not yet collected—are the nearest asset to cash, and inventory follows receivables. Finished goods are more current or liquid than goods-in-process, and goods-in-process more so than raw materials, for a going concern. The relative composition of the inventory can become a matter of importance, and is sometimes unfortunately overlooked in analyzing the current credit position of a manufacturing firm.

A problem in presenting inventory values on the balance sheet is to keep separate the amount properly ascribed to supplies. Supplies are not part of the normal stock in trade, nor are they processed directly into finished goods. In general, an item that is an integral part of the final product is part of the raw material inventory, whereas items used in corollary functions are supplies. Supplies are usually placed with the miscellaneous current assets; like prepaid expenses, they represent expenditures made currently that save outlays in the future.

Valuation of the inventory is an additional problem with which the accountants must wrestle. The usual rule of valuation is "cost or market, whichever is lower." This rule gives a conservative value to the inventory. Firms may now make a choice between the rule of first in, first out (FIFO) and last in, first out (LIFO) as methods of inventory valuation. Under FIFO (which most firms still use) it is considered (whether physically true or not) that sales have been made of the older items, and that the items most recently manufactured or purchased compose the inventory. Conversely, if LIFO is used to value the inventory, then the new items coming in are considered to enter the cost of goods sold, and the cost of the older stock sets the value of the inventory. Under the first method, FIFO, the value given the inventory on the balance sheet is meaningful, but the cost of goods sold figure used on the income statement may not truly represent current economic costs if price levels have been changing rapidly. Under FIFO the accounting figure for cost of goods sold tends to lag behind price level changes, so that reported accounting profits are large on an upturn and decrease rapidly (or turn into reported losses) on a downturn in prices. By contrast, LIFO reduces the lag in the accounting for cost of goods sold when the price level changes, thus modifying the swing of reported accounting profits during the trade cycle.

The LIFO method of inventory valuation, however, tends to develop an inventory figure on the balance sheet that may not be at all representative of any current cost or price levels. The asset value of the inventory may become more and more fictitious or meaningless as time passes. The reader need only think of the inventory value of a 386 computer to IBM. Moreover, in defense of FIFO, any distortion it produces on the profit and loss statement is not very great for firms that turn over their inventory rapidly (i.e., for firms whose stock is replaced rapidly in relation to their sales).

Other current assets besides cash, receivables, and inventories are accruals, prepaid expenses, and temporary investments. Accrued items are amounts that the firm has earned over the accounting period but which are not yet collectible or legally due. For example, a firm may have earned interest on a note receivable given to it in the past even though the note is not yet due. The proportionate amount of interest earned on the note from the time it was issued to the date of the balance sheet is called accrued interest, and under modern accounting procedures is brought onto the books as an asset.

Prepaid expenses are amounts the company has paid in advance for services still to be rendered. The company may have paid part of its rent in advance or paid in on an advertising campaign yet to get under way. Until the service is rendered the prepayment is properly considered an asset (i.e., something of value due the firm). When the service is rendered, the proportionate share of the prepaid item is charged off as an expense.

Temporary investments are holdings of highly marketable and liquid securities, representing the investment of temporary excess cash balances. If these are to be classified as a current asset, the firm must intend eventually to use these funds in current operations. If, however, the securities are to be sold to finance the purchase of fixed assets or to cover some long-term obligation, such holdings are more correctly grouped with the other assets or miscellaneous assets.

Fixed Assets The fixed assets and the current assets are the two important asset classes. The fixed assets are items from which the funds invested are recovered over a relatively longer period than those invested in the current assets. The fixed assets are also called capital assets, capital equipment, or the fixed plant and equipment of the firm. Buildings and structures, machinery, furniture, fixtures, shelves, vehicles, and land used in the firm's operations constitute fixed assets. Almost all fixed assets except land are depreciable. In determining the value of a fixed asset, we must remember that their economic life is not limitless, and that eventually they will wear out or otherwise prove economically useless in their present employment.

The accounting reports allow for the loss of value on fixed assets through the passage of time by setting up a reserve for depreciation, allowance for depreciation, or accumulated depreciation account. Every fiscal period a previously determined amount is set up as the current charge for depreciation, and is subtracted as an expense on the income statement. The matching credit is placed in the allowance for depreciation account, where it accumulates along with the entries from previous periods until either (1) the allowance for depreciation equals the depreciable value (original cost less estimated scrap value) of the asset or (2) the asset is sold, lost, or destroyed. On the balance sheet the allowance for depreciation constitutes a valuation account or reserve; the historically accumulated depreciation is subtracted from the original acquisition cost of the fixed assets, and the balance, called net fixed assets, is added into the sum of the total assets.

The problem of making adequate allowance for depreciation and determining the periodic depreciation charge properly has caused considerable difficulty for accountants. The most commonly used depreciation method is the straight-line method. This technique is quite simple (accounting, among other reasons, for its popularity). The probable useful life of the asset is estimated; the estimated scrap value of the asset is deducted from its original cost in order to obtain its depreciable value; the depreciable value divided by the estimated life gives the yearly depreciation. This depreciation charge remains the same year after year even though the net book value of the asset is constantly reduced.

Although the straight-line method is the most popular, it does not reflect the fact that for most fixed assets the loss in economic value is higher in the first periods of use. Because of this, the Internal Revenue Service now allows firms to adopt alternative depreciation policies; that is, the Tax Recovery Act of 1986 established a Modified Accelerated Cost Recovery System (MACRS), which set tax depreciation schedules. For seven-year-lived assets, as are many industrial assets, the annual depreciation percentages are 14.20, 24.49, 17.49, 12.49, 8.93, 8.92, 8.93, and 4.45, respectively, that permit a larger amount to be deducted for depreciation in the earlier years of an asset's life. The major advantage of these methods of depreciation is that they allow the company to defer some of its income tax liabilities to the future, thus providing more present funds for operations or expansion. For many companies depreciation is often a large source of funds, relative to their primary source, net income.

Depreciation allowances are generally based on the original acquisition cost of the fixed asset to the firm. Any subsequent change in the value of the fixed asset, for example, through price level changes, is generally not reflected in the value of the asset on the books nor in the allowable depreciation rate. The depreciation rate is set by the original purchase price and is not changed for the new price level that may exist currently. Thus, even if the funds released to the business by its depreciation allowances were actually segregated (which they are not) for the replacement of fixed assets, they would not prove adequate if the replacement or reproduction cost of these assets had gone up in the meantime. There is an account called allowance for depletion that appears on the books of mining or extractive companies and other companies, such as lumber firms, engaged in processing natural resources, which is similar to the allowance for depreciation in a manufacturing firm. The accumulated depletion account represents the proportionate cost of the amount of ore, crude oil, and so on, that has been removed since the company started operation. It is subtracted on the balance sheet from the original acquisition costs of the company's estimated mineral reserves or resources. For income tax purposes, however, most companies take a percentage depletion allowance. (The rate varies for different types of minerals.) The allowable percentage is applied to the market value of the ore or crude oil and is subtracted from income before computing taxes. Under the law, annual percentage depletion can continue to be taken even if the accumulated depletion already equals the original cost of the oil or mineral reserves.

Other Assets Other assets consist of items such as permanent investments and the so-called intangible assets (i.e., goodwill, franchises, trademarks, patents, and copyrights).

Permanent investments are the acquisition costs of stocks or bonds invested in other companies. If the percentage holding of common stock in the other company is large enough, the balance sheets of the two companies are often combined or consolidated. The value of the common shares of outside holders is then presented as minority stock of subsidiaries on the liability side of the major firm's balance sheet. If the firm's holding in another company is large enough to give it considerable control in the other company's management but the parent company does not care for one reason or another to consolidate the statements, the account will usually be headed "investment in nonconsolidated subsidiaries." A fairly common adjustment to the investment account is to add the retained earnings of the subsidiary company to the acquisition cost of the original securities. If this is done, the going market price and the original cost of the investments should be indicated in a footnote to the balance sheet.

Patents, franchises, and copyrights are classified among the intangible assets. They are carried at a conservative development cost or at the purchase cost, if they were bought from some other firm or individual. Since patents, copyrights, and franchises have a limited legal life (17 years for patents), they are written down in value, or amortized, year by year over their legal lives, or sooner if they have lost their economic value. The proportionate periodic charge is considered a proper expense deduction on the profit and loss statement. If these assets do have true economic value, it is reflected in a higher rate of earnings on the firm's tangible assets compared to the return of other companies.

A major item that sometimes appears among the intangible assets is goodwill. It represents the capitalized value of some intangible economic advantage the firm possesses over similar companies: perhaps a good name built up over many years, a superior product, an advantageous geographical location, or an especially efficient management. The advantage, whatever it may be, should be reflected in the rate of earnings above the normal return for this type of business; the conservatively capitalized value of this extra flow of earnings represents goodwill. Accountants, however, are generally reluctant to recognize goodwill or put it on the books unless it is purchased or sold in a bona fide, arm's-length transaction. Such a transaction occurs when a successor firm is justifiably capitalized at a higher figure than the book value of the old company's assets, or when a firm is sold as a subsidiary to another company at a figure higher than its net asset value on the books. Similarly, goodwill is recognized if a new partner entering a firm is willing to invest more money for an equal partnership than the book value of the shares of the other partners. Goodwill should be understood for what it is and its justification tested in terms of present or potential earning power of a going concern.

LIABILITIES AND CAPITAL

The liabilities and capital (shareholders' equity) section of the balance sheet shows the claims of owners and creditors against the asset values of the business. It presents the various sources from which the firm obtained the funds to purchase its assets and thereby conduct its business. The liabilities represent the claims of people who have lent money or extended credit to the firm. We use the terms capital, net worth, and equity accounts interchangeably. These terms represent the investment of the owners in the business.

This, the credit side of the balance sheet, is often called the financial section of the balance sheet or the financial structure of the firm. It is especially important to the student of finance. Many of the items found here are discussed only briefly in this chapter since they are taken up in considerably more detail in other parts of the book.

Current Liabilities

The current liabilities are those liabilities, claims, or debts that fall due within one year. Among the more common current liabilities are accounts payable, representing creditors' claims for goods or services normally sold on open account, and notes payable or trade acceptances payable arising out of similar economic transactions.

Notes payable to bank, bank loans payable, or similar accounts show the amounts owing to banks for money borrowed. Usually these arise from short-term loans, but the amounts due within the year on installment or term loans are also current liabilities. Similarly, any portion of the long-term debt (i.e., bonds, mortgages, etc.) maturing during the year is also carried in the current liabilities section. Accruals, a common group of current liabilities, represent claims that have built up but are not yet due, such as accrued wages, interest payable, and accrued taxes. An item that accounts for the bulk of many corporations' accruals today is the amount owing on the federal and state corporation taxes. It appears as accrued income tax, provision for federal income tax, or other similar title. Dividends on the common or preferred stock that have been declared but have not yet been paid are carried among the current liabilities as dividends payable.

The relationship of current liabilities to current assets is useful in many types of financial analysis and is especially important in analyzing the short-run credit position of the firm. Thus, the current liabilities are divided into the current assets to obtain the current ratio, and the current liabilities are subtracted from current assets to obtain the firm's net working capital. The larger the current ratio and the larger the net working capital relative to its total operations, the greater is the comparative safety of the firm's short-run financial position. The methods commonly used to judge the safety of the current liability coverage or the adequacy of net working capital vary with the type of firm and industry and with the judgment and analytical ability of the analyst. This subject will be discussed more thoroughly in Chapter 3.

Long-Term Debt

Under the classification of long-term debt, fixed liabilities, or funded debt is placed the amount the corporation owes on bond issues, mortgage notes, debentures, borrowings from insurance companies, or term loans from banks. The company may have obtained funds to acquire assets and invest in the business from these sources, and this section of the balance sheet shows the amounts still owing.

There are generally three distinctions between the long-term debt and the current liabilities. First, the items making up the long-term debt are usually more formal than those in the current liabilities section. A written legal contract or indenture describes the obligation, contains provisions for repayment under different circumstances, details various devices for protecting the creditors against default, and contains other clauses or provisions that might work to the benefit of the debtor company. The long-term debt is also often composed of securities, or printed certificates issued by the corporation standing for evidence of the ownership of the debt, which may be freely traded or negotiated.

The second important distinction is that the long-term debt will not mature for at least a year and usually for some time longer than that. Moreover, the current liabilities are generally composed of recurring items, whereas the long-term obligations are incurred only on occasion.

Third, the majority of long-term obligations carry some interest charge, whereas most current liabilities do not. Somewhere between the liability and equity section of the balance sheet we often find a category headed "deferred credits" or perhaps "deferred, prepaid, or unearned income." These show a source of funds or assets for which the firm has not as yet performed any service. For example, suppose a company received a cash prepayment for a job on which work is not yet completed. The deferred credit classification does not mean that the firm owes money for this payment but that it owes completion of the project. Furthermore, if the firm has made this contract on a normal basis, some part of the prepayment will not be covered by services or goods, but will revert to the firm as profit. As the contract progresses, the accountants will normally analyze the results to date and apply a proportionate part of the prepayment to expenses, another part to profits (if any), and last leave (among the deferred credits) only that proportion which represents the uncompleted part of the contract.

Capital Section of the Balance Sheet

The items classified here go to make up the shareholders' equity, net worth, capital, or ownership section of the balance sheet.[1] Those terms and other variants are used interchangeably; they mean approximately the same thing, and students should learn to identify these terms so that they will not be confused if one or the other is used. This section of the balance sheet contains the items making up the ownership claims against the business. A stockholder who owns 100 shares of Johnson & Johnson common stock is a part owner of the corporation. Given that Johnson & Johnson has approximately 2,968 million shares outstanding in February 2005, the owner of 100 shares probably feels that his or her vote at proxy time carries little weight in financial decision making. Every vote counts, though. It represents the original investments of the owners plus any earnings they have retained in the business, or less any accumulated losses the business may have suffered.

The amount shown as preferred stock represents the par or stated value of the various types of preferred stock issued, sold, and outstanding. The class of preferred stock is usually identified by its stated yearly dividends. Creditors often classify or consider the preferred issues simply as another form of equity, yet these shares have a prior claim on dividends and usually in case of dissolution have a claim prior to the common stockholders on the assets. They therefore, from the viewpoint of the common shareholders, take on some of the aspects of a creditor claim.

The common stock account shows the par value or stated value of the common stock issued, sold, or outstanding. It is often said that this account represents the amount that the stockholders originally put into the business, but this is not likely to be literally true and should be modified by our historical knowledge of the firms' financial affairs. In one sense the capital stock account may represent more than the original investment, since common stock may have been issued and sold periodically in the primary market as the firm raised funds to expand and to improve its equity base. In another sense the capital stock account may represent less than the original investment, for if in time the value of the firm's stock went over par, or over its stated value, and new issues were sold at a higher price, the difference is classified as capital or paid-in surplus. However, the new purchasing stockholders, at least, might well consider this amount part of their original investment. Lastly, the capital stock account is increased if the firm issues stock dividends. These have the accounting effect of reducing the earned surplus account and raising the capital stock account, but they do not increase the investment in the company at all.

The surplus accounts represent claims of ownership or shareholders' investments above and beyond the par or stated value of the stock. Essentially the surplus accounts break down into two divisions. The earned surplus or retained earnings is the amount put in by the common shareholders over time out of the company's earnings. The accounts loosely classified as capital surplus do not arise out of the firm's earnings but out of some of the firm's financial transactions, generally with its own stockholders. The term "surplus" ideally should not be used to describe these accounts, since the existence of a surplus account in no way implies that the firm has idle cash, nor indeed an excess of any sort of asset. Whether the firm has redundant fluid assets can be determined only by a careful comparison of the company's asset structure with its liabilities and operating needs.

The capital surplus accounts—paid-in surplus, donated surplus, premium on capital stock, or perhaps investment in excess of par value of capital stock—represent funds or assets given to the business on behalf of the ownership interests. These funds or assets do not arise out of the normal operations of the firm but out of certain financial transactions. For example, a capital surplus would arise if someone, perhaps but not necessarily a stockholder, were to donate some assets to the firm without asking for stock or other legal obligation in return. Most commonly capital surplus arises when a firm floats an issue of its stock at more than par value. After a company has been in operation for a time the market value of the stock is more likely than not to be higher than the par value. The amount the company obtains in excess of the par value is classified as paid-in surplus or premium on stock issued. A premium on the issue price of either preferred or common stock is considered capital surplus.

Earned surplus or retained earnings shows the amount that the firm has reinvested in the business out of earnings that could otherwise have been paid out in common stock dividends. This surplus differs from capital surplus in that it arises out of accumulated retained earnings and not out of financial transactions. If the firm's operations over time show accumulated losses rather than earnings, there is, of course, no earned surplus account but an accumulated deficit, which is subtracted from the other capital accounts on the balance sheet. One year's unsuccessful operation may not create a deficit on the balance sheet, since the losses of the current period may be more than covered by a previously accumulated surplus. The earned surplus accounts are basically derived from this equation: earnings minus losses minus dividends equal earned surplus. For the account to be negative, accumulated losses and dividends over time have to exceed the amounts earned. The earned surplus provides a safety stock of equity such that a year of losses need not bankrupt the firm and cause its stockholders to lose all of their investments. The reader need only look at Lucent or America Online (AOL) to see large operating deficits of firms that are not bankrupt. We will use the retained earnings concept in calculating the Altman Z bankruptcy prediction statistic in Chapter 3.

Book Value of Common Stock

The book value of the common stock is not directly indicated on the balance sheet, but it is readily derived from the balance sheet data. The book value is the net asset value of a share of common stock as presented by accounting convention on the balance sheet. To obtain this figure we subtract the total liabilities from total assets shown on the balance sheet, subtract the voluntary liquidation value of the preferred stock plus any accumulated dividends, and divide the remainder by the number of common shares outstanding. Alternatively, the book value per share equals the stated or par value of the common shares issued and outstanding, plus all the capital surplus, earned surplus, and surplus reserve accounts, less any liquidation premium or accrued dividends on the preferred shares, divided by the number of common shares outstanding.

Preferred stock is not included in book value either as a sum or as part of the divisor. If the term "book value" is used, it is usually understood as referring to the book value of the common stock, since the concept of book value of the preferred is not important or useful. Except in rare instances the preferred stockholders are not conceived of as having any ownership or interest in the surplus accounts; it is the common shares' pro rata equity in the surplus account that lends meaning to the concept of book value.

Calculating and understanding the concept of book value is not difficult; it shows the net equity per share of the common stock. The book value of a share of stock, however, reflects only the information given formally by the accounting data on the balance sheet. Although book value has some significance in indicating the worth of a share, it cannot give the earning power per share of stock, its market value, its value for control, or its probable future value. Book value is only one of many financial benchmarks. The role of book value in the stock selection process, as we see in Chapter 8, is becoming very important and controversial.

CONSOLIDATED BALANCE SHEETS

If a company like Johnson & Johnson has numerous subsidiaries and owns a major part of another firm, it may wish to present the financial position of the combined companies on one balance sheet. This is called a consolidated balance sheet. All the assets of the subsidiary are brought onto the parent company's balance sheet, and similarly all the liabilities are combined with the parent company's liabilities. The book value of the subsidiary company's minority stock (i.e., those shares of stock the parent company does not own) will be placed on the balance sheet midway between the liability and capital sections, since this account, usually entitled "interest of minority shareholders in consolidated subsidiaries," is somewhat of a hybrid. Since the actual assets and liabilities of the subsidiary company are brought onto the statement, the account representing the parent company's investment in the subsidiary is eliminated from the consolidated balance sheet. If at the time the parent company acquired the subsidiary it paid less than the net asset value (net book value) of the stock, the difference is labeled "surplus arising from consolidation" and considered one of the capital surplus items. Any growth in the subsidiary's book value since acquisition, such as the parent company's share of the subsidiary's retained earnings since the purchase, is considered a part of the consolidated earned surplus.

We show the AOL Personal Finance (Thomson) balance sheet for Johnson & Johnson in Table 2.1.

On December 31, 2003, the company had an investment of $22.995 billion in current assets, and current liabilities of $13.448 billion. Johnson & Johnson has invested funds in its current assets, relative to its current liabilities. The excess of the firm's current assets relative to its current liabilities is often referred to as the firm's net working capital. One could ask if the investment in its net working capital is large, and if so, relative to what level. Let us introduce several ratios that are useful to assessing the firm's balance sheet.

We can calculate the ratio of the firm's current assets relative to its total assets, and compare that ratio to the median ratio of all firms, or firms within the company's sector or industry. The greater the ratio of current assets to total assets (CATA), the greater is the firm's liquidity, and the greater is the firm's ability to pay its short-term creditors. A second ratio is the ratio of current liabilities to total assets (CLTA). A higher CLTA indicates lower liquidity and potentially higher risk. A third ratio is the ratio of current liabilities plus long-term debt to total assets, denoted total debt to total assets (TDTA). Current liabilities plus long-term debt represents the vast majority of total liabilities of the firm; the TDTA ratio ignores provisions for risks and charges, deferred income, and deferred taxes and other liabilities. The TDTA ratio allows the investor to assess much of the leverage factor, or how much of its fixed obligations funds the firm borrows from the capital markets. As of December 31, 2003, Johnson & Johnson had a CATA of 0.476, whereas

TABLE 2.1 Johnson & Johnson Balance Sheet, 1999–2003 ($ millions)

Assets	Dec-03	Dec-02	Dec-01	Dec-00	Dec-99
Cash and Short-Term Investments	9,523.00	7,475.00	7,972.00	5,744.00	3,879.00
Receivables (Net)	6,574.00	5,399.00	4,630.00	5,713.00	5,121.00
Total Inventories	3,588.00	3,303.00	2,992.00	2,842.00	3,095.00
Raw Materials	966.00	835.00	842.00	702.00	663.00
Work in Progress	981.00	803.00	605.00	458.00	416.00
Finished Goods	1,641.00	1,665.00	1,545.00	1,682.00	2,016.00
Progress Payments and Other	0.00	0.00	0.00	0.00	0.00
Prepaid Expenses	0.00	0.00	0.00	0.00	0.00
Other Current Assets	3,310.00	3,089.00	2,879.00	1,151.00	1,105.00
Current Assets—Total	22,995.00	19,266.00	18,473.00	15,450.00	13,200.00
Long-Term Receivables	18.00	25.00	30.00	35.00	41.00
Investment in Unconsolidated Subsidiaries	0.00	0.00	0.00	0.00	0.00
Other Investments	84.00	121.00	969.00	269.00	441.00
Property, Plant, and Equipment—Net	9,846.00	8,710.00	7,719.00	6,971.00	6,719.00
Property, Plant, and Equipment—Gross	17,052.00	14,314.00	12,458.00	11,248.00	11,046.00
Accumulated Depreciation	7,206.00	5,604.00	4,739.00	4,277.00	4,327.00
Other Assets	14,646.00	12,223.00	11,039.00	8,577.00	8,699.00
Deferred Charges	1,021.00	959.00	0.00	0.00	0.00
Tangible Other Assets	2,086.00	2,018.00	1,962.00	1,321.00	1,128.00
Intangible Other Assets	11,539.00	9,246.00	9,077.00	7,256.00	7,571.00
Total Assets	**47,589.00**	**40,345.00**	**38,230.00**	**31,302.00**	**29,100.00**
Liabilities and Shareholders' Equity					
Accounts Payable	4,966.00	3,621.00	2,838.00	2,083.00	2,003.00
Short-Term Debt and Current Portion of Long-Term Debt	1,139.00	2,117.00	565.00	1,479.00	1,806.00
Accrued Payroll	1,452.00	1,181.00	969.00	488.00	467.00
Income Taxes Payable	944.00	710.00	537.00	314.00	206.00
Dividends Payable	0.00	0.00	0.00	0.00	0.00
Other Current Liabilities	4,947.00	3,820.00	3,135.00	2,776.00	2,972.00
Current Liabilities—Total	13,448.00	11,449.00	8,044.00	7,140.00	7,454.00
Long-Term Debt	2,955.00	2,022.00	2,217.00	2,037.00	2,450.00
Provision for Risks and Charges	2,262.00	1,967.00	1,870.00	1,753.00	1,563.00
Deferred Income	0.00	0.00	0.00	0.00	186.00
Deferred Taxes	88.00	407.00	205.00	201.00	183.00
Deferred Tax Liability in Untaxed Reserves	0.00	0.00	0.00	0.00	0.00
Other Liabilities	1,949.00	1,778.00	1,631.00	1,328.00	1,010.00
Total Liabilities	**20,702.00**	**17,623.00**	**13,967.00**	**12,459.00**	**12,846.00**

TABLE 2.1 *(Continued)*

Assets	Dec-03	Dec-02	Dec-01	Dec-00	Dec-99
Nonequity Reserves	0.00	0.00	0.00	0.00	0.00
Minority Interest	0.00	0.00	0.00	0.00	0.00
Preferred Stock	0.00	0.00	0.00	0.00	0.00
Common Equity	26,887.00	22,722.00	24,263.00	18,843.00	16,254.00
Common Stock	3,120.00	3,120.00	3,120.00	1,535.00	1,535.00
Capital Surplus	0.00	0.00	0.00	0.00	0.00
Revaluation Reserves	0.00	0.00	0.00	0.00	0.00
Other Appropriated Reserves	(64.00)	(33.00)	(15.00)	(15.00)	0.00
Unappropriated (Free) Reserves	0.00	0.00	0.00	0.00	0.00
Retained Earnings	30,503.00	26,571.00	23,066.00	18,812.00	16,192.00
Equity in Untaxed Reserves	0.00	0.00	0.00	0.00	0.00
ESOP Guarantees	0.00	0.00	0.00	0.00	0.00
Unrealized Foreign Exchange Gain (Loss)	(373.00)	(707.00)	(697.00)	(522.00)	(477.00)
Unrealized Gain (Loss) on Marketable Securities	(153.00)	(102.00)	182.00	67.00	81.00
Treasury Stock	6,146.00	6,127.00	1,393.00	1,034.00	1,077.00
Total Liabilities and Shareholders' Equity	**47,589.00**	**40,345.00**	**38,230.00**	**31,302.00**	**29,100.00**
Common Shares Outstanding (thousands)	2,967,973.00	2,968,295.00	3,047,215.00	2,781,874.00	2,779,366.00

the median firm on the WRDS database had a CATA of 0.489. The company's current assets investment was in line with the median firm in the economy—its CLTA was 0.279 in 2003, whereas the median firm CLTA was 0.228, slightly lower. One could see a slight risk factor from the Johnson & Johnson position of higher relative current liabilities to total assets: It had a TDTA of 0.340 as of December 31, 2003, whereas the median firm TDTA was 0.427, indicating that Johnson & Johnson's total debt policy was less debt-intensive than the median firm, meaning potentially lower risk. Johnson & Johnson has been consistently lower in TDTA relative to the median WRDS firm during the 1970–2003 period (see Table 2.2).

The use of debt, often referred to as leverage, can enhance stockholder returns when the firm's return on assets exceeds its cost of debt; however,

TABLE 2.2 Liquidity and Total Debt Ratios of Johnson & Johnson, Selected Years, 1970–2003

Ratio	1970	1975	1980	1985	1990	1995	2000	2001	2002	2003
Johnson & Johnson										
CATA	0.628	0.610	0.590	0.568	0.491	0.444	0.493	0.478	0.475	0.476
CLTA	0.168	0.204	0.231	0.230	0.275	0.244	0.228	0.209	0.282	0.279
TDTA	0.203	0.229	0.252	0.286	0.414	0.363	0.293	0.267	0.332	0.340
Firm: Median—WRDS Ratio										
CATA	0.569	0.574	0.571	0.551	0.524	0.544	0.491	0.480	0.489	0.489
CLTA	0.223	0.243	0.260	0.247	0.255	0.247	0.233	0.236	0.242	0.228
TDTA	0.474	0.498	0.498	0.473	0.491	0.458	0.458	0.466	0.458	0.427
N	3,580	5,857	5,740	6,542	6,405	8,314	8,110	7,549	6,931	5,889

CATA—Current assets to total assets.
CLTA—Current liabilities to total assets.
TDTA—Total debt to total assets.
N—Number of firms.

leverage can be equally devastating when the firm's return on assets falls below its cost of debt. Leverage, the use of other people's money, enhances stockholder returns when the firm is profitable. We examine leverage more closely in Chapter 4.

THE OPERATING STATEMENTS: THE INCOME STATEMENT AND SOURCES AND USES OF FUNDS

The balance sheet is an accounting snapshot at a point of time, whereas the income statement is a condensation of the firm's operating revenues and expenses over a given period of time, most often during a quarter or year.[2] It depicts certain changes that have occurred between the prior balance sheet and the present one. The balance sheet (position statement) and the income statement may be reconciled through the earned surplus account. If this reconciliation is presented formally, it becomes the surplus statement.

The income statement is very important. The balance sheet depicts how much in assets historically have been invested in a firm; the operating statement indicates how successful (whether by efficiency or luck) the company has been in making a return on the assets committed to it. The detailed breakdown made for the operating management is usually not presented in the annual report to the general stockholders. Furthermore, the format and the order of items on the report differ according to the tastes and traditions of the managements of different firms.

Financial services gather data on corporations for the investment community. The financial services use a similar format for all firms to make it easy to compare companies. The form used by the services breaks out most of the important variables that are interesting for investment analysis. For example, a company's annual report will often lose the depreciation charges in a lumped account such as "manufacturing costs" or "cost of goods sold," and the actual depreciation charges can be obtained only in a footnote or in an obscure part of the report. The financial services show the depreciation charges as a separate item.

Table 2.3 is the AOL Personal Finance (Thomson) income statement for Johnson & Johnson during the 1999–2003 period. The income statement is highly useful for various financial analyses, because its bottom line is the net income of the firm. The firm produces goods and services, and markets and sells its goods and services, generating sales and producing net income. Net income may well be negative.

The sales account shows the total gross revenue received by the firm during the period. It includes sales for cash and for credit, whether or not they were collected at the end of the period. The sales figure should be net of allowances made to the buyers for spoiled or poor-quality goods or returned shipments.

The direct operating costs are the amounts spent for material and labor on the goods sold; costs of goods sold; and depreciation, depletion, and amortization expenses. Net sales minus cost of goods sold and the depreciation, depletion, and amortization expenses yield the gross income of the firm. One subtracts selling, general, and administrative (SG&A) expenses, other operating expenses (including research and development expenses), and extraordinary charges to determine earnings before interest and taxes (EBIT).

The nonoperating income account includes interest income, dividends on investments, and similar items. Income from major subsidiaries should be consolidated on the reported income statement, even if this is not done for tax purposes. Thus this account does not include the dividends from dominated subsidiary companies. Irregular income, such as that which might occur from the sale of an operating asset at a profit, are presented near the foot of the statement after the results of regular operations are reported.

Earnings before interest, taxes, depreciation, and amortization (EBITDA) represent the gross return on the company's operation. It is the

TABLE 2.3 Income Statement, Johnson & Johnson, 1999–2003 ($ millions)

	Dec-03	Dec-02	Dec-01	Dec-00	Dec-99
Net Sales or Revenues	41,862.00	36,298.00	33,004.00	29,139.00	27,471.00
Cost of Goods Sold	10,307.00	8,785.00	7,931.00	7,346.00	6,998.00
Depreciation, Depletion, and Amortization	1,869.00	1,662.00	1,605.00	1,515.00	1,444.00
Gross Income	**29,686.00**	**25,851.00**	**23,468.00**	**20,278.00**	**19,029.00**
Selling, General, and Administrative Expenses	18,815.00	16,173.00	15,583.00	13,801.00	13,103.00
Other Operating Expenses	0.00	0.00	0.00	0.00	0.00
Other Expenses—Total	30,991.00	26,620.00	25,119.00	22,662.00	21,545.00
Operating Income	10,871.00	9,678.00	7,885.00	6,477.00	5,926.00
Extraordinary Credit—Pretax	230.00	0.00	0.00	0.00	0.00
Extraordinary Charge—Pretax	918.00	424.00	252.00	54.00	0.00
Nonoperating Interest Income	177.00	256.00	456.00	379.00	246.00
Reserves—Increase (Decrease)	0.00	0.00	0.00	0.00	0.00
Pretax Equity in Earnings	0.00	0.00	0.00	0.00	0.00
Other Income/Expenses—Net	155.00	(59.00)	(38.00)	(34.00)	(222.00)
Earnings before Interest and Taxes (EBIT)	**10,515.00**	**9,451.00**	**8,051.00**	**6,768.00**	**5,950.00**
Interest Expense on Debt	315.00	258.00	248.00	242.00	278.00
Interest Capitalized	108.00	98.00	95.00	96.00	81.00
Pretax Income	10,308.00	9,291.00	7,898.00	6,622.00	5,753.00
Income Taxes	3,111.00	2,694.00	2,230.00	1,822.00	1,586.00
Current Domestic Income Taxes	2,934.00	2,042.00	1,726.00	1,321.00	994.00
Current Foreign Income Taxes	897.00	726.00	610.00	668.00	599.00
Deferred Domestic Income Taxes	(409.00)	20.00	(22.00)	(75.00)	94.00
Deferred Foreign Income Taxes	(311.00)	(94.00)	(84.00)	(92.00)	(101.00)
Income Tax Credits	0.00	0.00	0.00	0.00	0.00
Minority Interest	0.00	0.00	0.00	0.00	0.00
Equity in Earnings	0.00	0.00	0.00	0.00	0.00
After-Tax Income/Expense	0.00	0.00	0.00	0.00	0.00
Discontinued Operations	0.00	0.00	0.00	0.00	0.00
Net Income before Extra Items/Preferred Dividends	**7,197.00**	**6,597.00**	**5,668.00**	**4,800.00**	**4,167.00**
Extra Items and Gain (Loss) Sale of Assets	0.00	0.00	0.00	0.00	0.00
Net Income before Preferred Dividends	7,197.00	6,597.00	5,668.00	4,800.00	4,167.00
Preferred Dividend Requirements	0.00	0.00	0.00	0.00	0.00
Net Income Available to Common	**7,197.00**	**6,597.00**	**5,668.00**	**4,800.00**	**4,167.00**

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amount by which the revenues exceed the variable costs. Out of this sum come the funds to satisfy various claimants to a return from the firm, and internal funds that can be used to reduce debt or buy new assets according to the company's position after fixed claims are met and the distribution to the owners is decided.

Depreciation and other noncash charges such as depletion or amortization of franchises and patents can be a significant source of cash flow. Depreciation is usually by far the most important of these items. The depreciation account is the estimated capital (i.e., fixed assets) used up during the year. The depreciation charge is based on the cost—not the present value—of the assets, and the schedule of depreciation charges on an asset once set initially cannot be varied except under special circumstances. The level of depreciation charges is important in setting the amount of corporate profit tax due. It is important in reminding the management that not all the returns coming in are income; some must be considered a return of capital, and dividends policies should be set accordingly.

The annual depreciation charges do not, however, set the amount of fixed assets that will be replaced or new fixed assets purchased. This decision is based on the forecasted future profitability of the replacement or of the new assets. If investment in new fixed assets appears worthwhile, available internal funds or other sources of funds will be found to finance it; if the new investment in fixed assets does not exceed the amount of depreciation, then the extra funds can be used for something else.

Earnings before interest and taxes (EBIT), or operating income, represent the income of the firm after the book charge for depreciation has been made. After this figure is determined, the effects of many past financial decisions come into play. The amount of interest that will be paid is based on the amount of interest-bearing debt the firm has incurred, and this influences the profits tax. The amount available for the common stockholders is obtained after dividends on the preferred stock is subtracted. These figures are influenced by decisions on alternate methods of financing the firm. The pros and cons of these decisions make up a large part of the subject of corporation finance.

The interest expense represents the interest paid by the company on debt. It is reduced by the amortization of any premium on bonds payable, and increased by the amortization of bond discounts. Interest expense is deductible before calculating the corporate income tax. The corporate profits tax rate is 35 percent, and the tax is calculated after all regular expenses are deducted but before the subtraction of preferred dividends. If, however, there are no profits, there is no tax liability.

Earnings after taxes or net income is the amount earned on the total equity of the corporation from regular sources. It is not the dividends paid on the owners' investment, nor is it the amount earned on the common stock equity. Nonrecurring losses or gains arise out of transactions such as the sale of fixed assets (buildings, land, or equipment) or the sale of subsidiaries or investments in securities. Losses can also occur because of natural disasters (floods or fires) or because of liabilities on lawsuits. In any case, these gains or losses do not arise out of the normal operations of the business. The firm's net income represents the profits of normal business operations.

These items are given separately, for they are special or nonrecurring and we do not wish them to affect the analysis of the normal operations of the firm. If a firm sells a plant or subsidiary at a profit, the earnings for a given year are raised, but the earnings generated by the subsidiary will no longer be available in the future. Whether or not nonrecurring losses are fully deductible for tax purposes depends on the circumstances. It is suggested that when nonrecurring gains or losses occur, they be entered net of taxes (a loss would be reduced if there were regular income tax that could be used as an offset) after the regular part of the income report. Details should be provided in footnotes. In our illustrative statement, there are no nonrecurring items.

Dividends declared on the preferred shares are subtracted from net profits to obtain the earnings available to the common shareholders. Although the preferred dividends are not a legally fixed obligation of the firm, they represent a claim senior to any return on common shares, and there can be no calculation of earnings on the common shareholders' investment until they are accounted for. The preferred dividends are a prior charge from the view of the true residual owners of the firm, the common shareholders.

Earnings available to common stockholders (EACS) represent the accounting profits or earnings accruing to the shareholders of the business after all prior deductions have been made. The phrase "accounting profits or earnings" is used deliberately. The accounting profits and the true or economic profits of the firm can differ considerably. Reported accounting profits serve as a useful available measure of the firm's success. Moreover, under the discipline of the accounting formalities, profits are reported on a sufficiently consistent basis to enable them to be used in the determination of important legal obligations and privileges. But even within the accounting rules there exist legitimate alternative methods of reporting certain expenses and charges, which can cause considerable variation in the operating results of any year.

Net income, or profits, should be measured relative to the firm's sales, total assets, or equity. One must standardize net income for comparison purposes. Johnson & Johnson has been consistently (and substantially) more profitable than the median firm in our economy, whether one measures profitability on the basis of sales, assets, or equity (see Table 2.4). The company's use of leverage has enhanced its return on equity (ROE) relative to its return on assets (ROA), such that it has generated returns on its equity more than three times the corresponding ratio for the median firm in the economy.

Dividends are a charge on earnings. In most jurisdictions, however, legally they constitute a charge against surplus, not current earnings, and may be declared as long as there is a sufficient credit balance in the surplus account, even if there are no current profits. Firms may elect to do this. As a practical matter, though, the dividend policies of most firms are conditioned by their current earnings positions and not by their retained surplus accounts, and so from the point of view of functional relationships the order of accounting presented seems quite correct. Common stock dividends are a voluntary distribution of the profits of the firm and not a legal obligation. Their declaration does not reduce the profits of the firm. Thus they are deducted after the earnings on the common stock are calculated. Moreover, the profits tax liability of the firm is not affected by the payment of either preferred dividends or common dividends.

What is left after all dividends are subtracted from the reported profits is the retained earnings, reinvested earnings, or net addition to surplus for the year. If expenses exceed revenues, there would be instead an operating loss or deficit for the year. The retained earnings for the period depend on the level of profit and the dividend policy of the company. These in turn are influenced by factors such as the stability and amount of the company's cash flow, the firm's growth prospects, and its need for equity funds either

TABLE 2.4 Johnson & Johnson Relative Returns on Sales, Assets, and Equity

Ratio	1970	1975	1980	1985	1990	1995	2000	2001	2002	2003
Johnson & Johnson										
ROS	0.083	0.083	0.083	0.096	0.102	0.128	0.165	0.172	0.182	0.172
ROA	0.118	0.118	0.120	0.120	0.120	0.134	0.153	0.147	0.163	0.149
ROE	0.157	0.160	0.177	0.183	0.233	0.266	0.255	0.234	0.291	0.268
Firm: Median—WRDS Ratio										
ROS	0.038	0.035	0.043	0.027	0.021	0.037	0.019	0.006	0.018	0.031
ROA	0.041	0.039	0.044	0.026	0.018	0.022	0.009	0.004	0.009	0.012
ROE	0.100	0.104	0.128	0.096	0.090	0.098	0.075	0.068	0.073	0.082
N	3,711	6,169	6,185	7,134	7,241	10,112	9,861	9,224	8,519	7,085

to acquire additional assets or to repay debt. The retained earnings accumulated over time become the earned surplus of the firm. The surplus account indicates only a historical source for the financing of the firm and does not represent an existing fund of cash.

The amount earned and paid in dividends on the individual stockholder's share is of more direct importance to him or her than the total amount earned by the firm. The earnings and trend of dividends on the individual shares in the long run establish their value in the market.

The earnings per share are obtained by dividing the total earnings available to the common stock by the number of shares of stock outstanding. Often the earnings per share are shown once, reflecting the regular, recurring income, and again, including extraordinary income items. An additional figure, not always available but often useful, is the cash flow per share. It includes earnings available to the common shareholders plus noncash charges divided by the number of shares. This figure shows the gross funds available per share of stock that may be used to repay debt, acquire assets, and pay dividends. An interesting possibility is to subtract required amortization of debt from the cash flow per share and arrive at the figure of free or disposable cash flow per share. This figure might prove useful in comparing two firms where earnings are similar but one firm is required to make payments on the principal of its debt.

SOURCES AND USES OF FUNDS

The income statement provides a picture of the firm's operations during the past year. The bottom line of the income statement is the firm's net income or after-tax profits. The firm's sources of cash flow from its operations are positive net income, having depreciation and other noncash expenses, and issuing new debt or equity. The firm's sources of funds must equal its uses of funds. The firm uses its cash flow to engage in capital expenditures, pay dividends, pursue research and development (R&D) activities, pay off its debt and/or equity, or reduce its net working capital (its current assets less its current liabilities). The reader only needs to look at Johnson & Johnson's sources and uses of funds in Table 2.5 to be reminded that net income is the firm's primary source of cash flow. Stockholders prefer to see the firm's cash flow derived from profits, not depreciation, because depreciation is an expense that serves to provide the firm with cash flow to replenish its capital investment. From Table 2.5, we find that the statement of cash flows can be divided into three sections: cash flows from operating activities, cash flows from investing activities,

TABLE 2.5 Sources and Uses of Funds, Johnson & Johnson, 1999–2003 ($ millions)

	Dec-03	Dec-02	Dec-01	Dec-00	Dec-99
Net Income/Starting Line	7,197.00	6,597.00	5,668.00	4,800.00	4,167.00
Depreciation, Depletion, and Amortization	1,869.00	1,662.00	1,605.00	1,515.00	1,444.00
Depreciation and Depletion	1,415.00	1,662.00	1,605.00	1,515.00	1,444.00
Amortization of Intangible Assets	454.00	0.00	0.00	0.00	0.00
Deferred Income Taxes and Investment Tax Credit	(720.00)	(74.00)	(106.00)	(167.00)	(7.00)
Deferred Income Taxes	(720.00)	(74.00)	(106.00)	(167.00)	(7.00)
Investment Tax Credit	0.00	0.00	0.00	0.00	0.00
Other Cash Flow	924.00	183.00	204.00	87.00	11.00
Funds from Operations	9,270.00	8,368.00	7,371.00	6,235.00	5,615.00
Extraordinary Items	0.00	0.00	0.00	0.00	0.00
Funds from/for Other Operating Activities	1,325.00	(192.00)	1,493.00	328.00	62.00
Decrease (Increase) in Receivables	(691.00)	(510.00)	(258.00)	(451.00)	(671.00)
Decrease (Increase) in Inventories	39.00	(109.00)	(167.00)	125.00	(333.00)
Increase (Decrease) in Accounts Payable	2,192.00	1,420.00	1,401.00	57.00	242.00
Increase (Decrease) in Income Taxes Payable	0.00	0.00	0.00	0.00	0.00
Increase (Decrease) in Other Accruals	0.00	0.00	0.00	0.00	0.00
Decrease (Increase) in Other Assets/ Liabilities	(215.00)	(993.00)	517.00	597.00	824.00
Net Cash Flow—Operating Activities	**10,595.00**	**8,176.00**	**8,864.00**	**6,563.00**	**5,677.00**
Capital Expenditures (Additions to Fixed Assets)	2,262.00	2,099.00	1,731.00	1,646.00	1,728.00
Additions to Other Assets	0.00	0.00	0.00	0.00	0.00
Net Assets from Acquisitions	2,812.00	478.00	225.00	68.00	271.00
Increase in Investments	7,590.00	6,923.00	8,188.00	5,383.00	3,538.00
Decrease in Investments	8,062.00	7,353.00	5,967.00	4,670.00	2,817.00
Disposal of Fixed Assets	335.00	156.00	163.00	161.00	35.00
Other Uses—Investing	259.00	206.00	79.00	102.00	257.00
Other Sources—Investing	0.00	0.00	0.00	0.00	0.00
Net Cash Flow—Investing	**4,526.00**	**2,197.00**	**4,093.00**	**2,368.00**	**2,942.00**
Proceeds from Stock Options	311.00	390.00	514.00	292.00	263.00
Other Proceeds from Sale/Issue of Stock	0.00	0.00	0.00	0.00	0.00

(Continued)

TABLE 2.5 *(Continued)*

	Dec-03	Dec-02	Dec-01	Dec-00	Dec-99
Common/Preferred Purchased, Retired, Converted, Redeemed	1,183.00	6,538.00	2,570.00	973.00	840.00
Long-Term Borrowings	1,023.00	22.00	14.00	4.00	793.00
Increase (Decrease) in Short-Term Borrowings	(1,072.00)	1,799.00	(771.00)	(671.00)	(855.00)
Reduction in Long-Term Debt	196.00	245.00	391.00	28.00	176.00
Cash Dividends Paid—Total	2,746.00	2,381.00	2,047.00	1,724.00	1,479.00
Common Dividends (Cash)	2,746.00	2,381.00	2,047.00	1,724.00	1,479.00
Preferred Dividends (Cash)	0.00	0.00	0.00	0.00	0.00
Other Sources—Financing	0.00	0.00	0.00	0.00	0.00
Other Uses—Financing	0.00	0.00	0.00	0.00	0.00
Net Cash Flow—Financing	**(3,863.00)**	**(6,953.00)**	**(5,251.00)**	**(3,100.00)**	**(2,294.00)**
Effect of Exchange Rate on Cash	277.00	110.00	(40.00)	(47.00)	(72.00)
Changes in Cash and/or Liquid Items	0.00	0.00	0.00	0.00	0.00

and cash flows from financing activities. These three sections will now be further explained in detail.

The operating activities section of the statement of cash flows lists the sources and uses of cash that arise from the normal operations of a firm. In general, the net cash flow from operations is computed as income statement net income plus adjustments for noncash revenues and expenses.

Cash flow from operating activities = Net income + Depreciation
– Change in modified net working capital

You may recall that net working capital is defined as the difference between current assets and current liabilities:

Net working capital = Current assets – Current liabilities

Thus, an increase in net working capital is a net investment in the firm's current assets, and an increase in an asset is considered a use of cash. A decrease in net working capital is a divestment of assets—that is, a source of cash.

A modified net working capital amount is used to compute cash flow from operating activities, as standard definitions of current assets include cash and marketable securities and standard definitions of current liabilities include notes payable. In the statement of cash flows, changes in notes payable are considered a financing flow and thus appear as a component of the cash flows from financing activities. The change in the cash account appears at the bottom of the statement, as the sum of cash flows from operating, investing, and financing activities. From Table 2.5, we know that the net cash inflows from operating activities for Johnson & Johnson in 2003 are $10,595 million, primarily composed of net income of $7,197 million. The net cash flows from investing and financing activities are $4,526 million and –$3,863, respectively.

The investing activities section of the statement of cash flows represents the investments a firm makes in both its own fixed assets and the equity of other firms, including subsidiaries or joint ventures. (These holdings are listed in the investment account of the balance sheet.) Increases and decreases in these accounts are considered investment activities. Johnson & Johnson pursued capital expenditures of $2.262 billion in 2003 and made acquisitions of $2.812 billion. The cash flow from investment activities is the change in gross plant and equipment plus the change in the investment account. The changes are added if they represent a source of funds; otherwise, they are subtracted. The dollar changes in these accounts are computed from the beginning and ending balance sheets.

The financing activities section of the statement of cash flows includes cash flows arising from purchases and sales of notes payable and long-term securities and dividend payments to equity holders (recall that interest payments to bondholders help determine the firm's net income, which is part of cash flows from operating activities). Cash flows from financing activities are computed as financing sources minus financing uses. Sources include increases in notes payable and new issues of bonds, preferred stock, and common stock, since these actions result in cash inflows. Uses include principal payments or the repurchase of notes payable, bonds, or stock. Dividend payments to equity holders also are considered a financing use. Table 2.5 shows that net cash used by financing activities in 2003 was $3,863 million, composed primarily of dividend payments of $2,746 million, and decreases in short-term borrowings of $1,072 million.

TABLE 2.6 Quarterly Balance Sheets, Johnson & Johnson ($ millions)

	Jun-04	Mar-04	Dec-03	Sep-03
Cash	5,681.00	5,637.00	5,377.00	3,850.00
Marketable Securities	5,105.00	4,724.00	4,146.00	4,998.00
Receivables	7,142.00	6,772.00	6,574.00	6,399.00
Total Inventories	3,528.00	3,522.00	3,588.00	3,739.00
Raw Materials	N/A	N/A	N/A	N/A
Work in Progress	N/A	N/A	N/A	N/A
Finished Goods	N/A	N/A	N/A	N/A
Notes Receivable	N/A	N/A	N/A	N/A
Other Current Assets	3,201.00	3,709.00	3,310.00	3,160.00
Total Current Assets	**24,657.00**	**24,364.00**	**22,995.00**	**22,146.00**
Net Property, Plant, and Equipment	9,557.00	9,669.00	9,846.00	9,245.00
Property, Plant, and Equipment	17,257.00	17,104.00	9,846.00	16,054.00
Accumulated Depreciation	7,700.00	7,435.00	N/A	6,809.00
Interest and Advance to Subsidiaries	62.00	70.00	84.00	120.00
Other Noncurrent Assets	N/A	N/A	N/A	N/A
Deferred Charges	995.00	822.00	692.00	402.00
Intangibles	11,805.00	11,442.00	11,539.00	11,679.00
Deposits and Other Assets	3,095.00	2,501.00	3,107.00	3,067.00
Total Assets	**50,171.00**	**48,868.00**	**48,263.00**	**46,659.00**
Liabilities and Shareholders' Equity				
Notes Payable	491.00	594.00	1,139.00	2,024.00
Accounts Payable	3,829.00	3,782.00	4,966.00	3,660.00
Current Long-Term Debt	N/A	N/A	N/A	N/A
Current Portfolio Capital Leases	N/A	N/A	N/A	N/A
Accrued Expense	6,412.00	6,213.00	6,399.00	5,978.00
Income Taxes	1,330.00	1,860.00	944.00	1,120.00
Other Current Liabilities	N/A	N/A	N/A	N/A
Total Current Liabilities	**12,062.00**	**12,449.00**	**13,448.00**	**12,782.00**
Mortgages	N/A	N/A	N/A	N/A
Deferred Charges/Inc.	995.00	822.00	692.00	402.00
Convertible Debt	N/A	N/A	N/A	N/A
Long-Term Debt	2,962.00	2,961.00	2,955.00	3,149.00
Noncurrent Capital Leases	N/A	N/A	N/A	N/A
Other Long-Term Liabilities	4,326.00	4,223.00	4,211.00	4,106.00
Total Liabilities	**20,119.00**	**20,374.00**	**21,394.00**	**20,921.00**
Minority Interest (Liabilities)	N/A	N/A	N/A	N/A
Preferred Stock	N/A	N/A	N/A	N/A
Common Stock	3,120.00	3,120.00	3,120.00	3,120.00
Capital Surplus	N/A	N/A	N/A	N/A
Retained Earnings	33,627.00	32,153.00	30,503.00	29,500.00
Treasury Stock	6,158.00	6,170.00	6,146.00	6,136.00
Total Shareholders' Equity	**30,052.00**	**28,494.00**	**26,869.00**	**25,738.00**
Total Liabilities and Net Worth	**50,171.00**	**48,868.00**	**48,263.00**	**46,659.00**
Common Shares Outstanding (thousands)	2,967.77	2,967.56	3,271.71	2,967.98

The sum of the cash flows from operating, investing, and financing activities is the net increase or decrease in the firm's cash. By detailing changes in important financial statement line items, the statement of cash flows reveals information that the balance sheet and income statement cannot provide. We have discussed the annual balance sheet, income statement, and sources and uses of funds for Johnson & Johnson during the 1999–2003 period, and showed ratios using the WRDS database for Johnson & Johnson and the median firm in the economy for selected years during the 1970–2003 period. Financial data is reported quarterly in the United States by most firms. The Johnson & Johnson quarterly balance sheets for four recent quarters are shown in Table 2.6, and quarterly income statements in Table 2.7. The company's quarterly returns on sales, total assets, and equity are very large, as we saw when we compared its ROE with the median firm ROE. As shown in Table 2.8, net income is the primary source of net cash flow for the company during the same four quarters, and dividends are the primary use or net cash outflow from financing.

In this chapter, we have introduced the reader to financial statements. In the next chapter, we calculate additional ratios and estimate composite indicators of the perceived financial health of firms. The composite indicators are often used in credit-granting processes.

TABLE 2.7 Quarterly Johnson & Johnson Income Statements ($ millions)

	Jun-04	Mar-04	Dec-03	Sep-03
Net Sales	11,484.00	11,559.00	11,254.00	10,455.00
Cost of Goods Sold	3,162.00	3,367.00	3,508.00	2,980.00
Gross Profit	**8,322.00**	**8,192.00**	**7,746.00**	**7,475.00**
R&D Expenditure	1,182.00	1,095.00	1,489.00	1,177.00
SG&A Expense	3,711.00	3,640.00	4,054.00	3,428.00
Depreciation and Amortization	N/A	N/A	N/A	N/A
Nonoperating Income	58.00	92.00	215.00	154.00
Interest Expense	52.00	45.00	44.00	75.00
Income before Taxes	**3,435.00**	**3,504.00**	**2,374.00**	**2,949.00**
Provision for Income Taxes	977.00	1,011.00	529.00	877.00
Minority Interest (Liabilities)	N/A	N/A	N/A	N/A
Investment (Gain/Loss)	N/A	N/A	N/A	N/A
Other Income	N/A	N/A	N/A	N/A
Net Income before Extra Items	2,458.00	2,493.00	1,845.00	2,072.00
Extra Items and Disc. Operations	N/A	N/A	N/A	N/A
Net Income	**2,458.00**	**2,493.00**	**1,845.00**	**2,072.00**

Data provided by Thomson, © Copyright 2004 Thomson.

TABLE 2.8 Quarterly Sources and Uses of Funds Data, Johnson & Johnson ($ millions)

	Jun-04	Mar-04	Dec-03	Sep-03
Net Income (Loss)	2,458.00	2,493.00	1,845.00	2,072.00
Depreciation/Amortization	1,027.00	502.00	1,869.00	1,347.00
Net Increase (Decrease) in Assets/Liabilities	(770.00)	(169.00)	1,325.00	(543.00)
Cash Flow from Disc. Operations	N/A	N/A	N/A	N/A
Other Adjustments—Net	(427.00)	(171.00)	204.00	887.00
Net Cash Flow from Operating	**4,781.00**	**2,655.00**	**10,595.00**	**7,043.00**
Increase (Decrease) in Property Plant and Equipment	(714.00)	(292.00)	(2,262.00)	(1,472.00)
(Acq.) Disp. of Subs. Business	(300.00)	N/A	(2,812.00)	(2,447.00)
Increase (Decrease) in Securities Investing	(970.00)	(591.00)	472.00	(391.00)
Other Cash Flow from Investing	120.00	33.00	76.00	(104.00)
Net Cash Flow from Investing	**(1,864.00)**	**(850.00)**	**(4,526.00)**	**(4,414.00)**
Issue (Repayment) of Debt	N/A	N/A	N/A	N/A
Increase (Decrease) in Borrowing	(564.00)	(508.00)	(245.00)	917.00
Dividends, Other Distribution	(1,559.00)	(713.00)	(2,746.00)	(2,033.00)
(Acq.) Disp. of Subs. Business	(300.00)	N/A	(2,812.00)	(2,447.00)
Other Cash Inflow (Outflow)	120.00	33.00	76.00	(104.00)
Net Cash Flow from Financing	**(2,572.00)**	**(1,503.00)**	**(3,863.00)**	**(1,817.00)**
Effect of Exchange Rate on Cash	(41.00)	(42.00)	277.00	144.00
Cash or Equivalents at Year Start	5,377.00	5,377.00	2,894.00	2,894.00
Cash or Equivalents at Year End	5,681.00	5,637.00	5,377.00	3,850.00
Net Change in Cash or Equivalent	**304.00**	**260.00**	**2,483.00**	**956.00**

CHAPTER 3

Ratio Analysis

In this chapter, we first review the basic concepts of ratio analysis. Ratio analysis is a well-established set of calculated variables that can often provide a quick and accurate assessment of the operating condition and financial health of companies. The current assets (cash, receivables, inventory, etc.) support the short-run operations of the business. We integrate current asset management, sources and uses of funds (introduced in the previous chapter), and ratio analysis in this chapter.

RATIO ANALYSIS AND THE FIRM'S PERCEIVED FINANCIAL HEALTH

Ratio analysis is an alternative to the flow of funds method of working capital analysis, although the two can be used to supplement each other. Ratio analysis is older and possibly a more popular approach than the flow of funds method of management, and is the tool most readily available to credit managers of other companies, or other outsiders. A person within the firm sometimes finds other analytical tools more useful.

Ratio analysis consists of studying ratio or percentage relationships of meaningful financial data. The results are compared (1) with standard ratios (i.e., the averages or median values of all firms or only similar firms); (2) with the firm's ratios in previous years; or (3) with some implicit standards existing in the mind of the analyst. In the hands of a skilled practitioner both "external analysis" (comparisons to standard ratios) and internal analysis (i.e., trends and relationships of the ratios within the company) can be revealing.

Innumerable ratios can be developed, since the financial accounts can be placed in almost unlimited combinations. For most purposes, however, about 13 popular ratios suffice for whatever can be learned from this method about the firm's current financial position.[1] In many cases only 6 to

10 of these ratios are needed for an understanding of the problem. If special areas seem to warrant additional attention, it is not difficult to develop other ratios.

The following ratios are the most generally used. The first two are most relevant for current analysis. The remaining ones reveal more general relationships.

Current Analysis Ratios

- Current ratio (CR)
- Acid test (AT)

Leverage Ratio

- Total debt/total assets (TDA)

Sales Efficiency Ratio

- Sales/total assets (SA)

Profitability Ratios

- Net profit/total assets (ROA)
- Net profit/sales (ROS)
- Net profit/equity (ROE)
- EBIT/interest—times interest earned (TIE)

Composite Firm Relative Valuation Ratios

- DuPont analysis, return on invested capital (DuPontA)
- Altman Z model (NewZ)

Current Analysis Ratios

Current Ratio The current ratio is obtained by dividing the current liabilities into the current assets. It indicates how many times current liabilities are covered by current assets. The higher the current ratio, the more conservative (and safer) the current financial position of the firm. One prefers a higher current ratio. Management can use its current assets to immediately reduce its current liabilities (i.e., pay them off). A 2-to-1 ratio is a rule-of-thumb benchmark indicating a minimum level of the working capital position. Other circumstances must always be considered; no financial analysis can proceed rigidly. A ratio below 2 does not necessarily make the firm unsafe, nor does a current ratio well over 2 ensure financial soundness. Much depends on the collectibility and time structures of the firm's receivables and the type and quantity of inventory the firm carries. Public utilities and railroad companies often have a current ratio of 1 to 1 or below.[2] In an electric utility company, for example, the low current ratio is possible because of its minimum inventory requirements and the stability of its revenues and cash flow.

Acid Test The acid test, or quick ratio, is obtained by dividing current liabilities into the firm's net receivables and cash. This ratio highlights the firm's short-term liquidity position. One prefers a higher acid test ratio. The rule-of-thumb measure of a satisfactory acid test ratio is 1 to 1; that is, an acid test ratio of 1 indicates that the firm could turn all current assets, with the exception of inventory, into cash and pay off its current liabilities. From an obverse point of view, the acid test ratio tends to indicate the amount of inventory in the working capital position of the firm. For example, if the current ratio is 3 to 1 and the acid test is only .85 to 1, the inventory account probably constitutes a heavy proportion of the current assets. A corporation's inventory may not be as valuable as the initial value of the finished goods, such as in the case of older computers.

Leverage Ratio

The current analysis ratios are most important to credit managers who pass on credit sales and others who are interested in the firm's short-term position. The leverage ratios are useful to investors, long-term creditors, and others concerned with the firm from a longer-term basis. Of course, in any case, whether the analyst's interest is short- or long-term, selections of pertinent ratios should be made from both groups.

Short-term creditors have sometimes lent (given) a firm funds on the basis of a good current position, unwisely ignoring other fundamental financial analysis. For although the first grant of credit might be repaid on time, many short-term arrangements turn out to be semipermanent as the supplier periodically renews or extends new credit to the customer firm. If fundamental financial weaknesses outside the current position are passed over, they may cause failure at some later date with consequent losses to the supposedly short-term creditor. In essence, leverage ratios tell the investor what a corporation owes its creditors.

Total Debt to Assets The total debt to total assets ratio, discussed in the previous chapter with respect to Johnson & Johnson (JNJ), helps investors and creditors assess the riskiness of the firm. One prefers a lower total debt to total assets ratio.

Sales Efficiency Ratio

Sales to Total Assets The ratio of sales to total assets indicates how intensively the total assets are used in production. One prefers a higher sales to total assets ratio. A low sales to total assets ratio in comparison with similar firms or with previous periods gives some indication of idle capacity—that is, excess assets compared to the level of operations. Interindustry comparisons of this ratio are not very useful. A wholesale distributor, for example, with no processing costs, a small margin, and a large turnover of goods shows a relatively high volume of sales to total assets. A better ratio to measure the basic concept of the rate of utilization of capital would be value added to total asset—that is, something approaching a capital coefficient. Unfortunately, possibly because of statistical difficulties, value-added ratios are not commonly used in financial analysis.

Profitability Ratios

Profitability ratios tell the investor how efficiently a corporation uses its assets to produce net income or profits.

Net Profit (Net Income) to Total Assets This ratio is intended to relate the return of the firm to its total investment (i.e., the total assets it has available). It has some use, but it is subject to the criticism that the relationship presented is not the most logical one and that it does not present sufficient new information. The net profit figure has already been reduced by taxes and the cost of external funds (i.e., interest); to relate this figure to total assets is an illogical relating of a net concept (net profits) with a gross concept (total assets). Moreover, the ratio does not give much independent information if the net profit on owners' equity is to be calculated too, as it usually is. Obviously the net profit rate of return (or rate of loss) on total assets is always less than that on the owners' equity. The difference depends on the relative amount of total leverage.[3] One prefers higher profitability ratios.

Net Profits to Sales The net income to sales ratio allows the investor to compare its net income to sales, in addition to its total assets.

Net Profits to Equity The net income to sales ratio allows the investor to compare its net income to equity, in addition to its total assets and sales. The firm's return on equity allows the investor or creditor to assess the firm's efficient use of its assets to generate net income, and its effective use of leverage. A comparison of this ratio to rate of profit on equity indicates how well the firm has adjusted its financial mix. Comparison of these ratios (allowing for the fact that one is an after-tax return) indicates something about the profitability—but not much about the risk of the firm's use of leverage.

EBIT to Interest Charges (Times Interest Earned—TIE) This ratio is obtained by dividing the firm's annual interest charges into its earnings before interest and taxes (EBIT).[4] The size of the ratio obtained indicates something of the safety of the long-term debt component of the firm's financing. Standard & Poor's Corporation makes extensive use of the times interest earned ratio in ranking debt with respect to possible default. The operational safety of long-term debt affects the short-term creditors and working capital management indirectly. If the coverage is good, the firm may safely operate on a relatively smaller net working capital margin. A poor or erratic coverage may cast doubt on what otherwise appears to be an adequate current position.

We calculate these eight ratios and the general analysis ratios for JNJ for selected years during the 1970–2003 period, using the WRDS database, and will discuss the implications of these ratios later in the chapter when we compare them to their respective sector and group medians.

FINANCIAL RATIOS AND THE PERCEIVED FINANCIAL HEALTH OF FIRMS

Financial analysis often combines the information of several ratios to gain insight into a picture of the firm's health. In this chapter, we examine two composite measures of the firm's health, the DuPont system rate of return, dating back to the early twentieth century, and the Altman Z bankruptcy prediction model, created in 1968. The DuPont system, or measure, divides net operating income by sales and multiplies the result by the ratio of sales to investment, producing a return on investment (ROI).

$$\frac{\text{NOI}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Investment}} = \text{ROI}$$

Stockholders should invest in firms with higher ROIs, and management could seek to maximize the DuPont ROI to maximize its stock price. The DuPont analysis uses information inherent in its return on sales and sales turnover ratios.

Pierre DuPont and Donald Brown, a DuPont Corporation employee, developed the DuPont return on investment relationship to access the firm's financial performance. General Electric calculated profitability by dividing earnings by sales (or costs). However, this calculation ignored the magnitude of invested capital. In 1903, Pierre DuPont created a new general ledger account for "permanent investment," where capital expenditures were charged at cost. The DuPont Corporation executive committee was presented with monthly sales, income, and return on invested capital on the firm's 13 products in 1904 (Chandler 1977). Donald Brown contributed to the DuPont analysis by pointing out that as sales volume rose, the return of invested capital rose, even if prices remained constant. Brown's turnover analysis was defined as sales divided by total investment. The multiplication of turnover by the ratio of earnings to sales produced the DuPont return on invested capital, still in use by the DuPont Corporation and most American firms. Total investment includes working capital, cash, inventories, and accounts receivable, as well as permanent investment, bonds, preferred stock, and stocks. The DuPont return on invested capital combines and consolidates financial, capital, and cost accounting. The DuPont return on total investment helped DuPont develop many modern management procedures for creating operating and capital budgeting and making short-run and long-run financial forecasts.

A second composite model is the Altman Z model, which is useful to identify potentially bankrupt firms. The Altman Z score used five primary ratios in its initial 1968 version.

$$Z = .012X_1 + .014X_2 + .033X_3 + .006X_4 + .999X_5$$

where X_1 = (Current assets – Current liabilities)/Total assets
X_2 = Retained earnings/Total assets
X_3 = EBIT/Total assets
X_4 = Market value of equity/Book value of debt
X_5 = Sales/Total assets

The Altman Z score used a liquidity, past profitability, (present) profitability, leverage, and sales turnover ratios to produce a single score. An Altman Z score of less than 2.67 implied that the firm was not healthy. An Altman Z score exceeding 2.67 implied financial health. The Altman Z score successfully predicted impending bankruptcy for 32 of 33 firms (97 percent) in the year prior to bankruptcy, for Altman's initial sample. The model correctly predicted 31 of 33 (94 percent) nonbankrupt firms in this sample for the year prior to bankruptcy.

Altman modified his equation in 2000 to become:

$$Z = .717X_1 + .847X_2 + 3.107X_3 + .420X_4 + .998X_5$$

where X_4 is now book value of equity relative to book value of debt. The new critical level is 2.0. We show the modified Altman Z score and its components in Table 3.1 for JNJ for selected years during the 1970–2003 period. JNJ substantially, and consistently, outperforms the median U.S. firm in sales efficiency, profitability, and lower leverage. The higher profitability leads to much higher DuPont return on invested capital, higher return on equity, and higher Altman (new) Z score. JNJ is a quite healthy financial firm, having a (new) Z score of 3.04.

TIME SERIES OF RATIOS IN THE UNITED STATES, 1970–2003

Is there a consistent pattern of movement in financial ratios over the 1970–2003 period? Yes, as we can see in Table 3.1. For all firms listed on

TABLE 3.1 Johnson & Johnson and the Median WRDS Firm Altman Z Score and Its Components, Selected Years, 1970–2003

Ratio	1970	1975	1980	1985	1990	1995	2000	2001	2002	2003
Johnson & Johnson										
CR	3.745	2.995	2.548	2.471	1.778	1.809	2.164	2.297	1.683	1.710
SA	1.418	1.434	1.447	1.260	1.182	1.054	0.930	0.858	0.895	0.867
TDA	0.204	0.229	0.252	0.268	0.414	0.363	0.293	0.267	0.332	0.340
DuPontA	0.149	0.154	0.171	0.174	0.184	0.215	0.230	0.214	0.267	0.241
ROE	0.157	0.160	0.177	0.183	0.233	0.266	0.255	0.234	0.290	0.268
NewZ	4.571	4.332	4.024	3.725	3.175	3.041	3.267	3.304	3.145	3.041
WRDS Ratios, Median Values										
CR	2.027	1.965	1.829	1.768	1.620	1.727	1.672	1.585	1.580	1.703
SA	1.205	1.270	1.231	0.995	1.000	0.900	0.700	0.695	0.710	0.701
TDA	0.473	0.497	0.498	0.474	0.491	0.457	0.458	0.466	0.458	0.427
DuPontA	0.061	0.060	0.074	0.055	0.044	0.060	0.037	0.027	0.037	0.047
ROE	0.100	0.104	0.128	0.098	0.090	0.098	0.075	0.058	0.073	0.083
NewZ	3.050	2.756	2.765	2.321	2.131	2.226	1.806	1.666	1.639	1.752
N	3,524	5,559	5,444	5,239	6,107	7,972	7,826	7,309	6,732	5,484

CR—Current ratio.
SA—Sales/assets.
TDA—Total debt/assets.
DuPontA—DuPont analysis.
ROE—Return on equity.
NewZ—Altman Z model.
N—Number of firms.

TABLE 3.2 Median WRDS Firm Altman Z Score and Its Components for I/B/E/S Sectors in 2003

WRDS Ratios, Median Values, 2003, by I/B/E/S Sector											
Ratio	1	2	3	4	5	6	7	8	9	10	11
CR	1.665	2.952	2.068	1.671	1.853	1.197	1.291	2.482	1.868	1.941	0.998
SA	0.072	0.681	1.168	1.234	1.273	0.511	1.045	0.812	0.881	1.061	0.438
TDA	0.427	0.323	0.417	0.425	0.470	0.432	0.460	0.323	0.456	0.432	0.475
DuPontA	0.079	0.000	0.080	0.048	0.065	0.051	0.059	0.005	0.037	0.040	0.048
ROE	0.110	0.017	0.120	0.082	0.086	0.085	0.094	0.007	0.068	0.069	0.107
NewZ	1.925	1.844	2.590	2.516	2.514	1.626	2.050	1.827	1.949	2.210	1.109
N	65	603	221	778	149	205	87	937	239	364	250

the WRDS database, firms have substantially lowered their liquidity over the 34-year period, with the median current ratio falling from 2.027 in 1970 to 1.703 in 2003. The median debt-to-assets ratio has fallen slightly, from 0.473 in 1970 to 0.429 in 2003. Sales efficiency has fallen from 1.205 in 1970 to 0.701 in 2003. The median on equity has fallen from 10 percent in 1963 to 8.2 percent in 2003. The falling liquidity, sales efficiency, and return on equity have driven the median Altman (new) Z from 2.992 in 1963 to 1.752 in 2003.

We should make one last comparison with JNJ and the 56 firms in the WRDS database for 2003 in the health care industry. Although JNJ has a lower current ratio, 1.71, relative to the current ratio of the median health care sector firm (2.51), its profitability, as measured by its return on equity and DuPont return on invested capital (0.241 and 0.258), far exceeds the median health care ROE and DuPont return values of 0.072 and 0.009, respectively, such that the Altman Z score of JNJ (3.04) substantially exceeds the median health care score of 2.00. JNJ is a highly profitable and lower-leveraged firm relative to the median firm in its sector or in the economy. The Altman Z score and its components calculated for the 11 I/B/E/S sectors for 2003 are shown in Table 3.2. There are significant industry effects.

LIMITATIONS OF RATIO ANALYSIS

Although ratio analysis is an extremely versatile tool, applying it can be dangerous if its limitations are not understood. Ratio analysis may be useless if the analyst does not have a feeling for the normal differences among different industries, or if the analyst does not run his or her analysis for the appropriate sector or industry. Neither is the analysis likely to be relevant if the analyst does not allow for special situations that may influence the financial position of a particular firm.[5] Ratio analysis may not protect the investor from corporations that release misleading or fraudulent data, as we have seen in recent court proceedings.

The importance of the various ratios varies with the individual circumstances of the firm and the major interests of the analyst. The picture of the firm's financial position does not emerge until the relationships of all the germane ratios are carefully appraised. We have examined the financial health of a firm via composite ratios such as the DuPont analysis and Altman Z score. Scores were developed for all the important ratios, standard weights were applied, and the resulting weighted average was supposed to indicate the company's overall financial health.

CHAPTER 4

Debt, Equity, Financial Structure, and the Investment Decision

Traditionally the capital structure of a firm has been defined as the book value of its common stock, its preferred stock, and its bonds, or fixed liabilities. We discuss these balance sheet items in Chapter 2. The equity and long-term debt items are considered to be the permanent financing of the firm. A company that has only common shares in its capital structure is often described as conservatively or safely financed. But if, for example, the firm has considerable trade debt outstanding, owes on a bank loan, or is tied up with long-run rental contracts, it may not be safely financed.

Although distinguishing between current liabilities and longer-term financing is convenient in some analyses, the degree of difference between current and funded debt is often grossly exaggerated. The so-called permanent financing is not unalterable; bonds can be retired, reduced, or increased; so can preferred stock; and the book value of the total common stock equity may also be varied. However, no operating firm is likely to function without some amount of current liabilities; thus some current debt is permanent to the financial structure. Perhaps it would be better to consider a firm's capital or financial structure as consisting of all the items on the credit side of the balance sheet representing the equity and all the liability accounts.

An important general tool of financial structure analysis is, then, the ratio of total debt to total assets. Of course, in a detailed financial analysis, the relationships and ratios among the items on the credit side of the balance sheet and among liability groupings and certain assets are significant and useful; but sometimes the usual financing analysis may be misleading, when only the fixed debt is employed in depicting the capital structure of the firm.

DEFINITION OF LEVERAGE—PROFITS AND FINANCIAL RISK

An important concept in understanding the relationships in the financial structure of the firm is the ancient idea of "trading on the equity," now going under the current term "leverage."[1] Leverage is the amount of outside funds (debt) the owners use in proportion to their own contributions to the financing of the firm. The use of debt is called leverage because these funds, acquired at a priority of repayment and given a priority of return, widen the potential swing of both gains and losses to the ownership shares. Any earnings on the assets acquired by borrowing in excess of the rate that has to be paid to the creditors belongs to the owners and increases their net rate of return; however, if the earnings on the assets acquired with borrowed funds fall below the contracted rate or if there are overall losses, the negative difference sharply reduces the rate of return or increases the loss on the equity. But as long as the marginal assets employed in the firm earn more than the cost of the borrowed funds, it will be profitable to use leverage, with the proviso that the financial risk of the firm is not thereby inordinately increased. In the King's English, if a corporation can borrow funds at 5 percent interest, and invest those funds into assets that generate 10 percent return on assets, then clearly the firm's stockholders earn the differential return and are compensated for bearing risk. The degree of leverage in a firm's capital structure is measured by noting how much the rate of return on equity would change with any change in the average rate of return on the total assets. The greater the proportion of outside funds to ownership capital, the more emphatic is the leverage effect.

Some financial analysts apparently recognize leverage only if the outside funds are acquired under a definite contract and the suppliers of these funds are paid a fixed positive rate of return. Leverage is thus limited to the use of bonds, preferred stock, or long-term bank loans. Under this concept many banks, for example, are not considered as leveraged, since they often have no bonds or preferred stock outstanding in their capital structure. Nevertheless, authorities in the field of money and banking note the "highly leveraged aspect" of the typical bank's capital structure, the small percentage of equity in comparison to the total deposits or liabilities carried.

A broad definition of leverage covers the relationship between all the prior claim securities or obligations and the ownership capital. Trade accounts and other current liabilities are included in this concept of leverage. These obligations have priority over the ownership shares; they must be paid at least a zero rate of return. This seems a paradox until we remember that ours is a profit-and-loss economy. Shareholders may earn a negative rate of return and the owners may absorb losses, but liability claims are not written down unless there is a failure or reorganization. The zero return placed on current liabilities is thus, in a sense, a fixed return, and it accordingly widens the possibilities for gains and losses on the ownership investment just as does any other borrowing from outside sources.

The use of current debt is a cheap method of financing; carried too far, it may become quite risky. Current liabilities constrict the firm's net working capital position. Although current liabilities carry a minimum interest charge, if any, the principal amount is continually coming due. From this point of view, fixed debt, when it can be obtained on favorable terms, is a safer component of leverage than current debt. The interest charges on long-term debt reduce the profits derived from successful leverage and increase the possibilities of loss in case of downturn, but at least the repayment of the principal of the debt is delayed into the future. Thus the firm has a chance to recover its financial position before the due date.

Leverage is profitable if the rate of earnings on total assets is higher than the going rate of interest on the debt. Of course, the risk to the stockholders of loss and failure in case of a downturn must always be considered. It is generally felt that to finance safely with leverage, the stability of the earnings, or better the cash flow, is more important than its level.

Let us follow the Lerner-Carleton derivation of a return on equity and the issue of leverage. The operating return on assets (ROA or R) is the ratio of the firm's EBIT to total assets. The firm pays interest on its liabilities (L) with a coupon rate of r.

EBIT = R(Total assets)

Operating income (EBIT) = R(Liabilities + Equity) = $R(L + E)$

Less interest paid = $-I = r$(Liabilities) = rL

Earnings before taxes (EBT) = $R(L + E) - rL$

Taxes paid (–Taxes) = $t[R(L + E) - rL]$

Earnings after taxes (EAT) = $(1 - t)[R(L + E) - rL]$

The return on equity is given by earnings after taxes divided by equity.

$$\text{ROE} = \frac{EAT}{E} = \frac{(1-t)[R(L+E)-rL]}{E}$$

$$= \frac{(1-t)[RL+RE-rL]}{E}$$

$$= (1-t)\left[R+(R-r)\frac{L}{E}\right]$$

Thus, as long as the return on asset exceeds the cost of debt, then the return on equity rises linearly with leverage.

The Pure Theory of the Optimal Financial Structure

The pure theory of the optimal capital structure is based on the assumption that the firm is a semimonopsonistic demander of funds from the capital market. By discriminating against the suppliers of funds through employing varying debt instruments and judiciously balancing the total of financial risk and external risks, the firm can achieve an optimum financial structure, reducing total financing costs and maximizing the value of its shares. The four parameters constituting the environment in which the firm exists are:

1. The individual firm is confronted by two types of risks. One type we might call the external risk, while the other type the internal or financial risk.[2]
2. The external risks are a composite of the stability of earnings or cash flow of the firm, and the liquidity, safety, and marketability of the assets typically held by the firm. The level of external risk is in large part dictated by the nature of the industry in which the firm is engaged and is not subject to any great extent to the control of the financial decision makers. External risk may be referred to as the "degree of operating leverage," as it is concerned with the firm's operating income (Copeland and Weston 1992).
3. Internal risk is the financial risk of the firm's capital structure. It is set by the types of liabilities (short-term or funded) that the firm carries and the total amounts of the liabilities in proportion to the firm's equity capital. The factors constituting the firm's capital or financial structure can be varied considerably by the financial management. Financial risk is often referred to as the degree of financial leverage Copeland and Weston 1992. The firm's (net income) profitability is a function of its interest payments.
4. The two types of risks together are the sum of the hazards to which the owners and the creditors of the firm may be subjected. The external risks are a parameter given by the nature of the industry; these external risks are borne in mind by both borrowers and lenders and influence the optimum financial risk that different types of firms are likely to carry.

The optimum capital structure for any widely held company is one that maximizes the long-run market value per share of the common stock. This is not quite the same as asserting that the optimum capital structure is one that will maximize profit or earnings per share. For both the earnings per share of stock and the rate at which they are capitalized must be considered.

The amount of financial risk that a firm carries helps set the capitalization rate. If a firm's financial structure carries too much borrowers' risk, the market may set a lower price for the shares than it would give for similar shares with perhaps somewhat smaller earnings but less financial risk.

The ability of the firm to set up an optimum capital structure implies the ability to discriminate against suppliers of funds, investors, individuals, or financial institutions, with different preferences for income and aversions to risk. Discrimination on one level leads to complex financial structures. It means that by raising funds through securities and contracts with varying return and security provisions, the firm could lower its total financial costs. On a broader macro level, varying preferences for return and risk implies that by a judicious mix of overall debt (financial risk) and equity, the firm could maximize the value of its shares (minimize the cost of capital)—that is, achieve an optimum capital structure.

The theoretical trade-off for a given firm between the rate of return on ownership capital (equity), the degree of financial risk (debt), and the market preference yielding the maximum price for the shares is illustrated in Figure 4.1. The financial risk factor is indicated indirectly in Figure 4.1. It is shown on the horizontal axis, inversely related to the proportion of equity

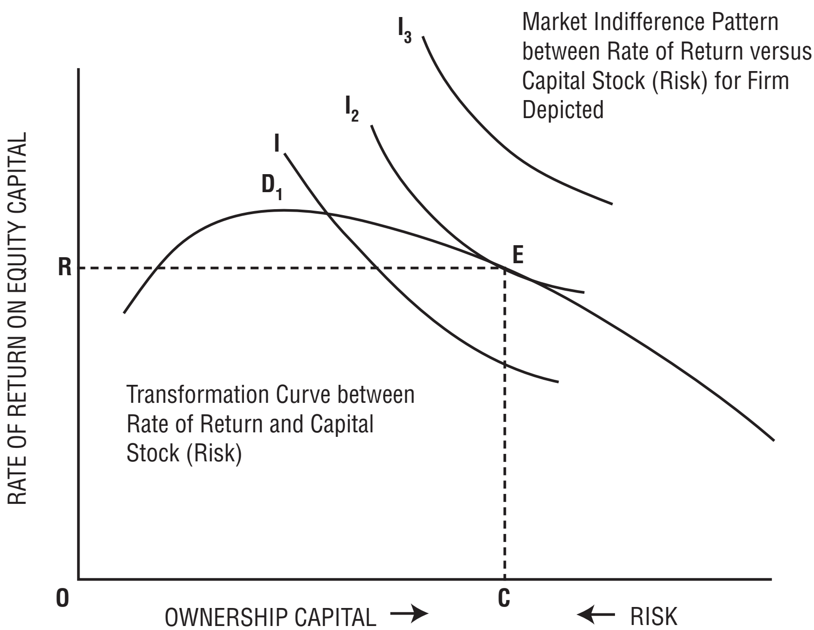

FIGURE 4.1 Formal Solution of a Firm's Optimum Capital Structure

(capital stock) in the capital structure. Thus as the amount of equity capital increases in a particular firm's capital structure, the debt-equity ratio and the degree of financial risk decrease. The conventional rate of return on the equity is depicted on the vertical axis. Because of the pro forma profitability of leverage, the rate of return on the equity falls as the proportional amount of share financing increases, although volatility and financial risk decrease.

The transformation curve D gives the average rate of return for shares and degree of risk for a financial structure containing varying amounts of ownership capital. Superimposed in the figure are investors' indifference curves showing the investors' substitution rate between earnings and the degree of risk for a firm of this type. Each indifference curve represents a given constant stock price. The tangency point E indicates the financial structure, the trade-off between risk and return that will fetch the highest price for the shares on the market. It is the point where the earnings and the risk-adjusted discount rate yield the highest amount.

The tangency point E indicates the optimum amount of equity capital and rate of return on equity capital for the firm. In brief, the optimum conditions are:

Marginal Sacrifice in Earnings		**Marginal Decrease in Earnings**
Marginal decrease in risk (investor's choice)	=	Marginal increase in ownership (decrease risk) (in the financial structure of the firm)

The letter R indicates the rate of earnings on equity investment and OC the optimum amount of equity capital for the firm, setting up the market capitalization rate and expected earnings that maximize the value of the shares.

The optimum capital structure varies for firms in different industries because the typical asset structures and the stability of earnings that determine inherent risks vary for different types of production. The theoretical solution of the optimum capital structure is made in a very formal manner, since it must give consideration to many variables—increasing lender's risk, increasing borrower's risk, the interest rate structure, the forecasted earnings function, and the possibility of discriminating against the market supply of outside capital.

Modigliani and Miller—Constant Capital Costs

Professors Franco Modigliani and Merton Miller (M&M) in their 1958 study posited a model where in a nontax world, for a firm of a given risk class, capital costs are constant regardless of the financial risk. There is no optimum financial structure.

In the M&M model, the trade-off between financial risk and the cost of funds is unitary; if more debt is added to the financial mix, the cost of debt rises and the desired rate of return on equity rises, so that the weighted cost of the financial mix remains constant. Let us briefly recount the three propositions of M&M in their seminal presentation of the cost of capital and valuation. First, M&M hold for a class of similar (homogeneous) firms—those firms that are perfect substitutes of each other, such as the industry concept—the cost of capital is a constant, ρ_o. The constant is determined by dividing the expected return per share by the stock price. This constant is the market rate of capitalization for firms in a particular class of firms. Thus, the average cost of capital is independent of capital structure.

Second, the expected stock yield is equal to the return on a pure equity firm (the return on assets ρ_o) plus a premium for financial risk proportional to the return on assets less the interest rate. Our earlier Lerner-Carleton derivation is a variation of the M&M Proposition II. M&M argued that the firm must earn a return on investments exceeding ρ_o. M&M's Proposition III holds that if the firm earns at least ρ_o on its investments, the project is acceptable regardless of the securities issued to finance the investment. M&M presented empirical evidence in their 1958 study, using the 40-firm electric utilities study of Allen (1954) and the 42-firm oil companies sample of Smith (1955). Both Allen and Smith provided data on the average values of debt and preferred stocks and market values of securities, such that M&M could calculate the debt-to-total value of securities ratio, *d*. M&M regressed the net returns, *x*, defined as the sum of interest, preferred dividends, and net income, as a function of ratio *d*. The Allen electric utilities sample covered 1947–1948 and the Smith sample of oil companies was for the year 1953. The M&M regressions were:

$$\text{Electric utilities: } x = 5.3 + .006d$$
$$(.008)$$
$$\text{Oil companies: } x = 8.5 + .006d$$
$$(.024)$$

M&M held that the regression results supported their Proposition I. The calculated t-statistics, found by the ratio of the regression slope, *b*, divided by its standard error (in parentheses), should be 1.96 (or 1.645 at the 10 percent level) to be statistically significant. The calculated t-statistic on the electric utilities sample is 0.75, far less than 1.645. The calculated t-statistic for the oil companies sample is 0.25. Thus, there is no statistical significance between net returns and the debt-to-assets ratio in the initial M&M study. We take a detailed look at hypothesis testing in Chapter 9. M&M used the Allen and Smith samples to test their Proposition II. M&M regressed ROEs, defined by dividing net income by equity, as a function of the debt-to-equity ratio, *b*:

$$\text{Electric utilities: ROE} = 6.6 + \underset{(.004)}{.017\text{h}}$$

$$\text{Oil companies: ROE} = 8.9 + \underset{(.012)}{.051\text{h}}$$

The estimated t-statistics of the electric utilities and oil companies sample of 4.25 and 4.35, respectively, rejected the null hypothesis of no association between ROE and the debt-to-equity ratio. Thus, support is found for Proposition II.

The major constitution of the M&M model is to show that each type of financing, debt or equity, brings about changes in the costs of the other. Nevertheless, when the costs of failure, bankruptcy, reorganization, and various transaction costs are considered, it is clear that the trade-off is not likely to be perfect. Should not a judicious financial management knowing the environmental conditions of their firm do a better job of setting up the financial structure than the outside investor? Finally, the empirical evidence that financial structures are not random, but appear to be significantly different for varying classes of firms, points in the direction of the existence of optimal capital structure. The M&M hypothesis sharpens the argument or more clearly points out the tax advantage (the tax deductibility of interest) of debt under our current corporate income tax laws.

M&M recognized the cost of capital implications of interest deductibility in their original 1958 study. M&M held that the interest deductibility feature of corporate taxation leads to a decreasing cost of capital as the debt ratio rises. By 1963, M&M formulated the before-tax earnings yield, the ratio of expected earnings before interest and taxes, $\bar{x}$, to the market value of the firm, $\hat{v}$, as:

$$\frac{\bar{x}}{\hat{v}} = \frac{\rho^T}{1-t}\left[1 - t\frac{D}{V}\right]$$

The cost of capital of the firm decreases with leverage.

The Optimal Capital Structure and the M&M Hypothesis

The difference between optimal capital structure theory and the M&M hypothesis can be exaggerated. Both models emphasize the point that the use of one class of financing has rebound effects on the costs of the rest of the financial structure. In the optimal model, the overall cost of capital at any given time is constant within the range of the optimal capital structure. Debt or equity financing or some combination may be used for any particular project, as long as the financial mix is kept within an optimal range. Nevertheless, because every type of financing has interactions with the other sources of financing, the return on a project is not to be compared to the direct cost of its mode of financing but to the overall cost of the financial mix.

In the M&M model, the interaction between different types of financing is complete so there is no optimal financial structure. Thus the firm's overall cost of capital at any point of time is constant at the proper financial mix, or it is constant regardless of the mix. Quite importantly, both of these views are in opposition to the sequential cost models, in which the cost of capital depends on the financing that is being used currently, so that the cost is lowest when the firm uses retained earnings, rises for outside borrowing, and becomes still higher when borrowing capacity is strained and additional funds depend on the flotation of new shares.

Empirical Factors Influencing Financial Structures

The two main external factors influencing the financial structure of a firm are the composition of its assets and the stability of its cash flow. Financial firms, such as banks and insurance companies, are prime examples of enterprises where the liquidity and marketability of their assets enable them to carry a high proportion of liabilities. Of course, in this instance, the firm's selection of assets for safety, marketability, and liquidity may be predetermined by the heavy volume of the firm's contingent or short-term liabilities, rather than the other way around. Nevertheless, a firm with safe marketable or short-term assets can finance these assets with a high proportion of debt with relatively matching maturities. Thus, marketing firms carry short-term inventories and creditable short-term accounts receivable can safely carry a relatively high proportion of short-term debt.

The stability of cash flow is influential in shaping the financial structure. The cash flow is the amount of free funds the firm can utilize over a short-run period. Cash flow and accounting profits or earnings may differ considerably. Cash flow is less than earnings, for example, by any increases in costs incurred on work in process; cash flow exceeds reported earnings by the extent of depreciation, depletion, and other book or noncash changes (i.e., noncash charges representing the using up of assets acquired in the past). Although for internal control and budgeting purposes detailed analyses are made of the components of the cash flow, the rough rule of thumb for measuring the cash flow is reported earnings for the period plus depreciation, depletion, and any other noncash charges.

In calculating the leverage a firm might carry, the financial decision makers must estimate not only the average level of the cash flow over time, but also the likelihood and extent of deviations from the norm. Where fluctuations from the average are not expected to be either deep or sustained, the firm may safely carry a high percentage of debt.

The inclusion of depreciation charges in the cash flow helps explain why firms with a good proportion of fixed assets may also carry more long-term debt. The fact that firms having a considerable fixed plant usually float bonds is not related to any physical attribute of the fixed plant; it is not dependent on any presumed safety that bricks and mortar bring to the bond mortgage. The affinity of fixed assets and long-term debt rests on the fact that the cash flow of firms holding considerable fixed assets must exceed their reported earnings. The depreciation charges taken against the fixed assets act as an extra cushion, which, added to the accounting net earnings, may help the firm meet its interest and principal obligations. A firm may show zero accounting profits after depreciation, yet have a positive flow of cash. As long as reported losses do not exceed depreciation and depletion charges, some cash flow will be available to pay debt obligations. In other words, some cash is always generated as long as operating revenues are greater than out-of-pocket operating costs, no matter what the depreciation charges may be.

COST OF CAPITAL

Let us find the cost of capital for a firm with the following capital structure:

Long-term debt	$ 5,647
Equity	9,063
Total capital	$14,710

The firm has a bond rating of AA3 (Moody's AA) and a beta of 0.84 versus the S&P 500 index.

The cost of capital, k_c, can be calculated by using an acceptable market risk premium and the current AA bond yield of 5.6 percent. The Ibbotson and Sinquefield (1976, and annual editions thereafter) market risk premium of 8.15 percent was based on the 1926–2003 period. If we use the Ibbotson and Sinquefield data for the 1951–2002 period, found on WRDS, we find an average annual rate of return on equities of 12.53 percent, and a corresponding average Treasury bill yield of 5.15 percent, implying a

7.38 percent market risk premium. The cost of equity capital for our acquiring firm is:

$$k_e = .0515 + (.0738)\ .84 = .1135$$

The cost of equity capital, via the capital asset pricing model, is 11.35 percent. The weighted average cost of capital may be calculated as:

$$\begin{aligned} k_c &= k_e\left(\frac{E}{D+E}\right) + k_d\left(\frac{D}{D+E}\right)(1-t) \\ &= .1135\left(\frac{9{,}063}{5{,}647+9{,}063}\right) + .056\left(\frac{5{,}647}{5{,}647+9{,}063}\right)(1-.35) \\ &= .084 \end{aligned}$$

The acquiring firm's weighted average cost of capital is the appropriate discount rate for calculating the profitability of investment opportunities or valuating merger candidates.

Let us now discuss the capital budgeting, or investment decision. We assume that management can correctly calculate the firm's cost of capital, and can use that discount rate for all projects. Given the cost of capital (i.e., the appropriate discount rate), the determination of a worthwhile capital investment is straightforward. An investment is desirable when the present value of the estimated net inflow of benefits (or net cash inflow for pure financial investments) over time, discounted at the cost of capital, exceeds or equals the initial outlay on the project. If the project meets this criterion, it is potentially profitable or economically desirable; its yield equals or exceeds the appropriate discount rate. On a formal level, it does not appear too difficult to carry out the theoretical criterion. The stream of the forecasted net future cash flows must be quantified; each year's return must be discounted to obtain its present value. The sum of the present values is compared to the total investment outlay on the project; if the sum of the present values exceeds this outlay, the project should be accepted. The discounted cash flow approach has been widely accepted since the 1950s.

The formula for obtaining the net present value (NPV) of a project runs in this form:

$$\begin{aligned} PV &= \frac{CF_1}{(1+i)} + \frac{CF_2}{(1+i)^2} + \frac{CF_n}{(1+i)^n} + \frac{S_n}{(1+i)^n} \\ NPV &= PV - I \end{aligned} \tag{4.1}$$

where PV is the present value of the net cash flow stream (CF_1, CF_2, etc.) over time to n years, S_n is the scrap value, or the remaining value of the project at the end of its economic life at year n, and i is the applicable discount rate or cost of capital. The net present value is the present value of the benefit stream minus I, the full investment cost of the project.

If there is a cost for removing the project at the end of its economic life, then S (the scrap value) is negative. If the stream of returns is constant, their present value can be obtained by the summarization annuity formula: $PV = CF[1 - (1 + i)^{-n}]/i$.

Table 4.1 gives an example of the mechanics of the capital evaluation problem. Let us assume that the corporation has a weighted average cost of capital of 12 percent. The project illustrated would be accepted because the present value of the estimated stream of net returns is \$4,431,470.57, which is \$431,470.57 above the project's initial cost of \$4,000,000. Thus, the projected rate of return on the project is higher than the 12 percent discount rate, the estimated cost of capital. The net present value (NPV) is obtained by subtracting the initial outlays from the gross present value of the benefits discounted at the given cost of capital. A project is acceptable if the NPV is positive.

There are two criteria:

1. The internal rate of return is the rate that brings the present value of the cash flows into equality with the initial outlay. The equation for the internal rate of return is formally similar to that for present value.

TABLE 4.1 Net Present Value of Capital Project

Years	Investment Cost of Project	Estimated Net Annual Inflows	Discount Factor (Cost of Capital = 12%) $\frac{1}{(1.12)^n}$	Present Value of Inflows
0	\$4,000,000	\$ 0	0	\$ 0
1		1,000,000	.8929	892,857.14
2		1,500,000	.7972	1,195,800.00
3		2,000,000	.7118	1,423,600.00
4		1,500,000	.6355	635,500.00
5		1,000,000	.5674	283,713.43
6*		500,000	.5674	283,713.43
Total	\$4,000,000			\$4,431,470.57

*Period 6 includes a return of \$250,000 and \$250,000 scrap value.

$$I = \frac{CF}{(1+r)} + \frac{CF_1}{(1+r)^1} + \ldots + \frac{CF_n}{(1+r)^n} \tag{4.2}$$

2. I (the initial investment) is a given factor and one solves for r, the internal rate of return (IRR)—the rate of discount that brings the present value of the benefits equal to the outlay, I. If the internal rate of return exceeds the cost of capital, the project is economically feasible.

Both criteria give the proper signal as to whether a single project is acceptable in the vast majority of capital investment projects. If a project's net present value is positive, it necessarily follows that its rate of return also exceeds the company's cost of capital. The project's positive net present value increases the firm's profit and increases its stock price, ceteris paribus. However, a selection conflict may arise when in comparing mutually exclusive projects, one project has a higher internal rate of return and one shows a higher net present value.

REAL OPTIONS AND THE INVESTMENT DECISION

We have just discussed the capital budgeting process in which a financial manager accepts a project only if the discounted cash flow of that project exceeds the initial costs of the project. The discount rate is the cost of capital. The difference between the discounted cash flow and the initial cash outlay is the net present value (NPV), which should be positive to accept a project. In this chapter, we discuss another application of cash flow and valuation, the application of real options analysis.

Real options analysis can take several forms. We concentrate on two primary applications in this chapter. First, we examine the possible complications of the strict application of the NPV rule to an R&D investment decision, and how the stockholder wealth may be enhanced by the use of real options analysis. The second application of real options strategies is the case of abandonment valuation. When one calculates the value of a real option, one equates the investment cost of the project with the exercise price of the real option. The present value of the project is equivalent to the price of the underlying asset.

Research and development expenditures are capital expenditures involving discounting cash flow such that the net present value is positive. The research and development expenditure leading to the implementation of new technology is the call premium with the present value of the final project being the value of the call option. The R&D cost is the premium paid to acquire the future investment cash flow of the project resulting from the R&D activities. A pharmaceutical firm that engages in R&D expenditures may need to consider abandonment values and decisions. Current R&D projects lead to future and expansive R&D projects. A current or static negative net present value need not lead management to eliminate the R&D project from its consideration. It is possible to reconsider the project at a later date when initial cash outlays of projects change, costs of capital change, or estimated future cash flows are different.

Abandonment Value

A project does not always produce its expected cash flow, and the net present value of a project, initially calculated to be positive, does not always produce value for the stockholders. How does management come to grips with cash flow forecasts that turn out to be incorrect or based on assumptions that are not substantiated? What can the firm's financial managers do to minimize stockholders' losses? A possible solution is abandonment of the project.

Let us develop an investment scenario where abandonment value enhances our decision-making process. An R&D project requires the construction of a new building near to, but off, the main corporate grounds. The new building will cost $90,000,000 and can house a small production facility for three years even if management decides to forgo or postpone the R&D project. Sales of the production facility are dependent on the state of the economy. The corporate economists have prepared a set of three-year cash flow forecasts that are first-year probabilities and second- and third-year conditional probabilities. That is, the cash flow forecasts are dependent on particular states of nature occurring in years 1 and 2. (See Table 4.2.) One should calculate the expected net present value of the projected cash flow, assuming a 10 percent cost of capital.

The calculations of the expected net present value and internal rate of return are shown in Table 4.3. One multiplies the cash flow under the various economic scenarios—depression, recession, normal, and boom—by the cash flow occurring in that state of the economy. For the four scenarios, three-period analysis produces 64 possible states of the economy. The key to the analysis is to calculate the joint probabilities of each possible state. Each state of the economy is conditional upon the previous period's state of the economy. See Table 4.3 for the calculation of the joint probabilities, the expected present value, and the expected net present value.

TABLE 4.2 Economic Scenarios of the Economy and Project Cash Flow

State of Economy	Year 1 Probabilities	Year 1 Cash Flow ($mm)	Year 2 Probabilities	Year 2 Cash Flow ($mm)	Year 3 Probabilities	Year 3 Cash Flow ($mm)
Depression	.10	$10	.15	$ 5	.20	$ 1
			.35	10	.50	25
			.40	20	.25	30
			.10	30	.05	40
Recession	.30	15	.10	10	.15	3
			.40	20	.45	20
			.35	50	.30	30
			.15	60	.10	40
Normal	.40	25	.05	20	.05	20
			.20	25	.33	30
			.50	50	.61	60
			.25	75	.01	90
Boom	.20	40	.01	30	.01	30
			.10	45	.14	40
			.40	60	.40	75
			.49	100	.45	200

TABLE 4.3 Calculation of Expected Net Present Value

State of Economy	Cash Flow Year 1	Cash Flow Year 2	Cash Flow Year 3	PVIF Year 1	PVIF Year 2	PVIF Year 3	PV CF	Prob1	Prob2	Prob3	JointProb	E PV
Depression	10	5	1	0.909	0.826	0.751	13.974	0.10	0.15	0.20	0.00300	0.04
	10	5	25	0.909	0.826	0.751	32.006	0.10	0.15	0.50	0.00750	0.24
	10	5	30	0.909	0.826	0.751	35.763	0.10	0.15	0.25	0.00375	0.13
	10	5	40	0.909	0.826	0.751	43.276	0.10	0.15	0.05	0.00075	0.03
	10	10	1	0.909	0.826	0.751	18.107	0.10	0.35	0.20	0.00700	0.13
	10	10	25	0.909	0.826	0.751	36.138	0.10	0.35	0.50	0.01750	0.63
	10	10	30	0.909	0.826	0.751	39.895	0.10	0.35	0.25	0.00875	0.35
	10	10	40	0.909	0.826	0.751	47.408	0.10	0.35	0.05	0.00175	0.08
	10	20	1	0.909	0.826	0.751	26.371	0.10	0.40	0.20	0.00800	0.21
	10	20	25	0.909	0.826	0.751	44.403	0.10	0.40	0.50	0.02000	0.89
	10	20	30	0.909	0.826	0.751	48.159	0.10	0.40	0.25	0.01000	0.48
	10	20	40	0.909	0.826	0.751	55.672	0.10	0.40	0.05	0.00200	0.11
	10	30	1	0.909	0.826	0.751	34.636	0.10	0.10	0.20	0.00200	0.07
	10	30	25	0.909	0.826	0.751	52.667	0.10	0.10	0.50	0.00500	0.26
	10	30	30	0.909	0.826	0.751	56.424	0.10	0.10	0.25	0.00250	0.14
	10	30	40	0.909	0.826	0.751	63.937	0.10	0.10	0.05	0.00050	0.03

(Continued)

TABLE 4.3 *(Continued)*

State of Economy	Cash Flow Year 1	Cash Flow Year 2	Cash Flow Year 3	PVIF Year 1	PVIF Year 2	PVIF Year 3	PV CF	Prob1	Prob2	Prob3	JointProb	E PV
Recession	15	10	3	0.909	0.826	0.751	24.155	0.30	0.10	0.15	0.00450	0.11
	15	10	20	0.909	0.826	0.751	36.927	0.30	0.10	0.45	0.01350	0.50
	15	10	30	0.909	0.826	0.751	44.440	0.30	0.10	0.30	0.00900	0.40
	15	10	40	0.909	0.826	0.751	51.953	0.30	0.10	0.10	0.00300	0.16
	15	20	3	0.909	0.826	0.751	32.419	0.30	0.40	0.15	0.01800	0.58
	15	20	20	0.909	0.826	0.751	45.192	0.30	0.40	0.45	0.05400	2.44
	15	20	30	0.909	0.826	0.751	52.705	0.30	0.40	0.30	0.03600	1.90
	15	20	40	0.909	0.826	0.751	60.218	0.30	0.40	0.10	0.01200	0.72
	15	50	3	0.909	0.826	0.751	57.213	0.30	0.35	0.15	0.01575	0.90
	15	50	20	0.909	0.826	0.751	69.985	0.30	0.35	0.45	0.04725	3.31
	15	50	30	0.909	0.826	0.751	77.498	0.30	0.35	0.30	0.03150	2.44
	15	50	40	0.909	0.826	0.751	85.011	0.30	0.35	0.10	0.01050	0.89
	15	60	3	0.909	0.826	0.751	65.477	0.30	0.15	0.15	0.00675	0.44
	15	60	20	0.909	0.826	0.751	78.249	0.30	0.15	0.45	0.02025	1.58
	15	60	30	0.909	0.826	0.751	85.763	0.30	0.15	0.30	0.01350	1.16
	15	60	40	0.909	0.826	0.751	93.276	0.30	0.15	0.10	0.00450	0.42
Normal	25	20	20	0.909	0.826	0.751	54.282	0.40	0.05	0.05	0.00100	0.05
	25	20	30	0.909	0.826	0.751	61.796	0.40	0.05	0.33	0.00660	0.41
	25	20	60	0.909	0.826	0.751	84.335	0.40	0.05	0.61	0.01220	1.03
	25	20	90	0.909	0.826	0.751	106.875	0.40	0.05	0.01	0.00020	0.02
	25	25	20	0.909	0.826	0.751	58.415	0.40	0.20	0.05	0.00400	0.23
	25	25	30	0.909	0.826	0.751	65.928	0.40	0.20	0.33	0.02640	1.74
	25	25	60	0.909	0.826	0.751	88.467	0.40	0.20	0.61	0.04880	4.32
	25	25	90	0.909	0.826	0.751	111.007	0.40	0.20	0.01	0.00080	0.09
	25	50	20	0.909	0.826	0.751	79.076	0.40	0.50	0.05	0.01000	0.79
	25	50	30	0.909	0.826	0.751	86.589	0.40	0.50	0.33	0.06600	5.71
	25	50	60	0.909	0.826	0.751	109.128	0.40	0.50	0.61	0.12200	13.31
	25	50	90	0.909	0.826	0.751	131.668	0.40	0.50	0.01	0.00200	0.26
	25	75	20	0.909	0.826	0.751	99.737	0.40	0.25	0.05	0.00500	0.50
	25	75	30	0.909	0.826	0.751	107.250	0.40	0.25	0.33	0.03300	3.54
	25	75	60	0.909	0.826	0.751	129.790	0.40	0.25	0.61	0.06100	7.92
	25	75	90	0.909	0.826	0.751	152.329	0.40	0.25	0.01	0.00100	0.15
Boom	40	30	30	0.909	0.826	0.751	83.696	0.20	0.01	0.01	0.00002	0.00
	40	30	40	0.909	0.826	0.751	91.210	0.20	0.01	0.14	0.00028	0.03
	40	30	75	0.909	0.826	0.751	117.506	0.20	0.01	0.40	0.00080	0.09
	40	30	200	0.909	0.826	0.751	211.420	0.20	0.01	0.45	0.00090	0.19
	40	45	30	0.909	0.826	0.751	96.093	0.20	0.10	0.01	0.00020	0.02
	40	45	40	0.909	0.826	0.751	103.606	0.20	0.10	0.14	0.00280	0.29
	40	45	75	0.909	0.826	0.751	129.902	0.20	0.10	0.40	0.00800	1.04
	40	45	200	0.909	0.826	0.751	223.817	0.20	0.10	0.45	0.00900	2.01
	40	60	30	0.909	0.826	0.751	108.490	0.20	0.40	0.01	0.00080	0.09
	40	60	40	0.909	0.826	0.751	116.003	0.20	0.40	0.14	0.01120	1.30
	40	60	75	0.909	0.826	0.751	142.299	0.20	0.40	0.40	0.03200	4.55
	40	60	200	0.909	0.826	0.751	236.213	0.20	0.40	0.45	0.03600	8.50
	40	100	30	0.909	0.826	0.751	141.548	0.20	0.49	0.01	0.00098	0.14
	40	100	40	0.909	0.826	0.751	149.061	0.20	0.49	0.14	0.01372	2.05
	40	100	75	0.909	0.826	0.751	175.357	0.20	0.49	0.40	0.03920	6.87
	40	100	200	0.909	0.826	0.751	269.271	0.20	0.49	0.45	0.04410	11.87
												100.92
Cost of Project												90.00
Expected Net Present Value												10.92

PVIF—Present value.
PV—Present value cash flow.
E PV—Expected present value.

The expected present value of cash flow is $100,920,000. Given the cost of the building of $90,000,000, the expected net present value of the new building is $10,920,000. The expected net present value exceeds zero and the new building can be justified at a cost of capital of 10 percent. The expected internal rates of return (IRRs) of the project for the 64 scenarios are shown in Table 4.4.

The expected IRR for the project is 11.14 percent. The expected IRR exceeds the cost of capital, and hence the expected net present value is positive. The expected variance of the project is 16.3 percent, and the calculations are shown in Table 4.5.

What is the economic benefit of being able to abandon the new building project after year 2 at an abandonment value of $70,000,000? If the abandonment value of $70 million exceeded the expected present value of

TABLE 4.4 Calculation of Expected Internal Rate of Return

State of Economy	Cash Flow Year 1	Year 2	Year 3	IRR	Prob1	Prob2	Prob3	JointProb	E IRR
Depression	10	5	1	–0.645	0.10	0.15	0.20	0.00300	–0.0019
	10	5	25	–0.278	0.10	0.15	0.50	0.00750	–0.0021
	10	5	30	–0.239	0.10	0.15	0.25	0.00375	–0.0009
	10	5	40	–0.173	0.10	0.15	0.05	0.00075	–0.0001
	10	10	1	–0.570	0.10	0.35	0.20	0.00700	–0.0040
	10	10	25	–0.249	0.10	0.35	0.50	0.01750	–0.0044
	10	10	30	–0.212	0.10	0.35	0.25	0.00875	–0.0019
	10	10	40	–0.147	0.10	0.35	0.05	0.00175	–0.0003
	10	20	1	–0.449	0.10	0.40	0.20	0.00800	–0.0036
	10	20	25	–0.190	0.10	0.40	0.50	0.02000	–0.0038
	10	20	30	–0.157	0.10	0.40	0.25	0.01000	–0.0016
	10	20	40	–0.097	0.10	0.40	0.05	0.00200	–0.0002
	10	30	1	–0.350	0.10	0.10	0.20	0.00200	–0.0007
	10	30	25	–0.134	0.10	0.10	0.50	0.00500	–0.0007
	10	30	30	–0.103	0.10	0.10	0.25	0.00250	–0.0003
	10	30	40	–0.048	0.10	0.10	0.05	0.00050	0.0000
Recession	15	10	3	–0.489	0.30	0.10	0.15	0.00450	–0.0022
	15	10	20	–0.267	0.30	0.10	0.45	0.01350	–0.0036
	15	10	30	–0.189	0.30	0.10	0.30	0.00900	–0.0017
	15	10	40	–0.125	0.30	0.10	0.10	0.00300	–0.0004
	15	20	3	–0.385	0.30	0.40	0.15	0.01800	–0.0069
	15	20	20	–0.204	0.30	0.40	0.45	0.05400	–0.0110
	15	20	30	–0.133	0.30	0.40	0.30	0.03600	–0.0048
	15	20	40	–0.074	0.30	0.40	0.10	0.01200	–0.0009
	15	50	3	–0.141	0.30	0.35	0.15	0.01575	–0.0022
	15	50	20	–0.027	0.30	0.35	0.45	0.04725	–0.0013
	15	50	30	0.025	0.30	0.35	0.30	0.03150	0.0008
	15	50	40	0.072	0.30	0.35	0.10	0.01050	0.0008
	15	60	3	–0.074	0.30	0.15	0.15	0.00675	–0.0005
	15	60	20	0.027	0.30	0.15	0.45	0.02025	0.0005
	15	60	30	0.075	0.30	0.15	0.30	0.01350	0.0010
	15	60	40	0.118	0.30	0.15	0.10	0.00450	0.0005

(Continued)

TABLE 4.4 *(Continued)*

State of Economy	Cash Flow Year 1	Year 2	Year 3	IRR	Prob1	Prob2	Prob3	JointProb	E IRR
Normal	25	20	20	–0.152	0.40	0.05	0.05	0.00100	–0.0002
	25	20	30	–0.083	0.40	0.05	0.33	0.00660	–0.0005
	25	20	60	0.089	0.40	0.05	0.61	0.01220	0.0011
	25	20	90	0.182	0.40	0.05	0.01	0.00020	0.0000
	25	25	20	–0.120	0.40	0.20	0.05	0.00400	–0.0005
	25	25	30	–0.055	0.40	0.20	0.33	0.02640	–0.0015
	25	25	60	0.092	0.40	0.20	0.61	0.04880	0.0045
	25	25	90	0.202	0.40	0.20	0.01	0.00080	0.0002
	25	50	20	0.028	0.40	0.50	0.05	0.01000	0.0003
	25	50	30	0.079	0.40	0.50	0.33	0.06600	0.0052
	25	50	60	0.202	0.40	0.50	0.61	0.12200	0.0246
	25	50	90	0.299	0.40	0.50	0.01	0.00200	0.0006
	25	75	20	0.161	0.40	0.25	0.05	0.00500	0.0008
	25	75	30	0.202	0.40	0.25	0.33	0.03300	0.0067
	25	75	60	0.306	0.40	0.25	0.61	0.06100	0.0187
	25	75	90	0.392	0.40	0.25	0.01	0.00100	0.0004
Boom	40	30	30	0.058	0.20	0.01	0.01	0.00002	0.0000
	40	30	40	0.108	0.20	0.01	0.14	0.00028	0.0000
	40	30	75	0.247	0.20	0.01	0.40	0.00080	0.0002
	40	30	200	0.585	0.20	0.01	0.45	0.00090	0.0005
	40	45	30	0.140	0.20	0.10	0.01	0.00020	0.0000
	40	45	40	0.184	0.20	0.10	0.14	0.00280	0.0005
	40	45	75	0.311	0.20	0.10	0.40	0.00800	0.0025
	40	45	200	0.611	0.20	0.10	0.45	0.00900	0.0055
	40	60	30	0.217	0.20	0.40	0.01	0.00080	0.0002
	40	60	40	0.257	0.20	0.40	0.14	0.01120	0.0029
	40	60	75	0.373	0.20	0.40	0.40	0.03200	0.0119
	40	60	200	0.657	0.20	0.40	0.45	0.03600	0.0237
	40	100	30	0.405	0.20	0.49	0.01	0.00098	0.0004
	40	100	40	0.435	0.20	0.49	0.14	0.01372	0.0060
	40	100	75	0.528	0.20	0.49	0.40	0.03920	0.0207
	40	100	200	0.775	0.20	0.49	0.45	0.04410	0.0342
Expected IRR									0.1114

TABLE 4.5 Calculation of Standard Deviation of Expected Internal Rate of Return

State of Economy	JointProb	IRR	E IRR	IRR–E IRR	(Col E)**2	JointProb* (Col F)
Depression	0.0030	–0.645	–0.002	–0.643	0.411	0.0012
	0.0075	–0.278	–0.002	–0.276	0.075	0.0006
	0.0038	–0.239	–0.001	–0.238	0.056	0.0002
	0.0008	–0.173	0.000	–0.173	0.030	0.0000
	0.0070	–0.570	–0.004	–0.566	0.316	0.0022
	0.0175	–0.249	–0.004	–0.245	0.058	0.0010
	0.0088	–0.212	–0.002	–0.210	0.043	0.0004
	0.0018	–0.147	0.000	–0.147	0.021	0.0000
	0.0080	–0.449	–0.004	–0.445	0.195	0.0016
	0.0200	–0.190	–0.004	–0.186	0.033	0.0007
	0.0100	–0.157	–0.002	–0.155	0.024	0.0002
	0.0020	–0.097	0.000	–0.097	0.009	0.0000
	0.0020	–0.350	–0.001	–0.349	0.122	0.0002

TABLE 4.5 *(Continued)*

State of Economy	JointProb	IRR	E IRR	IRR–E IRR	(Col E)**2	JointProb* (Col F)
	0.0050	–0.134	–0.001	–0.133	0.018	0.0001
	0.0025	–0.103	0.000	–0.103	0.011	0.0000
	0.0005	–0.048	0.000	–0.048	0.002	0.0000
Recession	0.0045	–0.489	–0.002	–0.487	0.235	0.0011
	0.0135	–0.267	–0.004	–0.263	0.067	0.0009
	0.0090	–0.189	–0.002	–0.187	0.034	0.0003
	0.0030	–0.125	0.000	–0.125	0.015	0.0000
	0.0180	–0.385	–0.007	–0.378	0.138	0.0025
	0.0540	–0.204	–0.011	–0.193	0.033	0.0018
	0.0360	–0.133	–0.005	–0.128	0.015	0.0005
	0.0120	–0.074	–0.001	–0.073	0.005	0.0001
	0.0158	–0.141	–0.002	–0.139	0.019	0.0003
	0.0473	–0.027	–0.001	–0.026	0.001	0.0000
	0.0315	0.025	0.001	0.024	0.001	0.0000
	0.0105	0.072	0.001	0.071	0.005	0.0001
	0.0068	–0.074	0.000	–0.074	0.005	0.0000
	0.0203	0.027	0.001	0.026	0.001	0.0000
	0.0135	0.075	0.001	0.074	0.005	0.0001
	0.0045	0.118	0.001	0.117	0.014	0.0001
Normal	0.0010	–0.152	0.000	–0.152	0.023	0.0000
	0.0066	–0.083	–0.001	–0.082	0.007	0.0000
	0.0122	0.089	0.001	0.088	0.008	0.0001
	0.0002	0.182	0.000	0.182	0.033	0.0000
	0.0040	–0.120	0.000	–0.120	0.014	0.0001
	0.0264	–0.055	–0.001	–0.054	0.003	0.0001
	0.0488	0.092	0.004	0.088	0.007	0.0003
	0.0008	0.202	0.000	0.202	0.041	0.0000
	0.0100	0.028	0.000	0.028	0.001	0.0000
	0.0660	0.079	0.005	0.074	0.005	0.0003
	0.1220	0.202	0.025	0.177	0.023	0.0028
	0.0020	0.299	0.001	0.298	0.089	0.0002
	0.0050	0.161	0.001	0.160	0.025	0.0001
	0.0330	0.202	0.007	0.195	0.036	0.0012
	0.0610	0.306	0.019	0.287	0.072	0.0044
	0.0010	0.392	0.000	0.392	0.153	0.0002
Boom	0.0000	0.058	0.000	0.058	0.003	0.0000
	0.0003	0.108	0.000	0.108	0.012	0.0000
	0.0008	0.247	0.000	0.247	0.061	0.0000
	0.0009	0.585	0.001	0.584	0.341	0.0003
	0.0002	0.140	0.000	0.140	0.020	0.0000
	0.0028	0.184	0.001	0.183	0.033	0.0001
	0.0080	0.311	0.002	0.309	0.094	0.0007
	0.0090	0.611	0.005	0.606	0.360	0.0032
	0.0008	0.217	0.000	0.217	0.047	0.0000
	0.0112	0.257	0.003	0.254	0.063	0.0007
	0.0320	0.373	0.012	0.361	0.122	0.0039
	0.0360	0.657	0.024	0.633	0.372	0.0134
	0.0010	0.405	0.000	0.405	0.163	0.0002
	0.0137	0.435	0.006	0.429	0.179	0.0025
	0.0392	0.528	0.021	0.507	0.237	0.0093
	0.0441	0.775	0.034	0.741	0.499	0.0220
Expected IRR			0.111			
Expected Variance						0.0266
Expected Standard Deviation						0.1630

cash flow of year 3 in any scenario or state of the economy, then the expected net present value calculation of the new building should be recalculated. The abandonment value of $70 million exceeds the expected present value of cash flow for year 3 in the depression ($66.717 million) and recession ($67.468 million) modes. (See Table 4.6.)

The recalculated expected net present value of the new building is shown in Table 4.7. The expected net present value is increased by $14.31

TABLE 4.6 Calculation of Expected Cash Value in Year 3

State of Economy	CF Year 3	PVIF Year 3	Prob3	PV CF3	Year 3 Scenario Total ($mm)
Depression	1	0.751	0.20	0.150	
	25	0.751	0.50	9.391	
	30	0.751	0.25	5.635	
	40	0.751	0.05	1.503	
	1	0.751	0.20	0.150	
	25	0.751	0.50	9.391	
	30	0.751	0.25	5.635	
	40	0.751	0.05	1.503	
	1	0.751	0.20	0.150	
	25	0.751	0.50	9.391	
	30	0.751	0.25	5.635	
	40	0.751	0.05	1.503	
	1	0.751	0.20	0.150	
	25	0.751	0.50	9.391	
	30	0.751	0.25	5.635	
	40	0.751	0.05	1.503	$66.717
Recession	3	0.751	0.15	0.338	
	20	0.751	0.45	6.762	
	30	0.751	0.30	6.762	
	40	0.751	0.10	3.005	
	3	0.751	0.15	0.338	
	20	0.751	0.45	6.762	
	30	0.751	0.30	6.762	
	40	0.751	0.10	3.005	
	3	0.751	0.15	0.338	
	20	0.751	0.45	6.762	
	30	0.751	0.30	6.762	
	40	0.751	0.10	3.005	
	3	0.751	0.15	0.338	
	20	0.751	0.45	6.762	
	30	0.751	0.30	6.762	
	40	0.751	0.10	3.005	$67.468

TABLE 4.6 *(Continued)*

State of Economy	CF Year 3	PVIF Year 3	Prob3	PV CF3	Year 3 Scenario Total ($mm)
Normal	20	0.751	0.05	0.751	
	30	0.751	0.33	7.438	
	60	0.751	0.61	27.498	
	90	0.751	0.01	0.676	
	20	0.751	0.05	0.751	
	30	0.751	0.33	7.438	
	60	0.751	0.61	27.498	
	90	0.751	0.01	0.676	
	20	0.751	0.05	0.751	
	30	0.751	0.33	7.438	
	60	0.751	0.61	27.498	
	90	0.751	0.01	0.676	
	20	0.751	0.05	0.751	
	30	0.751	0.33	7.438	
	60	0.751	0.61	27.498	
	90	0.751	0.01	0.676	$145.455
Boom	30	0.751	0.01	0.225	
	40	0.751	0.14	4.207	
	75	0.751	0.40	22.539	
	200	0.751	0.45	67.618	
	30	0.751	0.01	0.225	
	40	0.751	0.14	4.207	
	75	0.751	0.40	22.539	
	200	0.751	0.45	67.618	
	30	0.751	0.01	0.225	
	40	0.751	0.14	4.207	
	75	0.751	0.40	22.539	
	200	0.751	0.45	67.618	
	30	0.751	0.01	0.225	
	40	0.751	0.14	4.207	
	75	0.751	0.40	22.539	
	200	0.751	0.45	67.618	$378.362

million by the presence of the abandonment option. The project should be abandoned after year 2. The presence of an abandonment value of $70 million enhances the net present value of the project by $14.31 million because the abandonment value exceeds the expected present value of year 3 cash flows in the depression and recession scenarios. The abandonment analysis may not be complete until one calculates the present value of the cash flow forgone by abandoning the project. The present value of the abandoned cash flow is shown in Table 4.8, and is $40.192 million.

TABLE 4.7 Calculation of Expected Net Present Value with Abandonment Value

State of	Cash Flow			PVIF			PV					
Economy	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	CF	Prob1	Prob2	Prob3	JointProb	E PV
Depression	10	5	70	0.909	0.826	0.751	65.815	0.10	0.15	0.20	0.00300	0.20
	10	5	70	0.909	0.826	0.751	65.815	0.10	0.15	0.50	0.00750	0.49
	10	5	70	0.909	0.826	0.751	65.815	0.10	0.15	0.25	0.00375	0.25
	10	5	70	0.909	0.826	0.751	65.815	0.10	0.15	0.05	0.00075	0.05
	10	10	70	0.909	0.826	0.751	69.947	0.10	0.35	0.20	0.00700	0.49
	10	10	70	0.909	0.826	0.751	69.947	0.10	0.35	0.50	0.01750	1.22
	10	10	70	0.909	0.826	0.751	69.947	0.10	0.35	0.25	0.00875	0.61
	10	10	70	0.909	0.826	0.751	69.947	0.10	0.35	0.05	0.00175	0.12
	10	20	70	0.909	0.826	0.751	78.212	0.10	0.40	0.20	0.00800	0.63
	10	20	70	0.909	0.826	0.751	78.212	0.10	0.40	0.50	0.02000	1.56
	10	20	70	0.909	0.826	0.751	78.212	0.10	0.40	0.25	0.01000	0.78
	10	20	70	0.909	0.826	0.751	78.212	0.10	0.40	0.05	0.00200	0.16
	10	30	70	0.909	0.826	0.751	86.476	0.10	0.10	0.20	0.00200	0.17
	10	30	70	0.909	0.826	0.751	86.476	0.10	0.10	0.50	0.00500	0.43
	10	30	70	0.909	0.826	0.751	86.476	0.10	0.10	0.25	0.00250	0.22
	10	30	70	0.909	0.826	0.751	86.476	0.10	0.10	0.05	0.00050	0.04
Recession	15	10	70	0.909	0.826	0.751	74.493	0.30	0.10	0.15	0.00450	0.34
	15	10	70	0.909	0.826	0.751	74.493	0.30	0.10	0.45	0.01350	1.01
	15	10	70	0.909	0.826	0.751	74.493	0.30	0.10	0.30	0.00900	0.67
	15	10	70	0.909	0.826	0.751	74.493	0.30	0.10	0.10	0.00300	0.22
	15	20	70	0.909	0.826	0.751	82.757	0.30	0.40	0.15	0.01800	1.49
	15	20	70	0.909	0.826	0.751	82.757	0.30	0.40	0.45	0.05400	4.47
	15	20	70	0.909	0.826	0.751	82.757	0.30	0.40	0.30	0.03600	2.98
	15	20	70	0.909	0.826	0.751	82.757	0.30	0.40	0.10	0.01200	0.99
	15	50	70	0.909	0.826	0.751	107.551	0.30	0.35	0.15	0.01575	1.69
	15	50	70	0.909	0.826	0.751	107.551	0.30	0.35	0.45	0.04725	5.08
	15	50	70	0.909	0.826	0.751	107.551	0.30	0.35	0.30	0.03150	3.39
	15	50	70	0.909	0.826	0.751	107.551	0.30	0.35	0.10	0.01050	1.13
	15	60	70	0.909	0.826	0.751	115.815	0.30	0.15	0.15	0.00675	0.78
	15	60	70	0.909	0.826	0.751	115.815	0.30	0.15	0.45	0.02025	2.35
	15	60	70	0.909	0.826	0.751	115.815	0.30	0.15	0.30	0.01350	1.56
	15	60	70	0.909	0.826	0.751	115.815	0.30	0.15	0.10	0.00450	0.52
Normal	25	20	20	0.909	0.826	0.751	54.282	0.40	0.05	0.05	0.00100	0.05
	25	20	30	0.909	0.826	0.751	61.796	0.40	0.05	0.33	0.00660	0.41
	25	20	60	0.909	0.826	0.751	84.335	0.40	0.05	0.61	0.01220	1.03
	25	20	90	0.909	0.826	0.751	106.875	0.40	0.05	0.01	0.00020	0.02
	25	25	20	0.909	0.826	0.751	58.415	0.40	0.20	0.05	0.00400	0.23
	25	25	30	0.909	0.826	0.751	65.928	0.40	0.20	0.33	0.02640	1.74
	25	25	60	0.909	0.826	0.751	88.467	0.40	0.20	0.61	0.04880	4.32
	25	25	90	0.909	0.826	0.751	111.007	0.40	0.20	0.01	0.00080	0.09
	25	50	20	0.909	0.826	0.751	79.076	0.40	0.50	0.05	0.01000	0.79
	25	50	30	0.909	0.826	0.751	86.589	0.40	0.50	0.33	0.06600	5.71
	25	50	60	0.909	0.826	0.751	109.128	0.40	0.50	0.61	0.12200	13.31
	25	50	90	0.909	0.826	0.751	131.668	0.40	0.50	0.01	0.00200	0.26
	25	75	20	0.909	0.826	0.751	99.737	0.40	0.25	0.05	0.00500	0.50
	25	75	30	0.909	0.826	0.751	107.250	0.40	0.25	0.33	0.03300	3.54
	25	75	60	0.909	0.826	0.751	129.790	0.40	0.25	0.61	0.06100	7.92
	25	75	90	0.909	0.826	0.751	152.329	0.40	0.25	0.01	0.00100	0.15
Boom	40	30	30	0.909	0.826	0.751	83.696	0.20	0.01	0.01	0.00002	0.00
	40	30	40	0.909	0.826	0.751	91.210	0.20	0.01	0.14	0.00028	0.03
	40	30	75	0.909	0.826	0.751	117.506	0.20	0.01	0.40	0.00080	0.09
	40	30	200	0.909	0.826	0.751	211.420	0.20	0.01	0.45	0.00090	0.19
	40	45	30	0.909	0.826	0.751	96.093	0.20	0.10	0.01	0.00020	0.02
	40	45	40	0.909	0.826	0.751	103.606	0.20	0.10	0.14	0.00280	0.29
	40	45	75	0.909	0.826	0.751	129.902	0.20	0.10	0.40	0.00800	1.04
	40	45	200	0.909	0.826	0.751	223.817	0.20	0.10	0.45	0.00900	2.01
	40	60	30	0.909	0.826	0.751	108.490	0.20	0.40	0.01	0.00080	0.09

TABLE 4.7 *(Continued)*

State of Economy	Cash Flow Year 1	Year 2	Year 3	PVIF Year 1	Year 2	Year 3	PV CF	Prob1	Prob2	Prob3	JointProb	E PV
	40	60	40	0.909	0.826	0.751	116.003	0.20	0.40	0.14	0.01120	1.30
	40	60	75	0.909	0.826	0.751	142.299	0.20	0.40	0.40	0.03200	4.55
	40	60	200	0.909	0.826	0.751	236.213	0.20	0.40	0.45	0.03600	8.50
	40	100	30	0.909	0.826	0.751	141.548	0.20	0.49	0.01	0.00098	0.14
	40	100	40	0.909	0.826	0.751	149.061	0.20	0.49	0.14	0.01372	2.05
	40	100	75	0.909	0.826	0.751	175.357	0.20	0.49	0.40	0.03920	6.87
	40	100	200	0.909	0.826	0.751	269.271	0.20	0.49	0.45	0.04410	11.87
												115.23
Cost of Project												90.00
Expected Net Present Value												25.23

TABLE 4.8 Calculation of Expected Cash Value in Year 3

State of Economy	CF Year 3	PVIF Year 3	JointProb	PV CF3 ($mm)
Depression	1	0.751	0.00300	$0.002
	25	0.751	0.00750	0.141
	30	0.751	0.00375	0.085
	40	0.751	0.00075	0.023
	1	0.751	0.00700	0.005
	25	0.751	0.01750	0.329
	30	0.751	0.00875	0.197
	40	0.751	0.00175	0.053
	1	0.751	0.00800	0.006
	25	0.751	0.02000	0.376
	30	0.751	0.01000	0.225
	40	0.751	0.00200	0.060
	1	0.751	0.00200	0.002
	25	0.751	0.00500	0.094
	30	0.751	0.00250	0.056
	40	0.751	0.00050	0.015
Recession	3	0.751	0.00450	0.010
	20	0.751	0.01350	0.203
	30	0.751	0.00900	0.203
	40	0.751	0.00300	0.090
	3	0.751	0.01800	0.041
	20	0.751	0.05400	0.811
	30	0.751	0.03600	0.811
	40	0.751	0.01200	0.361

(Continued)

TABLE 4.8 *(Continued)*

State of Economy	CF Year 3	PVIF Year 3	JointProb	PV CF3 ($mm)
	3	0.751	0.01575	0.035
	20	0.751	0.04725	0.710
	30	0.751	0.03150	0.710
	40	0.751	0.01050	0.316
	3	0.751	0.00675	0.015
	20	0.751	0.02025	0.304
	30	0.751	0.01350	0.304
	40	0.751	0.00450	0.135
Normal	20	0.751	0.00100	0.015
	30	0.751	0.00660	0.149
	60	0.751	0.01220	0.550
	90	0.751	0.00020	0.014
	20	0.751	0.00400	0.060
	30	0.751	0.02640	0.595
	60	0.751	0.04880	2.200
	90	0.751	0.00080	0.054
	20	0.751	0.01000	0.150
	30	0.751	0.06600	1.488
	60	0.751	0.12200	5.500
	90	0.751	0.00200	0.135
	20	0.751	0.00500	0.075
	30	0.751	0.03300	0.744
	60	0.751	0.06100	2.750
	90	0.751	0.00100	0.068
Boom	30	0.751	0.00002	0.000
	40	0.751	0.00028	0.008
	75	0.751	0.00080	0.045
	200	0.751	0.00090	0.135
	30	0.751	0.00020	0.005
	40	0.751	0.00280	0.084
	75	0.751	0.00800	0.451
	200	0.751	0.00900	1.352
	30	0.751	0.00080	0.018
	40	0.751	0.01120	0.337
	75	0.751	0.03200	1.803
	200	0.751	0.03600	5.409
	30	0.751	0.00098	0.022
	40	0.751	0.01372	0.412
	75	0.751	0.03920	2.209
	200	0.751	0.04410	6.627
				$40.192

Here we follow Copeland and Weston (1992) and calculate the abandonment put value. One uses the present value of the abandoned cash flow as the equivalent of the stock price, the abandonment value as the exercise price, and a two-year period for the option. If the risk-free rate is 3 percent, the value of the put option is calculated to be $25.51 million.

$$v_c = P_{cs} N(d_1) - \frac{Ex}{e^{rt}} N(d_2)$$

$$d_1 = \frac{\ln\left(\frac{P_{cs}}{Ex}\right) + rt}{\sigma\sqrt{t}} + \frac{1}{2}\sigma\sqrt{t}$$

$$d_2 = d_1 = \sigma\sqrt{t}$$

$$\begin{aligned} d_1 &= \frac{\ln\left(\frac{40.192}{70}\right) + .03(2)}{.163\sqrt{2}} + \frac{1}{2}(.163)\sqrt{2} \\ &= \frac{-.55 + .06}{.163(2)} + \frac{1}{2}(.163)\sqrt{2} \\ &= \frac{-.55 + .06}{.33} + .12 = -1.36 \end{aligned}$$

$$d_2 = -1.36 - .163\sqrt{2} = -1.36 - (.23) = 1.59$$

$$N(d_1) = .09$$

$$N(d_2) = .06$$

$$\begin{aligned} v_c &= 40.192(.09) - \frac{70}{2.71828 - .03(2)}(.06) \\ &= 3.62 - \frac{70}{1.06}(.06) \\ &= 3.62 = 3.96 = -.34 \end{aligned}$$

$$v_{c_0} - P_0 = P_{cs} + \frac{Ex}{e^{rt}}$$

$$\begin{aligned} P_0 &= -.34 - 40.192 + \frac{70}{1.06} \\ &= -.34 - 40.192 + 66.04 = 25.51 \end{aligned}$$

In traditional investment analysis, a project or new investment should be accepted only if the returns on the project exceed the hurdle rate—the cost of capital that leads to a positive net present value. Several additional aspects of real options are embedded in capital budgeting projects. The first is the option to delay a project, especially when the firm has exclusive rights to the project. The second is the option to expand a project to cover new products or markets some time in the future.

Option to Delay a Project

Projects are traditionally analyzed using their expected cash flows and discount rates at the time of the analysis; the net present value computed on that basis is a measure of its value at that time. Expected cash flows and discount rates change over time, however, and so does the net present value. Thus, a project that has a negative net present value now may have a positive net present value in the future, if expected cash flow rises or the discount rate falls. In a competitive environment, in which individual firms have no special advantages over their competitors in taking on projects, this may not seem significant. In an environment in which only one firm, such as a firm with a patent, can take on a project, barriers to entry, such as extensive advertising or other restrictions, may create an unequal playing field. The changes in the project's value over time give it the characteristics of a call option.

In the abstract, assume that a project requires an initial investment, as the R&D program, C. The present value of expected cash inflows computed right now is PVCF. The net present value of this project is the difference between the two:

$$\text{NPV} = \text{PVCF} - \text{C}$$

Now assume that the firm has exclusive rights to this project for the next *n* years, and that the present value of the cash inflows may change over that time, because of changes in either the cash flows or the discount rate. Thus, the project may have a negative net present value right now, but it may still be a good project if the firm waits. Defining PVCF again as the present value of the cash flows, the firm's decision rule to accept the project should be if PVCF > C. If the firm does not take on the project, it incurs no additional cash flows, though it will lose what it originally invested in the project. The price of the project, such as an R&D project, is the price of the call option. The exercise price of the call option is the cost of future investments needed when an initial investment is made. The project expected net present value is analogous to the price of stock in the Black-Scholes option pricing model formulation. The underlying asset is the project, the strike price of the option is the investment needed to take the project, and the life of the option is the period for which the firm has rights to the project. The variance in this present value represents the variance of the underlying asset. The value of the option is largely derived from the variance in cash flows, as the higher the variance, the higher the value of the project delay option. Thus, the value of an option to do a project in a stable business will be less than the value of one in a changing environment. Mitchell and Hamilton (1988) emphasize that management needs to identify strategic objectives, review the impact of strategic options such as R&D projects directed toward strategic planning, and identify the strategic planning targets of future R&D projects.

Implications of Viewing the Right to Delay a Project as an Option

Several interesting implications emerge from the analysis of the option to delay a project as an option. First, a project may have a negative net present value based on expected cash flows currently, but it may still be a valuable project because of the option characteristics. Thus, while a negative net present value should encourage a firm to reject a project, it should not lead it to conclude that the rights to this project are worthless. Second, a project may have a positive net present value but still not be accepted right away. This is because the firm may gain by waiting and accepting the project in a future period, particularly for risky projects. In static analysis, increasing uncertainty increases the riskiness of the project and may make it less attractive. When the project is viewed as an option, an increase in the uncertainty may actually make the option more valuable, not less.

CHAPTER 5

An Introduction to Statistical Analysis and Simultaneous Equations

In this chapter, we introduce the reader to the techniques of statistical modeling and analysis including single variable regression, multiple regression, and simultaneous equations. We will use these estimation techniques in Chapters 6 and 7.

The horizontal line is called the x-axis and the vertical line the y-axis. Regression analysis looks for a relationship between the *X* variable (sometimes called the independent or explanatory variable) and the *Y* variable (the dependent variable). For example, *X* might be the aggregate level of gross national product (GNP) in the United States and *Y* would represent capital expenditures in the United States. (See Figure 5.1.) By looking up these numbers for a number of years in the past, we can plot points on the graph. Each point represents one year or quarter. More specifically, regression analysis seeks to find the "line of best fit" through the points. The term "best" has a very specific meaning in this context. Specifically, the regression line is drawn to best approximate the relationship between the two variables. Techniques for estimating the regression line (i.e., its intercept on the y-axis and its slope) are the subject of this chapter. Forecasting using the regression line assumes that the relationship that existed in the past between the two variables will continue to exist in the future. There may be times when this assumption is inappropriate; the forecaster must be aware of this potential pitfall.

Regression analysis can be expanded to include more than one independent variable; this is called multiple regression. For example, the forecaster might believe that capital expenditures depend not only on GNP but also on the level of interest rates. Historical data on these three variables

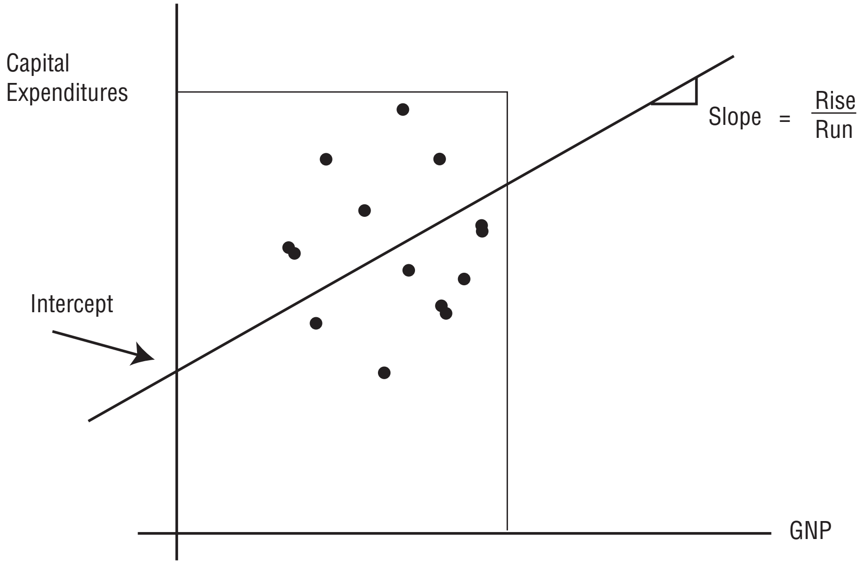

FIGURE 5.1 Fitting the Regression Line

must be obtained, then a plane of best fit estimated. Given an estimate of the future level of personal disposable income and interest rates, one can make a forecast of car sales. Regression capabilities are found in a wide variety of software packages and hence are available to anyone with a computer. We use the Statistical Analysis System (SAS) in this text.

In simple regression analysis, one seeks to measure the statistical association between two variables, X and Y. Regression analysis is generally used to measure how changes in the independent variable, X, influence changes in the dependent variable, Y. Regression analysis shows a statistical association or correlation among variables, rather than a causal relationship among variables.

Simple linear least squares regression is a reasonable tool to use in the forecasting of sales. Least squares regression assumes that the past is the proxy for the future—that the sales of the firm in the future will be determined by the same variables and magnitudes of the variables' influence as those that have determined the sales of the past. When one uses regression analysis, one seeks to examine the statistical association between two variables, so one may forecast using the regression analysis only if the association remains reasonably stable. This is an assumption which, if violated, can make a forecast of sales look absurd. The occurrence of a war or a change in Federal Reserve policy is a weakness of many economic models. Least squares regression on a firm's sales is powerless against major economic catastrophes, but it can point a reasonable direction for the firm to pursue.

There are four principal goals of regression and correlation analysis. First, regression analysis provides estimates of the dependent variable for given values of the independent variable. Second, regression analysis provides measures of the errors that are likely to be involved in using the regression line to estimate the dependent variable.

Third, regression analysis provides an estimate of the effect on the mean value of *Y* of a one-unit change in *X*. Regression analysis enables us to estimate this slope and to test hypotheses concerning its value. Fourth, correlation analysis provides estimates of how strong the relationship is between the two variables. The coefficient of correlation and the coefficient of determination are two measures generally used for this purpose.

THE LINEAR REGRESSION MODEL

A model is a simplified or idealized representation of the real world. All scientific inquiry is based to some extent on the use of models. In this section, we describe the model—that is, the set of simplifying assumptions—on which regression analysis is based. To begin with, the statistician visualizes a population of all relevant pairs of observations of the independent and dependent variables.

Holding constant the value of *X* (the independent variable), the statistician assumes that each corresponding value of *Y* (the dependent variable) is drawn at random from the population. (See Figure 5.2.)

The probability distribution of *Y*, given a specified value of *X*, is called the conditional probability distribution of *Y*. The conditional probability distribution of *Y*, given the specified value of *X*, is denoted by

$$P(Y|X)$$

where *Y* is the value of the dependent variable and *X* is the specified value of the independent variable. The mean of this conditional probability distribution is denoted by $\mu_{y \cdot x}$, and the standard deviation of this probability distribution is denoted by $\sigma_{y \cdot x}$.

Regression analysis makes the following assumptions about the conditional probability distribution of *Y*. First, it assumes that the mean value of

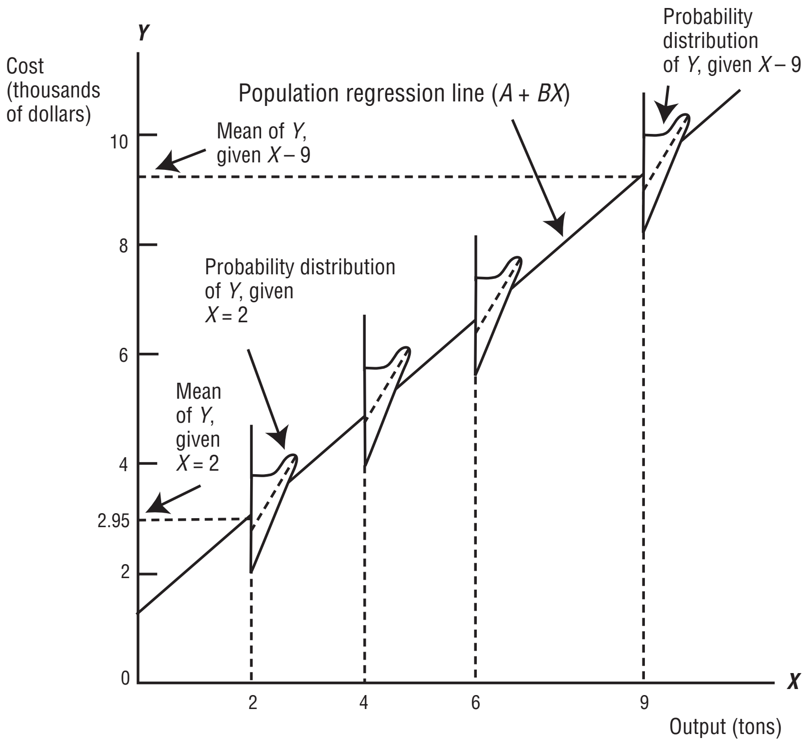

FIGURE 5.2 Fitting the Population Regression Line

Y, given the value of *X*, is a linear function of *X*. In other words, the mean value of the dependent variable is assumed to be a linear function of the independent variable. Put still differently, the means of the conditional probability distributions are assumed to lie on a straight line:

$$\mu_{y \cdot x} = A + BX$$

The straight line is called the population regression line or the true regression line.

Second, regression analysis assumes that the standard deviation of the conditional probability distribution is the same, regardless of the specified value of the independent variable. The characteristic (of equal standard deviations) is called homoscedasticity.

Third, regression analysis assumes that the values of *Y* are independent of one another. For example, if one observation lies below the mean of its conditional probability distribution, it is assumed that this will not affect the chance that some other observation in the sample will lie below the mean of its conditional probability distribution. Obviously, this assumption need not be true.

Fourth, regression analysis assumes that the conditional probability distribution of Y is normal. Actually, not all aspects of regression analysis require this assumption, but some do. It is also worth noting that in regression analysis only Y is regarded as a random variable. The values of X are assumed to be fixed. Thus, when regression analysis is used to estimate Y on the basis of X, the true value of Y is subject to error, but the value of X is known.

The four assumptions underlying regression analysis can be stated somewhat differently. Together they imply that the error term is normally distributed. Y_i is the ith observed value of the dependent variable, X_i is the ith observed value of the independent variable, and e_i is a normally distributed random variable with a mean of zero and a standard deviation equal to σ_e. Essentially, e_i is an error term—that is, a random variable. Because of the presence of this error term, the observed values of Y_i fall around the population regression line, not on it. (See Figure 5.3.)

The case of simple, linear, least squares regression may be written in the form:

$$Y = \alpha + \beta X + \varepsilon \tag{5.1}$$

where Y, the dependent variable, is a linear function of X, the independent variable. The parameters α and β characterize the population regression line and ε is the randomly distributed error term. The regression estimates of α and β will be derived from the principle of least squares. In applying least squares, the sum of the squared regression errors will be minimized; our regression errors equal the actual dependent variable minus the estimated value from the regression line. If Y represents the actual value and Y the estimated value, their difference is the error term, e. Least squares regression minimizes the sum of the squared error terms. The simple regression line will yield an estimated value of Y, $\hat{Y}$, by the use of the sample regression:

$$\hat{Y} = \hat{a} + \hat{b}X \tag{5.2}$$

In the estimation equation (5.2) $\hat{a}$ is the least squares estimate of α and $\hat{b}$ is the estimate of β. Thus, α and β are the regression constants that must be estimated. The least squares regression constants (or statistics) a and b are unbiased and efficient (smallest variance) estimators of α and β. The error

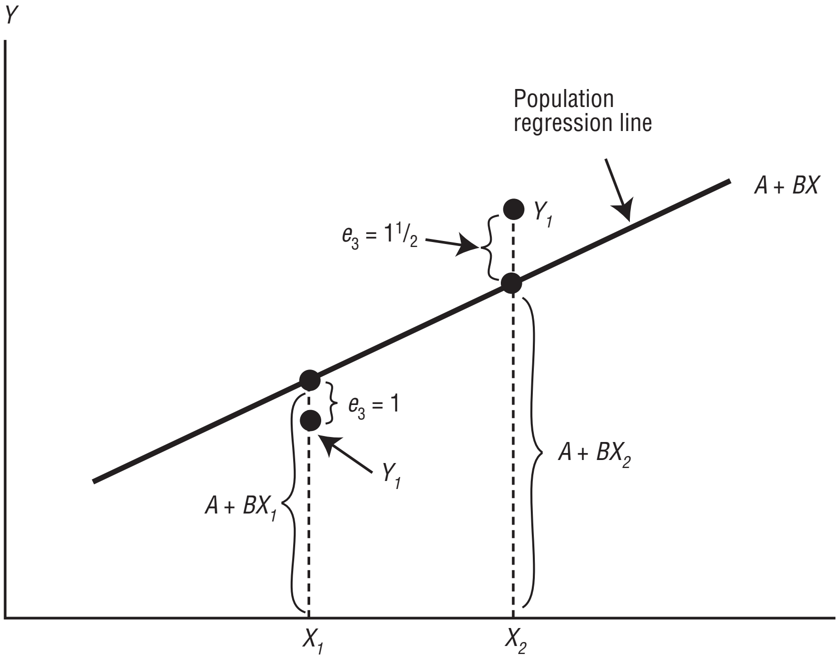

FIGURE 5.3 The Regression Model

term, e_i, is the difference between the actual and estimated dependent variable values for any given independent variable values, X_i.

$$e_i = \hat{Y}_i - Y_i \tag{5.3}$$

The regression error term, e_i, is the least squares estimate of ε_i, the actual error term.

To minimize the error terms, the least squares technique minimizes the sum of the squares error terms of the N observations,

$$\sum_{i=1}^{N} e_1^2 \tag{5.4}$$

The error terms from the N observations will be minimized. Thus, least squares regression minimizes:

$$\sum_{i=1}^{N} e_1^2 \sum_{i=1}^{N} [Y_i - \hat{Y}_i]^2 = \sum_{i=1}^{N} [Y_i - (\alpha + bX_i)]^2 \tag{5.5}$$

To assure that a minimum is reached, the partial derivatives of the squared error terms function

$$\sum_{i=1}^{N} [Y_i - (\alpha + bX_i)]^2$$

will be taken with respect to *a* and *b*.

$$\frac{\partial \sum_{i=1}^{N} e_1^2}{\partial a} = 2\sum_{i=1}^{N} (Y_i - a - bX_i)(-1)$$
$$= -2\left(\sum_{i=1}^{N} Y_i - \sum_{i=1}^{N} a - b\sum_{i=1}^{N} X_i\right)$$

$$\frac{\partial \sum_{i=1}^{N} e_1^2}{\partial b} = 2\sum_{i=1}^{N} (Y_i - a - bX_i)(-X_i)$$
$$= -2\left(\sum_{i=1}^{N} Y_i X_i - \sum_{i=1}^{N} X_i - b\sum_{i=1}^{N} X_1^2\right)$$

The partial derivatives will then be set equal to zero.

$$\begin{aligned} \frac{\partial \sum_{i=1}^{N} e_1^2}{\partial a} &= -2\left(\sum_{i=1}^{N} Y_i - \sum_{i=1}^{N} a - b\sum_{i=1}^{N} X_i\right) = 0 \\ \frac{\partial \sum_{i=1}^{N} e_1^2}{\partial b} &= -2\left(\sum_{i=1}^{N} YX_i - \sum_{i=1}^{N} X_i - b\sum_{i=1}^{N} X_1^2\right) = 0 \end{aligned} \tag{5.6}$$

Rewriting these equations, one obtains the normal equations:

$$\begin{aligned}\sum_{i=1}^{N} Y_i &= \sum_{i=1}^{N} a + b\sum_{i=1}^{N} X_i \\ \sum_{i=1}^{N} Y_i X_i &= a\sum_{i=1}^{N} X_i + b\sum_{i=1}^{N} X_1^2\end{aligned} \tag{5.7}$$

Solving the normal equations simultaneously for *a* and *b* yields the least squares regression estimates:

$$\hat{a} = \frac{\left(\sum_{i=1}^{N} X_1^2\right)\left(\sum_{i=1}^{N} Y_i\right) - \left(\sum_{i=1}^{N} X_i Y_i\right)}{N\left(\sum_{i=1}^{N} X_1^2\right) - \left(\sum_{i=1}^{N} X_i\right)^2}$$

$$\hat{b} = \frac{\left(\sum_{i=1}^{N} X_i Y_i\right) - \left(\sum_{i=1}^{N} X_i\right)\left(\sum_{i=1}^{N} Y_i\right)}{N\left(\sum_{i=1}^{N} X_1^2\right) - \left(\sum_{i=1}^{N} X_i\right)^2} \tag{5.8}$$

An estimation of the regression line's coefficients and "goodness of fit" also can be found in terms of expressing the dependent and independent variables in terms of deviations from their means, their sample moments. The sample moments will be denoted by *M*.

$$\begin{aligned}M_{XX} &= \sum_{i=1}^{N} x_1^2 = \sum_{i=1}^{N} (x_i - \overline{x})^2 \\ &= N\sum_{i=1}^{N} X_i - \left(\sum_{i=1}^{N} X_i\right)^2\end{aligned}$$

$$M_{XY} = \sum_{i=1}^{N} x_i y_i = \sum_{i=1}^{N} (X_i - \overline{X})(Y_i - \overline{Y})$$
$$= N\sum_{i=1}^{N} X_i Y_i - \left(\sum_{i=1}^{N} X_i\right)\left(\sum_{i=1}^{N} Y_i\right)$$

$$M_{YY} = \sum_{i=1}^{N} y_1^2 = \sum_{i=1}^{N} (Y - \overline{Y})^2$$
$$= N\left(\sum_{i=1}^{N} Y_1^2\right) - \sum_{i=1}^{N} (Y_i)^2$$

The slope of the regression line, b, can be found by:

$$\hat{b} = \frac{M_{XY}}{M_{XX}} \tag{5.9}$$

$$\hat{a} = \frac{\sum_{i=1}^{N} Y_i}{N} - b\frac{\sum_{i=1}^{N} X_i}{N} = \overline{y} - b\overline{X} \tag{5.10}$$

The standard error of the regression line can be found in terms of the sample moments.

$$S_e^2 = \frac{M_{XX}(M_{YY}) - (M_{XY})^2}{N(N-2)M_{XX}}$$
$$S_e = \sqrt{S_e^2} \tag{5.11}$$

The major benefits in calculating the sample moments are that the correlation coefficient, r, and the coefficient of determination, r^2, can easily be found.

$$r = \frac{M_{XY}}{(M_{XX})(M_{YY})}$$
$$R^2 = (r) \tag{5.12}$$

The coefficient of determination, R^2, is the percentage of the variance of the dependent variable explained by the independent variable. The coefficient of determination cannot exceed one nor be less than zero. In the case of $R^2 = 0$, the regression line's $Y = Y$ and no variation in the dependent variable is explained. If the dependent variable pattern continues as in the past, the model with time as the independent variable should be of good use in forecasting.

The firm can test whether the $\hat{a}$ and $\hat{b}$ coefficients are statistically different from zero, the generally accepted null hypothesis. A t-test is used to test the two null hypotheses:

$$H_0 : \hat{a} = 0$$
$$H_A : \hat{a} \neq 0$$
$$H_0 : \hat{b} = 0$$
$$H_A : \hat{b} \neq 0$$

The H_0 represents the null hypothesis while H_A represents the alternative hypothesis. To reject the null hypothesis, the calculated t-value must exceed the critical t-value given in the t-tables. The calculated t-values for $\hat{a}$ and $\hat{b}$ are found by:

$$t_a = \frac{\hat{a} - \alpha}{S_e}\sqrt{\frac{N(M_{XX})}{M_{XX} + (N\overline{X})^2}}$$
$$t_b = \frac{\hat{b} - \beta}{S_e}\sqrt{\frac{(M_{XX})}{N}} \qquad (5.13)$$

The critical t-value, t_c, for the .05 level of significance with $N - 2$ degrees of freedom can be found in a t-table in any statistical econometric text.

If $t_a > t_c$, then reject H_{0_1}.

If $t_b > t_c$, then reject H_{0_2}.

The null hypothesis is that =0 can be rejected and therefore is statistically different from zero. The t-value of b leads to the rejection of =0, and is statistically different from zero. One has a statistically significant regression model if one can reject H_{0_2}.

We can create 95 percent confidence intervals for a and b, where the limits of a and b are:

$$a + ta/_2\ S_e{}^{+}\sqrt{\frac{(N\overline{X})^2 + M_{XX}}{N(M_{XX})}}$$
$$b + ta/_2\ S_e\sqrt{\frac{N}{M_{XX}}} \qquad (5.14)$$

To test whether the model is a useful model, an F-test is performed where:

$$H_0 = \alpha = \beta = 0$$
$$H_A = \alpha/\beta = 0$$

$$F = \frac{\sum_{i=1}^{N} Y^2 \div 1 - \beta^2 \sum_{i=1}^{N} X_1^2}{\sum_{i=1}^{N} e^2 \div N - 2} \qquad (5.15)$$

As the calculated F-value exceeds the critical F-value with (1, N – 2) degrees of freedom of 5.99 at the .05 level of significance, the null hypothesis must be rejected. The 95 percent confidence level limit of prediction can be found in terms of the dependent variable value:

$$(\hat{a} + \hat{b}X_0) + ta/_2\ S_e\sqrt{\frac{N(X_0 - \overline{X})^2}{1 + N + M_{XX}}} \qquad (5.16)$$

MULTIPLE REGRESSION

Business and economic analysts generally are interested in the way in which a dependent variable is related to more than one independent variable. The overall purpose of this chapter is to describe the nature and application of multiple regression and correlation techniques, the methods that are used when there is more than one independent variable. Among the specific objectives are:

- To show how one can calculate and interpret the intercept and slopes of a multiple regression (two or more independent variables).
- To define the multiple coefficient of determination and indicate how it can be computed and used.

- To discuss the role of the computer in calculating multiple regressions with any number of independent variables, and to indicate in detail how computer printouts should be interpreted and used.

Whereas a simple regression includes only one independent variable, a multiple regression includes two or more independent variables. Basically, there are two important reasons why a multiple regression must often be used instead of a simple regression. First, one can often predict the dependent variable more accurately if more than one independent variable is used. It may be reasonable to assume that

$$E(Y_i) = A + B_1X_{1i} + B_2X_{2i}$$

where Y_i is capital expenditures for the ith quarter, X_{1i} is the GNP for that quarter, and X_{2i} is the interest rate at the end of the quarter.

LEAST SQUARES ESTIMATES OF THE REGRESSION COEFFICIENTS

The first step in multiple-regression analysis is to identify the independent variables and to specify the mathematical form of the equation relating the expected value of the dependent variable to these independent variables. The relationship between the expected value of the dependent variable and these independent variables is linear. Having carried out this first step, we next estimate the unknown constants A, B_1, and B_2 in the true regression equation. Just as in the case of simple regression, these constants are estimated by finding the value of each that minimizes the sum of the squared deviations of the observed values of the dependent variable from the values of the dependent variable predicted by the regression equation.

To understand more precisely the nature of least squares estimates of A, B_1, and B_2, suppose that a is an estimator of A, b_1 an estimator of B_1, and b_2 an estimator of B_2. Then the value of the dependent variable Y_i predicted by the estimated regression equation is

$$\hat{Y}_i = a + b_1X_{1i} + b_2X_{2i}$$

and the deviation of this predicted value from the actual value of the dependent variable is

$$Y_i - \hat{Y}_i = Y_i - a - b_1X_{1i} - b_2X_{2i}$$

Just as in the case of simple regression, the closeness of fit of the estimated regression equation to the data is measured by the sum of squares of these deviations:

$$\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2 = \sum_{i=1}^{n}(Y_i - a - b_1 X_{1i} - b_2 X_{2i})^2 \qquad (5.17)$$

where n is the number of observations in the sample. The larger the sum of squares, the less closely the estimated regression equation fits; the smaller the sum of squares, the more closely it fits. Thus, it seems reasonable to choose the values of a, b_1, and b_2 that minimize the expression in equation (5.17). These estimates are least squares estimates, as in the case of simple regression.

MULTIPLE COEFFICIENT OF DETERMINATION

In a previous section we described how the coefficient of determination can be used to measure how well a simple regression equation fits the data. When a multiple regression is calculated, the multiple coefficient of determination, rather than the simple coefficient of determination discussed previously, is used for this purpose. The multiple coefficient of determination is defined as:

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2}{\sum_{i=1}^{n}(Y_i - \overline{Y})^2} \qquad (5.18)$$

where $\hat{Y}_i$ is the value of the dependent variable that is predicted from the regression equation, which means that R^2 measures the proportion of the total variation in the dependent variable that is explained by the regression equation. The positive square root of the multiple coefficient of determination is called the multiple correlation coefficient and is denoted by R. It, too, is sometimes used to measure how well a multiple-regression equation fits the data.

If there are only two independent variables in a multiple regression, as in equation (5.16), a relatively simple way to compute the multiple coefficient of determination is:

$$R^2 = \frac{\hat{b}_1 \sum_{i=1}^{n} (X_{1i} - \overline{X}_i)(Y_i - \overline{Y}) + \hat{b}_2 \sum_{i=1}^{n} (X_{2i} - \overline{X}_2)(Y_i - \overline{Y})}{\sum_{i=1}^{n} Y_i^2 - \frac{\left(\sum_{i=1}^{n} Y_i\right)^2}{n}} \tag{5.19}$$

Ordinarily, however, a multiple regression is carried out on a computer, which is programmed to print out the value of the multiple coefficient of determination (or of the multiple correlation coefficient).

ESTIMATION OF SIMULTANEOUS EQUATIONS SYSTEMS

Let us generalize regression analysis using K variables. A certain class of estimators for the parameters of a simultaneous equations (S.E.) system can be shown to have an interpretation as an ordinary least squares (OLS) estimator. In view of this fundamental unity of estimation procedures, it would be desirable at this stage to review carefully the estimation problem in the context of the general linear model and some of its (straightforward) extensions.

Let y be a variable of interest and suppose that observations on it, at time t, are generated by

$$y_t = \sum_{i=1}^{k} \beta_i x_{ti} + u_t \qquad t = 1,2,\ldots,T \tag{5.20}$$

Here y is said to be the dependent variable and the x_i, $i = 1,2,\ldots,k$, the independent or explanatory variables; the latter are usually assumed nonstochastic. The β_i are unknown parameters to be estimated.

$$Y = X\beta + u \tag{5.21}$$

where y is a $T \times 1$ vector of observations on the dependent variable,

$$X = (x_{ti}) \qquad t = 1,2,\ldots,T,\ i = 1,2,\ldots,k \tag{5.22}$$

is the matrix of observations on the explanatory variables, and

$$\beta = (\beta_1, \beta_2,\ldots, \beta_k)' \qquad u = (u_1, u_2,\ldots, ur)' \tag{5.23}$$

In connection with equation (5.23), the following assumptions are made:

$$|x_{ti}| < \chi \qquad E(u) = 0 \qquad \mathrm{Cov}(u) = \sigma^2 I \qquad E(X'u) = 0 \tag{5.24}$$

These assumptions, in order of appearance, mean:

1. The explanatory variables are uniformly bounded by the finite (but perhaps very large) constant χ.
2. The disturbances, u_t, have mean zero, are uncorrelated, and have common variance σ^2.
3. The explanatory variables are uncorrelated with the disturbances.
4. There are no linear dependencies among the explanatory variables; that is, the correlations among the independent variables are less than 1.0.

The technique of ordinary least squares (OLS) obtains an estimator for β, say b, by minimizing the sum of squared errors committed when we replace β by b—and thus "predict" y by Xb.

Thus, we minimize

$$S = (y - Xb)'(y - xb) = y'y - b'X'y - y'Xb + b'X'Xb \tag{5.25}$$

The first-order conditions are

$$\frac{\partial S}{\partial b} = -2X'y + 2X'Xb = 0 \tag{5.26}$$

Solving, we obtain

$$b = (X'X)^{-1}X'y \tag{5.27}$$

Estimators that are efficient with respect to the class of linear unbiased estimators are said to be best linear unbiased estimators (BLUE), the so-called Gauss-Markov theorem (Greene 1997).

To complete the estimation problem, we must derive an estimator for the remaining parameter, namely, σ^2. Thus consider

$$\hat{\sigma}^2 = \frac{\hat{u}'\hat{u}}{T - k} \tag{5.28}$$

where

$$\hat{u} = y - Xb \tag{5.29}$$

but

$$\hat{u}'\hat{u} = y'[I - X(X'X)^{-1}X']y = u'[I - X(X'X)^{-1}X']u \tag{5.30}$$

Hence

$$\begin{aligned} E(\hat{u}'\hat{u}) &= \sigma^2 tr[I - X(X'X)^{-1}X'] \\ &= \sigma^2[trI - tr(X'X)^{-1}X'X0] = (T - k)\sigma^2 \end{aligned} \tag{5.31}$$

The last equality holds, for I is $T \times T$, while $(X'X)^{-1}X'X$ is the identity matrix of order k.

Estimation of Parameters in Multiple Equation (Regression) Models

Let us generalize the preceding problem so that we consider not a single equation but rather a system of equations of the form

$$y_{rk} = \sum_{j=1}^{k} x_{tj}\beta_{ji} + u_{ti} \qquad t = 1,2,\ldots,T,\ i = 1,2,\ldots,m \tag{5.32}$$

The system here contains k independent (or exogenous) variables x_1, x_2,..., x_k and m dependent variables $y_1, y_2,\ldots, y_m$. It might seem that all independent variables appear in each equation of (5.32) but this need not be so, for some of the β_{ji} may be known to be zero. In general, we will assume that only $k_i \leq k$ independent variables appear in the ith equation.

Let us denote by $y_{.I}$ the vector of observations on the dependent variable y_i and by X_i the matrix of observations on the (k_i) independent variables actually appearing in the ith equation. Then the system in (5.32) may be written more conveniently as

$$y_{\cdot i} = X_i\beta_{\cdot i} + u_{\cdot i} \qquad i = 1, 2,\ldots, m \tag{5.33}$$

The vector $\beta_{\cdot i}$ differs from $(\beta_{1i}, \beta_{2i},\ldots, \beta_{ki})'$ in that it is the subvector of the latter resulting after deletion of elements β_{ji} known to be zero. Thus, in (5.33), $y_{\cdot i}$ is $T \times 1$, X_i is $T \times k_i$, $\beta_{\cdot i}$ is $k_i \times 1$, and $u_{\cdot i}$ is $T \times 1$. Now each equation in (5.33) represents a general linear model of the type examined earlier. The covariance vector of error terms is:

$$\mathrm{Cov}(u_{\cdot i}) = \sigma_{ii}I \tag{5.34}$$

We still need to say something about the covariance matrix of $u_{\cdot i}$ and $u_{\cdot j}$, $i \neq j$. The two vectors need not be uncorrelated. Clearly, if

$$\mathrm{Cov}(u_{\cdot i}, u_{\cdot j}) \neq 0 \tag{5.35}$$

then the ith equation conveys some information about the jth equation. One should use all statistical information in estimated equations.

In general, since the error terms of the system may be interpreted as reflecting, in part, the impact of many relevant influences that are not individually accounted for, it would be reasonable to assume that u_{it} is correlated with u_{tj}. Finally, if the observations are interpreted as being a random sample on the multivariate vector $(y_1, y_2, \ldots, y_m)$, then, of course, $u_{t'j}$ is uncorrelated with, indeed independent of, $u_{t'j}$ for $t \neq t'$. Hence let us solve the estimation problem posed by the system in (5.33) under these assumptions. Specifically, we assume

$$\begin{matrix} \mathrm{Cov}(u_{\cdot i}, u_{\cdot j}) = \sigma_{ij} I & E(X'_j u_{\cdot i}) = 0 \\ E(u_{\cdot i}) = 0 & i, j = 1, 2, \ldots, m \end{matrix} \tag{5.36}$$

Then the entire system in (5.33) can be written more compactly (and revealingly) as:

$$y = X\beta + u \tag{5.37}$$

The problem of efficient estimation of the parameter vector in (5.37) has already been solved in the preceding discussion; however, the solution depends on the form of the covariance matrix of the error vector u, which may be written as:

$$\begin{aligned} \mathrm{Cov}(u) = E(uu') = E &\begin{bmatrix} u_{\cdot 1}u'_{\cdot 1} & u_{\cdot 1}u'_{\cdot 2} & \ldots & u_{\cdot 1}u'_{\cdot m} \\ u_{\cdot 2}u'_{\cdot 1} & u_{\cdot 2}u'_{\cdot 2} & \ldots & u_{\cdot 2}u'_{\cdot 2} \\ \vdots & \vdots & & \vdots \\ u_{\cdot m}u'_{\cdot 1} & u_{\cdot m}u'_{\cdot 2} & \ldots & u_{\cdot m}u'_{\cdot m} \end{bmatrix} \\ = &\begin{bmatrix} \sigma_{11} I & \sigma_{12} I & \ldots & \sigma_{1m} I \\ \sigma_{21} I & \sigma_{22} I & \ldots & \sigma_{2m} I \\ \vdots & \vdots & & \vdots \\ \sigma_{m1} I & \sigma_{m2} I & \ldots & \sigma_{mm} I \end{bmatrix} \end{aligned} \tag{5.38}$$

The reader is referred to Greene (1997) and Dhrymes (1974) for complete statistical treatments of regression estimations.

TWO-STAGE LEAST SQUARES (2SLS)

Thus let us examine again the problem of estimating the parameters of

$$y_{\cdot 1} = Y_1\beta_{\cdot 1} + X_1\gamma_{\cdot 1} + u_{\cdot 1} \tag{5.39}$$

which is the first equation in a system of m-structural equations as discussed in the previous section. As before, let X (of rank G) be the $T \times G$ matrix of observations on all the predetermined variables appearing in the entire system and consider the transformed equation

$$X'y_{\cdot 1} = X'Y_1\beta_{\cdot 1} + X'X_1\gamma_{\cdot 1} + X'u_{\cdot 1} \tag{5.40}$$

The new explanatory variables consist essentially of sample cross moments between the current endogenous and the predetermined variables—the former as they appear in the first equation, the latter as they appear in the entire system. As the sample size increases, the new explanatory variables are nonstochastic and are uncorrelated with the error term appearing in (5.40). Thus, if one applies an "efficient" estimation technique to that equation, one obtains at least consistent estimators of the vectors $\beta_{\cdot 1}$ and $\gamma_{\cdot 1}$. Here we should caution the reader that, in general, it is not true that

$$\text{Cov}(X'u_{\cdot 1}) = E(X'u_{\cdot 1}u'_{\cdot 1}X) = \sigma_{11}X'X \tag{5.41}$$

The errors in the system are jointly normally distributed or the errors at time t are independent of errors at time t', for $t \neq t'$. If we do make the normal distribution or independence assumptions, then

$$E\left(\sum_{t'=1}^{T}\sum_{t=1}^{T} y_{t-1,s}u_{t1}u_{t'1}y_{t'-1,s}\right) = \sigma_{11}\sum_{t=1}^{T} E(y_{t-1,s}^2) \tag{5.42}$$

and thus for large samples we would have approximately

$$\text{Cov}(X'u_{\cdot 1}) = \sigma_{11}X'X \tag{5.43}$$

It appears that an "efficient" procedure for estimating $\beta_{\cdot 1}$ and $\gamma_{\cdot 1}$ from (5.40) would be the application of Aitken techniques, where the covariance matrix of the error vector $X'u_{\cdot 1}$ is taken as σ_{11} $(X'X)$. The Aitken estimation has some optimal properties, so it is reasonable to conjecture that 2SLS is optimal in some sense within the class of consistent estimators of the parameters $\beta_{\cdot 1}$, $\gamma_{\cdot 1}$, which use only information conveyed by the equation containing $\beta_{\cdot 1}$ and $\gamma_{\cdot 1}$ and thus disregard information conveyed by the rest of the system. By assumption, rank $(X) = G$, and thus $X'X$ is a positive definite matrix; hence there exists a nonsingular matrix R such that

$$X'X = RR' \tag{5.44}$$

Now transform equation (5.40) by R^{-1} to obtain

$$R^{-1}X'y_{\cdot 1} = R^{-1}X'Y_1\beta_{\cdot 1} + R^{-1}X'X_1\gamma_{\cdot 1} + R^{-1}X'u_{\cdot 1} \tag{5.45}$$

Let

$$\begin{aligned} w_{\cdot 1} &= R^{-1}X'y_{\cdot 1} \\ Q_1 &= (R^{-1}X'Y_1, R^{-1}X'X_1) \\ \delta_{\cdot 1} &= \begin{pmatrix} \beta_{\cdot 1} \\ \gamma_{\cdot 1} \end{pmatrix} \\ r_{\cdot 1} &= R^{-1}X'u_{\cdot 1} \end{aligned} \tag{5.46}$$

The 2SLS is simply the OLS estimator applied to equation (5.46).

But this particular formulation of the problem opens the way to a routine derivation of the 2SLS estimator of all the parameters of the entire system of m-structural equations. Every equation of the system may be put in the form exhibited in (5.46). Thus we can write

$$w_{\cdot i} = Q_i\delta_{\cdot i} + r_{\cdot i} \qquad i = 1, 2, \ldots, m \tag{5.47}$$

where
$$\begin{aligned} w_{\cdot i} &= R^{-1}X'y_{\cdot i} \\ Q_i &= (R^{-1}X'Y_i, R^{-1}X'X_i) \\ \delta_{\cdot i} &= \begin{pmatrix} \beta_{\cdot i} \\ \gamma_{\cdot i} \end{pmatrix} \\ r_{\cdot i} &= R^{-1}X'u_{\cdot i} \end{aligned} \tag{5.48}$$

and Y_i and X_i are, respectively, the matrices of observations on the explanatory current endogenous and predetermined variables appearing in the ith equation.

Let us define

$$w = \begin{pmatrix} w_{\cdot 1} \\ w_{\cdot 2} \\ \vdots \\ w_{\cdot m} \end{pmatrix} \quad \delta = \begin{pmatrix} \delta_{\cdot 1} \\ \delta_{\cdot 2} \\ \vdots \\ \delta_{\cdot m} \end{pmatrix}$$

$$Q = \operatorname{diag}(Q_1, Q_2, \ldots, Q_m) \qquad r = \begin{pmatrix} r_{\cdot 1} \\ r_{\cdot 2} \\ \vdots \\ r_{\cdot m} \end{pmatrix} \tag{5.49}$$

And thus write the entire system in equation (5.47) as

$$w = Q\delta + r \tag{5.50}$$

The 2SLS estimator of all the parameters of the system is therefore

$$\tilde{\delta} = (Q'Q)^{-1} Q'w = \delta + (Q'Q)^{-1} Q'r \tag{5.51}$$

The covariance matrix of $r_{\cdot 1}$ with $r_{\cdot j}$, $i \neq j$ will not vanish, and one suspects that $\tilde{\delta}$ is an asymptotically inefficient estimator of δ. We shall return to this problem in the next section when we consider three-stage least squares estimators. Let us now examine the precise nature of the estimator exhibited in equation (5.51).

We have

$$Q'Q = \begin{bmatrix} Q_1'Q_1 & & & 0 \\ & Q_2'Q_2 & & \\ & & \ddots & \\ 0 & & & Q_m'Q_m \end{bmatrix} \qquad Q'w = \begin{bmatrix} Q_1'w_{\cdot 1} \\ Q_2'w_{\cdot 2} \\ \vdots \\ Q_n'w_{\cdot m} \end{bmatrix} \tag{5.52}$$

Hence the *i*th subvector of $\tilde{\delta}$ is given by

$$\begin{aligned}\tilde{\delta}_{\cdot i} &= (Q_i'Q_i)^{-1}Q_i'w_{\cdot i}\\ &= \begin{bmatrix} Y_i'X(X'X)^{-1}X'Y_i & Y_i'X_i \\ X_i'Y_i & X_i'X_i \end{bmatrix}^{-1} \begin{bmatrix} Y_i'X(X'X)^{-1}X_i'y_{\cdot i} \\ X_i'y_{\cdot i} \end{bmatrix}\end{aligned} \tag{5.53}$$

which is exactly the 2SLS estimator and, incidentally, is also the computationally efficient method for obtaining it.

THREE-STAGE LEAST SQUARES (3SLS)

We reported that the problem of estimating the parameters of a structural system of equations by 2SLS can be reduced to the problem of estimating by ordinary least squares, the parameters of a single equation in the notation of (5.50).

However, it was also shown earlier that in this context whether such a procedure is efficient or not depends on the covariance structure of the error terms in the various equations of the system. In particular, it was shown that if the error terms between any two equations were correlated, then a gain in efficiency would result by applying Aitken's procedure provided that not all equations contain the same variables. A procedure that would take into account this postulated covariance structure will be efficient relative to the 2SLS procedure, which does not take it into account. In general, different equations will contain different explanatory variables. If their respective error terms are correlated, then by focusing our attention on one equation at a time we are neglecting the information conveyed by the rest of the system. If we could use such information, then clearly we would improve on 2SLS.

The Three-Stage Least Squares Estimator

Consider again the system

$$y_{\cdot i} = Y_i\beta_{\cdot i} + X_i\gamma_{\cdot i} + u_{\cdot i} \qquad i = 1, 2, \ldots, m \tag{5.54}$$

and its associated transform

$$R^{-1}X'y_{\cdot i} = R^{-1}X'Y_i\beta_{\cdot i} + R^{-1}X'X_{\cdot i}\gamma_{\cdot i} + R^{-1}X'u_{\cdot i} \qquad i = 1,2,\ldots,m \tag{5.55}$$

where R is a nonsingular matrix such that

$$RR' = X'X \tag{5.56}$$

One of the assumptions underlying this entire estimation scheme is that

$$\operatorname*{plim}_{T \to \infty} \frac{X'X}{T} = M_{xx} \tag{5.57}$$

exists as a nonsingular matrix.

In equation (5.50), it was held that

$$w = Q\delta + r$$

Now, by definition,

$$r = Fu \qquad F = I_m \otimes R^{-1}X' \qquad u = \begin{matrix} u_{\cdot 1} \\ u_{\cdot 2} \\ \vdots \\ u_{\cdot m} \end{matrix} \tag{5.58}$$

and we see that if the system does not contain any lagged endogenous variables, we can argue as follows: We know that

$$E(u) = 0 \qquad \text{Cov}(u) = \Sigma \otimes I_T \tag{5.59}$$

And thus, conditionally on X, we find

$$E(r) = 0 \qquad \text{Cov}(r) = F(\Sigma \otimes I_T)F' = \Sigma \otimes R^{-1}X'XR'^{-1} = \Sigma \otimes I_G \tag{5.60}$$

But equation (5.65) implies that even unconditionally on F the mean vector and covariance matrix of r do not depend on X. Now, if 2SLS estimation of δ is OLS estimation in the context of (5.50) and if the covariance matrix of r is not scalar, then we are encouraged to think that Aitken methods applied to the problem will yield relatively efficient estimators.

The Aitken estimator of δ is given by

$$\bar{\delta} = (Q'\Phi^{-1}Q)^{-1}Q'\Phi^{-1}w \tag{5.61}$$

where

$$\Phi = \Sigma \otimes I_G = \mathrm{Cov}(r) \tag{5.62}$$

Clearly, since Σ will typically be unknown, the estimator in (5.61) is not feasible. If a consistent estimator of the $(m \times m)$ matrix Σ exists, say $\hat{\Sigma}$, then the feasible Aitken estimator is given by

$$\hat{\delta} = (Q'\hat{\Phi}^{-1}Q)^{-1}Q'\Phi^{-1}w \qquad \hat{\Phi} = \hat{\Sigma} \otimes I_G \tag{5.63}$$

and represents the covariance matrix of the 2SLS residuals of the system.

The estimator in (5.63) was termed the three-stage least squares (3SLS) estimator, or perhaps the Aitken structural estimator, whereas the 2SLS should be termed the OLS structural estimator. The term 3SLS has the following intuitive interpretation: In stage one, we purge from the explanatory current endogenous variables their stochastic components; in the second stage we obtain a consistent estimator for Σ; in the third stage we obtain the desired estimator of the structural parameters. Although a rather cumbersome view of the process, it is, for better or worse, the historically initial and established view.

Actually, and despite the terminology, the 3SLS estimator in (5.63) can be computed in one operation, as we do in Chapter 6 using SAS. The reason is that the typical element of the matrix $\hat{\Sigma}$ can be expressed solely in terms of the moment matrices of the data. For example,

$$\hat{\sigma}_{ij} = \frac{1}{T} y'_{\cdot 1} A_{ij} y_{\cdot j} \qquad i, j = 1, 2, \ldots, m \tag{5.64}$$

where A_{ij} is the $T \times T$ matrix

$$A_{ij} = [I - Z(Q'_iQ_i)^{-1}Q'_iR^{-1}X']'[I - Z_j(Q'_jQ_j)^{-1}Q'_jR^{-1}X'] \tag{5.65}$$

Having defined what we wish to mean by the 3SLS estimator, let us take a more detailed view of it. Expanding (5.63), one sees that

$$\hat{\delta} = \begin{bmatrix} \hat{\sigma}^{11}Q_1'Q_1 & \hat{\sigma}^{12}Q_1'Q_2 & \cdot & \hat{\sigma}^{1}Q_1'Q_m \\ \hat{\sigma}^{21}Q_2'Q_1 & \hat{\sigma}^{22}Q_2'Q_2 & \cdot & \hat{\sigma}^{2m}Q_2'Q_m \\ \cdot & \cdot & \cdot & \cdot \\ \hat{\sigma}^{m1}Q_m'Q_1 & \hat{\sigma}^{m2}Q_m'Q_2 & \cdot & \hat{\sigma}^{mm}Q_m'Q_m \end{bmatrix}^{-1} \begin{bmatrix} \Sigma_{j=1}^{m}\hat{\sigma}^{1j}Z_1'X(X'X)^{-1}X'y_{\cdot j} \\ \Sigma_{j=1}^{m}\hat{\sigma}^{2j}Z_2'X(X'X)^{-1}X'y_{\cdot j} \\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot \\ \Sigma_{j=1}^{m}\hat{\sigma}^{mj}Z_m'X(X'X)^{-1}X'y_{\cdot j} \end{bmatrix} \tag{5.66}$$

where,

$$Q_i = R^{-1}X'Z_i \qquad \hat{\Sigma}^{-1} = (\hat{\sigma}^{ij}) \qquad Z_i = Y_i, X_i \qquad i = 1, 2, \ldots, m \tag{5.67}$$

In Chapters 6 and 7, we develop OLS, 2SLS, and 3SLS estimates of dividend, capital expenditures, new debt, and R&D equations.

CHAPTER 6

Interdependencies among Corporate Financial Policies

In this chapter, we develop and empirically verify the hypothesis that firms simultaneously determine their research and development, investment, dividend, and new debt policies. In this chapter we introduce the reader to the concept of effective debt, which holds that many firms use cash and/or marketable securities as a store of financing (liquidity). Firms may issue long-term bonds in excess of current need, reduce short-term indebtedness, and put any surplus into cash and/or marketable securities. The effective debt concept represents the net use of debt financing in a given accounting period. The determinants of research and development, dividend, investment, and effective debt decisions of the U.S. firms in the WRDS database are econometrically estimated during the 1952–2002 period for all firms with assets in 2002 exceeding $200 million.

The purpose of this chapter is to estimate an econometric model to analyze the interdependencies among the decisions concerning research and development, investment, dividends, and effective debt financing. We estimate the simultaneous equations modeling systems introduced in Chapter 5. Financial decisions on dividends, capital expenditures, and research and development activities are made while minimizing reliance on debt funding to generate future profits. Management may issue long-term bonds in excess of current needs and allocate the surplus debt into cash and/or marketable securities if economies of scale exist in the debt decision.

A firm has a pool of resources composed of net income, depreciation, and new debt issues, and this pool is reduced by dividend payments, investment in capital projects, and expenditures for research and development activities. We will develop and estimate our model having verified the imperfect markets hypothesis concerning financial decisions. Financial decisions are interdependent, and simultaneous equations must be used to estimate the equations econometrically.

The goal of this study is to test empirically the independence of financial decisions hypothesis using the Guerard, Bean, and Andrews (1987) framework of effective debt. Guerard and Stone developed and estimated their model using a set of simultaneous equations employing the 303-firm sample during the 1978–1982 period, as described in Guerard and McCabe (1992). We update the Guerard, Bean, and Andrews (1987) study and compare its initial 1987 results with those derived from the U.S. firms in the WRDS database for the 1952–2002 period. We find stronger evidence of the interdependence of financial decisions using the larger U.S. firms in the WRDS database than we reported in Guerard, Bean, and Andrews (1987) using the Guerard and McCabe and Guerard, Bean, and Stone (1990) 303-firm database for the 1978–1982 period. There is stronger evidence that U.S. financial decisions are interdependent.

THE MODEL

The model we developed employs investment, dividends, and new capital financing equations to describe the budget constraint facing the manager of a manufacturing firm. The manager may use available funds to undertake capitalized research and development activities (RDS) or new investment (IS), or to pay dividends (DS) or increase net working capital (CAK). The sources of funds are represented by net income (PK), depreciation (DEP), and new debt issues (FS):

$$RDS + IS + CAK = PK + DEP - DS + FS + NEQ \tag{6.1}$$

where CAK = increase in net current assets
NEQ = net new equity issues
Intercept = regression intercept
DE = debt-to-equity ratio
INTE = average cost of interest expense
DEPK = depreciation/capital stock
RDL = last year's R&D expenses/sales
Size = 1/total assets
PKL = last year's profits/capital stock

DIVL = last year's dividends/sales
CAK = increase in net working capital/sales
PK = profits/capital stock
D2sales = two-year change in sales
IK = investment/capital stock
DS = dividends/sales
IS = capital investments/sales
FS = external funds issued/sales
RDS = R&D/sales

The F-statistic shown in Tables 6.1 through 6.21 is an overall statistic regarding the goodness of fit of the regression. The Adj R2 denotes the percentage of variance in the dependent variable and is associated with the variances in the independent variables.

In the world of business during the past 30 years, net debt issues have accounted for about 80 percent to 90 percent of new capital issues. Here we present the estimation of a simultaneous equations system of the largest capitalized firms during the 1952–2002 period using the WRDS database.

The following is a summary of the hypothesized equation system:

$$DS = F(IS, RDS, CAK, FS, LDIV, PK) \qquad (6.2)$$

$$IS = F(DS, RDS, FS, CAK, PKL, D2sales) \qquad (6.3)$$

$$FS = F(IS, RDS, DS, PK, DEP, INTE, DE) \qquad (6.4)$$

$$RDS = F(LRDS, IS, DS, FS, PK) \qquad (6.5)$$

TABLE 6.1 Dividend Equation OLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.029	3.43	0.027	3.34	0.031	3.37	0.036	4.18
PK	0.018	1.72	0.025	2.4	0.045	3.3	0.042	3.08
CAK	–0.015	–1.38	–0.017	–1.53	–0.021	–1.58	–0.026	–2.11
IK	–0.043	–1.5	–0.085	–2.98	–0.068	–2.26	–0.059	–3.04
FS	0.223	3.98	0.335	4.95	0.117	2.91	0.069	1.46
F-Statistic	6.19		9.56		6.96		5.6	
Adj R2	0.12		0.18		0.13		0.1	

	1956		1957		1958		1959	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.032	4.35	0.039	5.55	0.037	4.46	0.039	5.09
PK	0.056	4.23	0.075	4.99	0.046	2.56	0.07	4.09
CAK	–0.031	–2.91	–0.041	–3.99	–0.026	–2.15	–0.039	–3.3
IK	–0.088	–4.34	–0.105	–4.94	–0.074	–2.48	–0.107	–3.99
FS	0.18	4.18	0.075	2.18	0.063	2.03	0.021	0.44
F-Statistic	15.43		12.22		4.08		7.16	
Adj R2	0.25		0.2		0.06		0.12	

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.036	5.76	0.035	6.81	0.051	6.26	0.003	1.16
PK	0.081	5.58	0.053	4.3	0.032	1.59	0.077	4.55
CAK	–0.036	–3.55	–0.027	–3.16	–0.047	–3.34	–0.007	–0.78
IK	–0.083	–3.76	–0.077	–3.38	–0.065	–2.29	–0.069	–3.32
FS	0.011	0.46	–0.001	–0.05	–0.037	–1.3	0.467	9.57
F-Statistic	10.35		6.15		3.72		41.85	
Adj R2	0.16		0.08		0.04		0.37	

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.003	1.56	0.014	3.1	0.029	6.58	0.035	7.46
PK	0.062	4.31	0.063	4.73	0.063	5.63	0.072	5.77
CAK	–0.004	–0.56	–0.021	–2.61	–0.04	–5.28	–0.05	–7.13
IK	–0.023	–1.57	–0.027	–2	–0.079	–4.62	–0.116	–6.06
FS	0.309	9.73	0.191	10.55	0.192	10.54	0.17	9.33
F-Statistic	46.16		36.75		44.88		43.5	
Adj R2	0.37		0.4		0.36		0.33	

TABLE 6.1 *(Continued)*

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.027	5.69	0.032	7.22	0.02	6.47	0.025	5.02
PK	0.073	6.71	0.067	6.17	0.059	7.96	0.034	2.27
CAK	–0.045	–6.46	–0.046	–6.65	–0.024	–5.02	–0.015	–3.25
IK	–0.09	–5.62	–0.114	–6.88	–0.027	–2.34	–0.055	–1.99
FS	0.12	7.19	0.116	8.56	–0.028	–2.27	–0.02	–1.35
F-Statistic	33.44		38.44		18.39		4.99	
Adj R2	0.25		0.27		0.14		0.03	

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.032	6.55	0.021	5.47	0.022	7.63	0.021	6.87
PK	0.084	5.62	0.084	7.31	0.039	5.88	0.049	6.34
CAK	–0.048	–6.35	–0.035	–6.3	–0.026	–5.84	–0.025	–5.42
IK	–0.136	–7.5	–0.12	–7.82	–0.067	–6.43	–0.078	–5.46
FS	0.083	9.35	0.084	14.26	0.074	10.51	0.058	5
F-Statistic	37.45		67.94		40.06		16.78	
Adj R2	0.23		0.35		0.23		0.1	

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.027	11.9	0.017	7	0.018	6.74	0.013	5.5
PK	0	0.38	0.024	4.3	0.039	6	0.015	2.94
CAK	–0.017	–4.79	–0.01	–3.57	–0.019	–5.16	–0.004	–1.81
IK	–0.049	–5.65	–0.031	–3.29	–0.041	–4.92	–0.002	–0.21
FS	0.035	4.74	–0.033	–3.96	0.01	3.35	–0.006	–0.99
F-Statistic	11.75		13.59		14.47		4.05	
Adj R2	0.07		0.08		0.08		0.02	

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.019	7.37	0.024	6.01	0.019	10.67	0.018	13.25
PK	0.036	5.85	0.019	2.03	0.029	6.01	0.002	1.22
CAK	–0.019	–5.05	–0.019	–3.4	–0.014	–5.17	–0.003	–1.44
IK	–0.049	–5.6	–0.035	–3.66	–0.033	–4.45	–0.014	–2.52
FS	0.053	5.14	0.007	0.67	0.001	0.11	0.002	0.86
F-Statistic	17.74		4.76		12.2		3.05	
Adj R2	0.1		0.02		0.06		0.01	

(Continued)

TABLE 6.1 *(Continued)*

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.013	4.68	0.014	14.08	0.012	9.82	0.01	1.37
PK	0.006	0.97	0.007	3.36	0.017	3.66	0.03	1.49
CAK	0	0.02	–0.004	–3.06	–0.002	–1.85	0.003	0.48
IK	–0.001	–0.1	–0.005	–1.15	–0.003	–0.75	–0.025	–1.35
FS	0.002	0.23	0.002	0.6	–0.009	–2.61	0.132	10.05
F-Statistic	0.71		4.86		5.28		25.71	
Adj R2	0		0.02		0.02		0.1	

	1988		1989		1990		1991	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.012	5.82	0.012	4.56	0.012	4.33	0.014	9.98
PK	0.064	6.65	0.036	5.87	0.033	4.92	0.026	5.77
CAK	–0.02	–6.17	–0.011	–2.83	–0.001	–0.43	–0.004	–5.24
IK	–0.038	–2.9	–0.005	–0.49	–0.029	–2.48	–0.029	–4.08
FS	0.038	4.95	–0.014	–1.71	0.03	3.76	0.015	2.69
F-Statistic	15.46		10.38		9.9		10.29	
Adj R2	0.06		0.04		0.03		0.03	

	1992		1993		1994		1995	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.017	10.91	0.019	9.4	0.02	8.44	0.014	6.03
PK	0.025	6.71	0.015	3.69	0.02	3.99	0.03	8.74
CAK	0.001	0.57	–0.011	–2.9	–0.017	–4.85	–0.022	–5.77
IK	–0.065	–6.24	–0.034	–4.12	–0.045	–4.71	–0.007	–0.89
FS	0.006	1.38	0.004	1.29	0	–0.45	0	–0.28
F-Statistic	11.98		5.89		11.66		27.39	
Adj R2	0.04		0.02		0.03		0.07	

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.019	8.94	0.025	11.83	0.026	6.34	0.015	12.34
PK	0.015	4.07	–0.017	–10.82	0.001	0.13	0.005	3.31
CAK	–0.013	–4.9	–0.015	–4.63	–0.019	–3.19	–0.006	–3.71
IK	–0.028	–3.58	–0.028	–5.68	–0.054	–2.94	–0.027	–3.53
FS	–0.005	–1.72	0.002	1.1	0.009	3.43	0	–0.16
F-Statistic	13.17		36.6		6.41		4.65	
Adj R2	0.03		0.08		0.01		0.01	

TABLE 6.1 *(Continued)*

	2000		2001		2002	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.012	9.76	0.01	11.59	0.01	10.17
PK	0.006	2.32	0.007	5.59	0.007	2.55
CAK	–0.005	–2.83	–0.004	–5.06	–0.002	–1.76
IK	–0.015	–2.74	–0.005	–1.08	–0.014	–1.72
FS	0.003	1.63	0.002	0.87	0.001	0.9
F-Statistic	4.82		9.38		2.73	
Adj R2	0.01		0.02		0	

TABLE 6.2 Investment Equation OLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.141	10.28	0.126	9.36	0.166	11.56	0.162	10.47
PKL	–0.01	–0.4	–0.019	–0.86	–0.03	–1.2	–0.021	–0.72
CAK	–0.205	–10.32	–0.19	–9.84	–0.23	–10.63	–0.221	–9.61
D2sales	0	–99	0.028	1.54	0.068	2.86	0.078	3.14
DS	0.351	2.03	0.249	1.48	0.316	1.93	–0.039	–0.25
FS	0.432	3.53	0.677	4.39	0.062	0.74	0.226	2.13
F-Statistic	43.27		39.53		33.79		29.6	
Adj R2	0.52		0.55		0.51		0.46	
	1956		**1957**		**1958**		**1959**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.188	7.52	0.189	11.6	0.139	10.69	0.16	10.3
PKL	–0.035	–0.68	–0.076	–1.85	–0.028	–0.8	0.001	0.02
CAK	–0.257	–6.85	–0.229	–9.29	–0.189	–9.52	–0.248	–10.44
D2sales	0.043	0.85	–0.027	–0.7	0.063	2.88	0.063	2.11
DS	–0.257	–0.8	0.056	0.24	0.528	2.95	0.275	1.45
FS	0.527	2.52	0.534	4.95	0.019	0.3	0.206	1.64
F-Statistic	14.52		27.26		24.94		29.39	
Adj R2	0.28		0.42		0.39		0.43	

(Continued)

TABLE 6.2 *(Continued)*

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.196	12.37	0.161	10.88	0.242	7.32	0.067	2.94
PKL	–0.053	–1.1	–0.016	–0.38	–0.037	–0.44	–0.166	–2.28
CAK	–0.289	–11.24	–0.232	–9.09	–0.32	–5.66	–0.067	–1.5
D2sales	0.063	1.77	0.027	0.63	–0.073	–0.85	0.047	0.5
DS	0.238	1.14	0.274	1.19	0.059	0.21	–0.31	–0.8
FS	0.346	4.99	0.248	3.12	0.009	0.07	2.038	5.65
F-Statistic	35.08		21.39		7.68		9.38	
Adj R2	0.47		0.3		0.12		0.13	

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.05	2.81	0.2	5.28	0.198	16.35	0.183	17.52
PKL	0.047	0.46	–0.077	–0.7	–0.027	–0.88	0.012	0.47
CAK	–0.119	–2.35	–0.262	–3.97	–0.257	–12.37	–0.241	–13.48
D2sales	–0.08	–0.71	0.019	0.19	0.007	0.2	0.002	0.1
DS	0.177	0.38	–0.35	–0.57	–0.051	–0.28	–0.259	–1.8
FS	1.596	4.97	0.731	3.37	0.121	1.56	0.113	1.92
F-Statistic	10.3		8.35		33.71		39	
Adj R2	0.13		0.14		0.34		0.35	

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.172	12.6	0.202	13.92	0.254	10.33	0.064	6.63
PKL	0.011	0.28	–0.09	–2.1	–0.176	–2.24	–0.077	–2.21
CAK	–0.255	–11.12	–0.257	–10.01	–0.31	–6.95	0.004	0.42
D2sales	0.006	0.2	0.042	1.31	0.004	0.07	–0.033	–1.42
DS	–0.112	–0.63	–0.041	–0.2	1.526	3.14	0.573	5.04
FS	0.334	5.1	0.139	2.16	–0.607	–4.71	1.23	41.59
F-Statistic	38.54		27.36		24.99		373.54	
Adj R2	0.33		0.24		0.22		0.8	

TABLE 6.2 *(Continued)*

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.186	13.63	0.153	13.6	0.158	12.64	0.144	15.86
PKL	0.006	0.12	0.05	1.36	0.029	0.79	0.085	3.27
CAK	–0.256	–10.94	–0.212	–11.88	–0.232	–12.6	–0.205	–13.66
D2sales	0.069	3.07	0.048	2.11	0.062	2.49	–0.058	–3.34
DS	–0.764	–4.83	–0.656	–4.32	–0.344	–1.75	–0.012	–0.07
FS	0.231	6.66	0.106	4.4	0.096	2.75	0.563	12.71
F-Statistic	39.62		34.68		38.86		73.1	
Adj R2	0.29		0.25		0.27		0.39	

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.103	8.76	0.128	12.26	0.178	13.03	0.119	9.88
PKL	0.064	1.52	0.005	1.44	0.046	1.24	–0.059	–1.62
CAK	–0.047	–5	–0.11	–7.85	–0.247	–11.74	–0.093	–7.32
D2sales	–0.129	–4.66	–0.104	–4.5	–0.009	–0.33	–0.065	–4.98
DS	–0.609	–2.09	0.937	3.88	0.178	0.65	1.653	7.05
FS	0.75	15.13	0.659	13.46	0.141	7.27	0.797	25.11
F-Statistic	57.82		54.95		37.17		157.41	
Adj R2	0.33		0.32		0.24		0.57	

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.159	12.09	0.203	12.58	0.118	10.09	0.103	10.76
PKL	–0.042	–1.15	–0.157	–3.34	–0.061	–1.46	–0.022	–0.69
CAK	–0.187	–8.53	–0.209	–8.46	–0.083	–5.16	–0.025	–3.79
D2sales	0.013	0.59	0.029	1.03	0.052	2.49	–0.088	–9.02
DS	0.128	0.5	0	0	0.377	1.35	0.027	0.1
FS	0.935	14.44	0.974	19.23	0.684	14.54	0.265	10.84
F-Statistic	70.31		117.78		55.63		27.24	
Adj R2	0.36		0.48		0.3		0.16	

(Continued)

TABLE 6.2 *(Continued)*

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.098	14.89	0.131	14.93	0.082	10.41	0.095	16.67
PKL	0.005	1.31	0.084	4.3	0.033	1.84	–0.03	–2.04
CAK	–0.015	–2.23	–0.119	–11.41	–0.006	–1.35	–0.003	–1.36
D2sales	–0.038	–2.33	–0.061	–2.81	–0.003	–0.16	0.016	1.35
DS	–0.094	–0.63	–0.669	–2.11	0.235	1.11	–0.005	–0.13
FS	0.285	7.54	0.539	16.57	0.254	12.15	0.06	3.37
F-Statistic	13.46		61.06		30.72		4.18	
Adj R2	0.08		0.29		0.16		0.02	

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.098	13.76	0.118	14.16	0.11	11.25	0.115	9.24
PKL	–0.009	–0.96	–0.009	–2.19	–0.027	–0.92	–0.061	–1.63
CAK	0	–0.1	–0.09	–5.68	–0.038	–3.62	0	–0.09
D2sales	–0.02	–1.24	–0.027	–2.21	0.014	0.98	–0.093	–3.32
DS	0.028	0.24	0.337	2.49	–0.038	–0.26	0.032	0.1
FS	0.23	7.94	0.396	11.75	0.138	3.9	0.545	9.63
F-Statistic	13.04		36.14		6.52		20.01	
Adj R2	0.06		0.16		0.03		0.08	

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.095	13.62	0.169	12.58	0.126	16.35	0.158	14.97
PKL	–0.003	–0.2	–0.012	–1.45	–0.021	–1.99	–0.057	–2.14
CAK	–0.022	–3.52	–0.122	–4.61	–0.121	–8.18	–0.15	–8.36
D2sales	0.026	1.13	–0.157	–4.48	0.054	3.05	0.002	0.17
DS	–0.006	–0.06	–0.472	–2.29	–0.03	–0.25	–0.094	–0.69
FS	0.413	23.35	0.771	39.16	0.056	41.98	0.075	17.16
F-Statistic	113.13		315.34		372.19		76.58	
Adj R2	0.33		0.56		0.58		0.21	

TABLE 6.2 *(Continued)*

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.14	7.67	0.043	3.07	0.145	15.64	0.13	14.52
PKL	–0.08	–2.33	0.017	0.44	–0.01	–1.32	–0.046	–2.36
CAK	–0.077	–2.79	0.001	0.14	–0.096	–5.71	–0.003	–0.65
D2sales	0.019	0.53	–0.056	–2.07	–0.063	–3.27	–0.14	–8.26
DS	–0.033	–0.12	–0.797	–3.64	–0.094	–1.25	–0.326	–1.65
FS	0.38	11.83	1.139	68.36	0.11	12.91	0.227	20.69
F-Statistic	32.84		941.18		44.15		98.16	
Adj R2	0.09		0.74		0.11		0.21	

	2000		2001		2002	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.094	14.29	0.075	15.2	0.074	19.21
PKL	–0.015	–3.22	0.003	0.26	–0.002	–0.39
CAK	–0.03	–3.07	–0.005	–1.61	–0.012	–2.93
D2sales	0.037	2.71	0.044	4.34	0.001	0.22
DS	–0.133	–0.9	–0.018	–0.14	0.105	1.01
FS	0.165	12.76	0.201	12.48	0.019	3.44
F-Statistic	38.46		39.47		4.29	
Adj R2	0.09		0.09		0.01	

TABLE 6.3 Financing Equation OLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.012	1.74	0.013	2.57	0.016	1.46	0.007	0.69
DE	0	1.28	0	–1.22	0.004	1.78	0	–0.18
INTE	0.031	0.56	–0.013	–0.34	–0.018	–0.2	0.092	0.81
DEPK	–0.096	–1.19	–0.073	–1.22	–0.172	–1.29	–0.066	–0.6
PK	0.014	0.93	0.01	0.87	0.02	0.69	0.055	2.31
DS	0.314	2.75	0.259	2.89	0.409	2.41	0.187	1.43
IS	0.209	4.81	0.205	5.99	0.264	3.86	0.236	4.74
F-Statistic	8.03		13.91		5.93		5.67	
Adj R2	0.21		0.33		0.16		0.14	

(Continued)

TABLE 6.3 *(Continued)*

	1956		1957		1958		1959	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.001	–0.11	–0.012	–1	0.027	1.82	0.016	1.77
DE	0.001	2.24	0.001	1.52	–0.001	–1.1	0	0.98
INTE	0.028	0.36	0.032	0.46	0.097	1.22	0.08	2.42
DEPK	0.071	0.88	–0.012	–0.11	–0.04	–0.27	–0.113	–1.1
PK	0.054	2.31	0.106	3.15	–0.042	–0.92	0.077	2.88
DS	0.521	4.26	0.157	1	0.435	2.19	–0.007	–0.06
IS	0.113	4.31	0.226	5.03	0.122	1.58	0.183	4.48
F-Statistic	9.54		6.41		1.99		5.68	
Adj R2	0.23		0.15		0.03		0.13	

	1960		1961		1962		1963	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.004	–0.29	0.011	0.82	0.014	0.86	0.001	0.37
DE	0	0.12	0	0.71	–0.001	–0.56	0	0.83
INTE	–0.004	–0.2	–0.003	–0.08	0.026	2.82	0.058	2.32
DEPK	–0.363	–1.98	–0.191	–1.19	0.067	0.35	0.17	2.5
PK	0.179	4.06	0.082	2.39	0.081	1.9	–0.002	–0.13
DS	–0.266	–1.22	–0.209	–1.09	–0.185	–1.34	0.527	9.26
IS	0.292	4.92	0.183	3.6	–0.012	–0.41	0.047	4.97
F-Statistic	5.88		2.85		2.91		34.18	
Adj R2	0.13		0.04		0.04		0.42	

	1964		1965		1966		1967	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.001	–0.18	0.007	0.57	–0.003	–0.32	0.003	0.29
DE	0	0.25	0	–0.68	–0.001	–2.58	0	1.22
INTE	–0.069	–1.7	–0.024	–1.4	0.046	1.42	0.025	0.66
DEPK	0.29	3.11	–0.061	–0.34	0.013	0.09	0.046	0.33
PK	0	0.02	–0.046	–1.13	–0.016	–0.56	0.024	0.72
DS	0.771	9.66	1.709	10.26	1.333	10.49	1.087	8.8
IS	0.052	4.98	0.08	3.75	0.038	0.86	0.065	1.39
F-Statistic	34.7		23.91		22.39		15.44	
Adj R2	0.4		0.39		0.29		0.2	

TABLE 6.3 *(Continued)*

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.042	3.81	0.031	2.41	0.019	2.15	–0.019	–2.41
DE	0	–0.51	0	0.23	0	2.26	0	–0.86
INTE	–0.001	–0.03	–0.002	–0.13	–0.001	–0.12	0	–0.01
DEPK	–0.145	–1.12	–0.124	–0.78	–0.073	–0.8	–0.062	–1.09
PK	–0.045	–1.4	–0.02	–0.54	0.129	4.76	–0.001	–0.02
DS	0.812	6.08	1.143	7.8	–0.255	–1.45	–0.447	–5.41
IS	0.199	5.37	0.091	2.47	–0.083	–5.17	0.654	42.29
F-Statistic	15.57		12.44		11.6		308.98	
Adj R2	0.19		0.14		0.13		0.8	

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.048	2.6	0.05	2.58	0.03	2.35	0.02	2.74
DE	–0.005	–2.86	–0.001	–0.9	0	0.36	0.001	1.74
INTE	–0.184	–4.56	–0.132	–8.51	–0.015	–2.85	–0.001	–0.27
DEPK	–0.456	–2.66	–0.582	–3.54	–0.626	–4.32	–0.911	–11.18
PK	–0.168	–2.69	–0.234	–3.54	–0.059	–1.56	0.05	2.18
DS	1.951	10.14	4.128	16.34	2.129	9.23	0.056	0.43
IS	0.338	6.95	0.309	4.54	0.204	4.16	0.402	14.89
F-Statistic	30.57		53.64		22.43		49.5	
Adj R2	0.27		0.39		0.2		0.34	

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.009	1.02	0.001	0.18	–0.056	–1.8	0.026	2.37
DE	0	0.56	0	0.99	0	0.81	0	0.14
INTE	–0.011	–1.36	0	0.54	–0.004	–0.75	0.003	0.52
DEPK	–0.498	–5.45	–0.284	–3.27	–0.59	–1.68	–0.592	–6.3
PK	–0.031	–4.75	0.054	2.02	0.185	1.92	–0.01	–0.38
DS	0.68	3.34	–1.277	–6.8	0.645	1.1	–1.428	–6.7
IS	0.394	16.04	0.382	13.54	0.49	5.83	0.647	25.28
F-Statistic	46.68		36.89		6.95		108.07	
Adj R2	0.32		0.27		0.06		0.52	

(Continued)

TABLE 6.3 *(Continued)*

	1980		1981		1982		1983	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.01	1.37	–0.01	–0.96	0.007	0.79	–0.022	–0.96
DE	0	–0.56	0	1.2	0	2.46	0	0.08
INTE	–0.001	–0.51	–0.001	–0.39	–0.002	–2.03	–0.034	–1.17
DEPK	–0.217	–2.54	–0.377	–3.38	–0.233	–3.03	–0.312	–1.64
PK	–0.029	–1.32	0.057	1.82	–0.002	–0.09	0.017	1.06
DS	0.313	2.24	–0.083	–0.67	–0.302	–1.54	0.231	0.33
IS	0.28	15.09	0.401	20.85	0.372	15.44	0.514	5.77
F-Statistic	43.51		76.48		41.42		6.24	
Adj R2	0.3		0.42		0.27		0.04	

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.046	4.64	–0.027	–2.71	–0.018	–1.3	0.006	0.39
DE	0.001	1.23	0	–1.87	–0.001	–0.98	0	–0.59
INTE	–0.011	–1.3	–0.027	–3.64	0.006	1.8	–0.006	–0.5
DEPK	–0.152	–4.94	–0.293	–6.08	–0.018	–0.35	0.007	0.54
PK	–0.141	–5.72	0.139	8.16	0.048	1.2	–0.058	–1.09
DS	0.089	0.63	–0.171	–0.56	–0.934	–2.75	0.784	9.95
IS	0.25	7.38	0.471	14.89	0.637	12.28	0.229	3.5
F-Statistic	15.48		71.09		26.88		19.9	
Adj R2	0.11		0.36		0.16		0.12	

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.022	–2.88	0.006	0.59	0.01	1.22	–0.007	–0.88
DE	0	–0.34	0	–0.1	–0.001	–2.34	0	–0.74
INTE	–0.013	–2.12	–0.004	–2.77	–0.001	–0.68	0	–0.37
DEPK	0.938	9.46	–0.13	–2.48	–0.156	–1.74	–0.006	–0.64
PK	–0.199	–9.42	–0.013	–0.53	–0.001	–0.02	–0.014	–0.7
DS	0.634	4.94	–0.324	–2.6	0.415	3.24	0.274	1.61
IS	0.217	6.1	0.319	11.7	0.12	4.2	0.142	9.08
F-Statistic	30.05		25.49		6.6		14.62	
Adj R2	0.16		0.13		0.03		0.07	

TABLE 6.3 *(Continued)*

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.059	–6.53	–0.056	–5.31	–0.729	–6.68	–0.032	–0.59
DE	0	–0.07	0	0.8	–0.002	–0.36	0	–0.11
INTE	0	–0.01	0	0.16	0.001	0.19	0	0.06
DEPK	–0.181	–1.75	–0.371	–2.96	–4.038	–4.54	–0.89	–2.26
PK	0.054	1.49	0.083	2.38	0.793	2.46	–0.218	–2.1
DS	–0.003	–0.02	0.227	1.13	–1.519	–0.92	–0.17	–0.22
IS	0.811	23.39	0.715	38.55	10.144	41.66	2.241	17.11
F-Statistic	91.92		249.04		290.45		50.71	
Adj R2	0.32		0.55		0.57		0.17	

	1996		1997		1998		1999	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.053	3.85	–0.003	–0.41	0.073	2.88	0.016	0.92
DE	0	–0.45	0	–1.1	0.001	2.54	0	0.01
INTE	0	–0.09	0	–0.59	0	–0.15	0	–0.1
DEPK	–0.216	–1.63	0	0	–0.454	–1.92	–0.145	–2.59
PK	–0.062	–1.98	0.002	0.22	–0.125	–2.29	–0.072	–2.66
DS	–0.358	–1.71	0.623	3.71	0.623	3.09	–0.004	–0.01
IS	0.219	12.09	0.648	68.44	0.79	12.8	0.797	19.86
F-Statistic	27.26		783.54		34.17		68.05	
Adj R2	0.09		0.74		0.1		0.18	

	2000		2001		2002	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.028	2.33	0.011	1.59	–0.001	–0.07
DE	0	0.32	0	–0.86	0	0.1
INTE	0	–0.67	–0.001	–1.58	–0.001	–0.39
DEPK	–0.132	–2.36	–0.049	–3.18	–0.093	–1.04
PK	–0.078	–2.98	–0.032	–2.89	0.009	0.16
DS	0.464	1.89	0.185	1.05	0.269	0.65
IS	0.467	12.6	0.386	13.18	0.301	3.4
F-Statistic	30.07		31.41		2.26	
Adj R2	0.08		0.09		0	

TABLE 6.4 Dividend Equation 2SLS

	1952		1953		1954		1955	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.037	–1.29	0.009	0.64	–0.001	–0.05	0.037	3.35
PK	0.01	0.5	0.024	2.05	0.031	1.72	0.043	2.9
CAK	0.041	1.39	0	0	0.018	0.7	–0.027	–1.89
IK	–0.013	–0.24	–0.092	–2.91	–0.03	–0.73	–0.059	–3.02
FS	1.306	3.18	0.703	3.37	0.418	2.48	0.057	0.46
F-Statistic	3.16		5.74		5.08		5.12	
Adj R2	0.05		0.11		0.09		0.09	

	1956		1957		1958		1959	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.026	2.7	0.041	5.37	–0.017	–0.67	0.052	5.21
PK	0.046	2.75	0.087	4.9	0.046	1.46	0.095	4.41
CAK	–0.023	–1.84	–0.042	–3.79	0.023	0.81	–0.049	–3.53
IK	–0.087	–4.19	–0.088	–3.54	–0.007	–0.11	–0.084	–2.64
FS	0.305	2.37	–0.086	–0.77	0.676	2.76	–0.332	–2.39
F-Statistic	11.94		9.95		2.86		6.86	
Adj R2	0.2		0.17		0.04		0.11	

	1960		1961		1962		1963	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.041	5.17	0.035	5.61	0.05	5.61	0.006	1.72
PK	0.066	3.15	0.043	2.73	0.042	1.85	0.107	4.03
CAK	–0.041	–3.46	–0.028	–2.69	–0.041	–2.64	–0.002	–0.16
IK	–0.109	–3.23	–0.114	–3.74	–0.044	–1.28	0.023	0.45
FS	0.144	1.16	0.238	2.78	–0.194	–1.52	–0.246	–0.73
F-Statistic	9.13		6.07		3.51		10.69	
Adj R2	0.14		0.08		0.04		0.12	

	1964		1965		1966		1967	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.004	1.8	0.017	3.14	0.034	6.74	0.036	6.97
PK	0.075	4.39	0.065	4.76	0.07	5.79	0.075	5.58
CAK	–0.008	–0.98	–0.024	–2.75	–0.046	–5.57	–0.051	–7.01
IK	–0.009	–0.55	–0.025	–1.8	–0.084	–4.62	–0.116	–6.02
FS	0.206	2.66	0.148	3.07	0.088	1.94	0.14	2.42
F-Statistic	23.48		11.04		16.41		23.03	
Adj R2	0.23		0.15		0.16		0.2	

TABLE 6.4 *(Continued)*

	1968		1969		1970		1971	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.024	3.86	0.034	6.76	0.02	6.42	0.028	5.26
PK	0.074	6.72	0.068	6.15	0.06	6.14	0.049	2.85
CAK	–0.043	–5.68	–0.047	–6.64	–0.024	–4.86	–0.017	–3.39
IK	–0.091	–5.63	–0.113	–6.77	–0.027	–2.34	–0.135	–2.76
FS	0.158	3.28	0.076	1.81	–0.038	–0.75	0.056	1.39
F-Statistic	22.93		20.51		17.23		4.76	
Adj R2	0.19		0.16		0.13		0.03	

	1972		1973		1974		1975	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.033	6.13	0.02	4.72	0.022	7.61	0.023	7.23
PK	0.079	4.76	0.085	6.34	0.039	5.68	0.055	6.7
CAK	–0.049	–6.32	–0.034	–6.24	–0.026	–5.84	–0.029	–5.9
IK	–0.132	–6.75	–0.121	–7.45	–0.067	–5.73	–0.105	–6.07
FS	0.06	1.64	0.088	3.23	0.07	3.17	0.124	4.91
F-Statistic	16.06		19.67		14.95		15.98	
Adj R2	0.11		0.13		0.1		0.1	

	1976		1977		1978		1979	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.025	9.4	0.017	7	0.008	1.75	0.013	5.5
PK	0.001	0.8	0.027	4.38	0.033	3.8	0.015	2.77
CAK	–0.015	–4.01	–0.011	–3.66	–0.004	–0.59	–0.004	–1.82
IK	–0.038	–3.26	–0.039	–3.29	0.001	0.03	0	–0.02
FS	0.005	0.24	–0.007	–0.27	–0.05	–2.31	–0.01	–0.45
F-Statistic	5.98		9.51		8.17		3.85	
Adj R2	0.03		0.06		0.05		0.02	

	1980		1981		1982		1983	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.019	7.05	0.021	4.6	0.018	9.29	0.017	13.21
PK	0.043	5.63	0.028	2.52	0.032	5.65	0.002	1.19
CAK	–0.019	–4.99	–0.015	–2.46	–0.014	–4.53	–0.003	–1.41
IK	–0.066	–4.63	–0.054	–3.75	–0.052	–4.86	–0.014	–2.45
FS	0.118	2.74	0.101	1.97	0.096	2.86	0	–0.13
F-Statistic	12.32		5.05		11.36		2.87	
Adj R2	0.07		0.03		0.06		0.01	

(Continued)

TABLE 6.4 *(Continued)*

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.023	5.39	0.013	11.97	0.013	9.65	0.017	1.97
PK	–0.011	–1.26	0.011	4.43	0.017	3.64	0.017	0.77
CAK	–0.009	–2.06	–0.002	–1.4	–0.004	–2.42	0	0.02
IK	0.004	0.64	–0.003	–0.76	0	–0.06	–0.024	–1.23
FS	–0.123	–3.2	–0.026	–3.02	–0.029	–2.54	0.007	0.1
F-Statistic	3.12		6.72		5.02		0.42	
Adj R2	0.01		0.03		0.02		0	

	1988		1989		1990		1991	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.014	6.17	0.012	4.36	0.012	4.02	0.014	8.02
PK	0.054	5.11	0.035	5.7	0.035	4.78	0.023	3.7
CAK	–0.018	–5.03	–0.01	–2.72	–0.001	–0.38	–0.003	–1.84
IK	–0.024	–1.65	0.001	0.08	–0.033	–2.51	–0.022	–1.32
FS	–0.034	–1.65	–0.041	–1.22	0.06	1.37	–0.009	–0.18
F-Statistic	9.19		9.9		6.74		8.35	
Adj R2	0.03		0.04		0.02		0.03	

	1992		1993		1994		1995	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.017	9.92	0.019	9.07	0.002	0.1	0.015	3.72
PK	0.031	6.99	0.02	3.1	0.046	1.52	0.03	5.45
CAK	0	–0.07	–0.011	–2.89	–0.001	–0.03	–0.022	–5.18
IK	–0.079	–6.56	–0.044	–3.26	–0.027	–0.75	–0.008	–0.84
FS	0.065	3.36	0.026	1.09	0.034	1.02	–0.002	–0.13
F-Statistic	12.82		5.5		1.32		27.31	
Adj R2	0.04		0.01		0		0.07	

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.021	8.83	0.027	11.62	0.016	2.62	0.016	10.43
PK	0.01	2.24	–0.018	–10.85	0.023	2.16	0.003	1.43
CAK	–0.015	–5.11	–0.016	–4.86	–0.016	–2.24	–0.004	–1.79
IK	–0.021	–2.41	–0.03	–5.81	–0.09	–3.57	–0.02	–2.2
FS	–0.046	–3.1	–0.014	–1.99	0.086	3.33	–0.028	–1.82
F-Statistic	13.39		35.77		5.15		4.53	
Adj R2	0.03		0.08		0.01		0.01	

TABLE 6.4 *(Continued)*

	2000		2001		2002	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.013	5.15	0.011	11.19	0.01	4.81
PK	0.004	1.08	0.007	5.12	0.012	1.81
CAK	–0.005	–2.83	–0.004	–4.57	–0.003	–1.42
IK	–0.015	–2.73	–0.003	–0.64	–0.034	–1.52
FS	–0.011	–0.38	–0.032	–2.32	0.09	1.25
F-Statistic	4.08		9.85		1.08	
Adj R2	0.01		0.02		0	

TABLE 6.5 Investment Equation 2SLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.189	3.8	0.056	1.29	0.278	5.35	0.49	2.18
PKL	0.028	0.8	–0.005	–0.12	–0.027	–0.47	0.179	1.04
CAK	–0.252	–4.52	–0.087	–1.64	–0.38	–4.9	–0.513	–2.25
D2sales	0	–99	–0.043	–1.1	0.133	2.11	0.576	1.46
DS	0.154	0.18	–1.586	–2.25	1.224	1.02	–0.876	–0.52
FS	–0.446	–0.34	3.208	3.36	–1.646	–1.91	–5.495	–1.27
F-Statistic	26.8		13.62		9.75		2.01	
Adj R2	0.4		0.29		0.22		0.03	
	1956		**1957**		**1958**		**1959**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.446	2.67	0.159	2.81	0.202	6.7	0.178	4.65
PKL	0.292	1.24	–0.212	–1.09	0.014	0.18	0.084	1.25
CAK	–0.597	–2.44	–0.136	–1.68	–0.245	–6.93	–0.247	–5.87
D2sales	0.559	1.4	–0.355	–2.31	0.023	0.49	–0.082	–0.92
DS	1.471	0.49	–1.046	–0.86	0.153	0.19	–1.498	–2.79
FS	–7.123	–1.36	3.379	2.26	–0.817	–1.59	0.873	1.01
F-Statistic	2.02		6.21		12.16		19.7	
Adj R2	0.03		0.13		0.23		0.33	

(Continued)

TABLE 6.5 *(Continued)*

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.289	4.18	0.203	2.1	0.273	3.51	0.031	0.59
PKL	–0.178	–0.68	–0.243	–0.72	–0.173	–1.11	–0.226	–1.37
CAK	–0.296	–3.02	–0.18	–1.32	–0.371	–3.92	–0.09	–0.73
D2sales	–0.37	–1.86	–0.775	–1.98	–0.305	–2.01	–0.831	–3.19
DS	–2.701	–1.47	–3.422	–1.18	–0.801	–0.56	–6.632	–2.4
FS	3.571	2.7	5.729	2.3	2.15	2.21	13.85	6.15
F-Statistic	4.04		2.03		5.11		8.29	
Adj R2	0.07		0.02		0.08		0.12	

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.037	–0.58	0.114	0.83	0.257	8.45	0.233	11.06
PKL	–1.753	–3.24	0.12	0.38	–0.075	–1.01	0.052	0.82
CAK	0.398	1.86	0.073	0.33	–0.244	–4.97	–0.292	–9.13
D2sales	–2.309	–3.62	–1.15	–2.23	–0.277	–1.99	–0.06	–1.15
DS	–1.952	–0.4	–9.32	–1.9	–3.34	–3.85	–2.416	–5.85
FS	17.153	4.3	7.661	2.79	2.07	2.4	0.658	1.27
F-Statistic	4.51		2.48		13.49		29.47	
Adj R2	0.05		0.03		0.17		0.29	

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.157	3.92	0.279	7.4	0.428	4.58	0.071	2.56
PKL	0.212	2.45	0.194	1.8	0.207	0.86	0.019	0.28
CAK	–0.262	–4.69	–0.354	–5.84	–0.571	–3.85	0.013	0.61
D2sales	–0.265	–3.06	–0.299	–2.22	–0.301	–1.35	–0.065	–1.9
DS	–3.841	–4.52	–5.644	–4.56	–7.746	–1.84	–1.293	–1.03
FS	2.138	4.03	1.753	2.14	1.487	0.81	1.534	18.57
F-Statistic	14.88		11.76		7.66		134.82	
Adj R2	0.15		0.12		0.07		0.6	

TABLE 6.5 *(Continued)*

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.174	8.04	0.151	10.67	0.203	9.51	0.194	11.32
PKL	0.102	1.78	0.107	2.57	0.186	3.19	0.227	4.64
CAK	–0.243	–7.82	–0.215	–10.21	–0.269	–9.15	–0.249	–9.99
D2sales	0.039	1.45	0.035	1.39	–0.047	–1.2	–0.094	–3.4
DS	–1.861	–5	–1.496	–5.76	–4.16	–5.49	–4.498	–5.16
FS	0.652	4.42	0.353	3.82	0.799	5.52	1.02	8.12
F-Statistic	31.65		33.79		28.56		32.8	
Adj R2	0.24		0.25		0.21		0.22	

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.101	6.21	0.183	6.48	0.269	5.28	0.269	2.62
PKL	0.078	1.3	0.005	0.87	0.155	1.15	0.475	1.79
CAK	–0.045	–3.83	–0.097	–4.07	–0.358	–5.84	–0.18	–2.68
D2sales	–0.102	–2.89	–0.241	–5.81	–0.359	–3.63	–0.182	–2.87
DS	–1.672	–1.82	–1.961	–1.47	–0.375	–0.12	–14.91	–1.81
FS	1.631	11.5	1.705	7.68	1.274	4.62	1.525	5.16
F-Statistic	40.11		26.44		9.99		8.93	
Adj R2	0.25		0.18		0.07		0.06	

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.165	5.01	0.151	2.08	0.133	4.05	0.199	1.59
PKL	0.122	1.8	0.144	1.05	0.251	2.12	0.938	2.72
CAK	–0.175	–4.14	–0.028	–0.31	–0.089	–2.31	–0.097	–2.63
D2sales	–0.078	–2.34	–0.276	–2.9	–0.019	–0.41	–0.789	–3.29
DS	–4.22	–2.59	–6.909	–2.54	–7.798	–3.54	–18.261	–1.76
FS	2.35	8.71	3.613	6.31	2.367	6.87	2.448	3.29
F-Statistic	36.07		18.25		15.17		2.69	
Adj R2	0.22		0.12		0.1		0.01	

(Continued)

TABLE 6.5 *(Continued)*

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.185	4.91	0.329	8.72	0.122	2.54	0.128	4.67
PKL	0.015	1.93	0.277	5.63	0.286	3.57	0.003	0.08
CAK	–0.022	–1.57	–0.207	–7.79	–0.004	–0.33	–0.004	–0.79
D2sales	–0.063	–1.88	–0.211	–4.33	–0.096	–2.19	–0.117	–2.01
DS	–6.363	–3.21	–14.406	–5.79	–8.179	–2.4	–2.785	–2.1
FS	0.759	2.75	0.902	6.67	1.076	4.17	1.032	2.67
F-Statistic	10.69		14.83		4.11		1.9	
Adj R2	0.06		0.09		0.02		0.01	

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.156	8.2	0.087	2.69	0.119	3.12	0.065	1.41
PKL	0.002	0.15	–0.008	–0.93	0.218	1.94	–0.202	–1.85
CAK	0	–0.06	–0.057	–1.68	–0.041	–1.28	–0.001	–0.22
D2sales	–0.018	–0.7	–0.116	–4.23	–0.154	–2.98	–0.338	–3.98
DS	–3.335	–3.51	0.738	0.51	–5.441	–2.4	4.462	1.62
FS	0.009	0.07	2.201	8.28	2.909	4.74	4.955	6.98
F-Statistic	3.4		16.28		5.67		10.08	
Adj R2	0.01		0.07		0.02		0.04	

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.062	1.79	0.186	2.56	0.241	9.81	0.162	4.59
PKL	0.022	0.46	0.001	0.05	–0.014	–0.75	–0.028	–0.64
CAK	–0.087	–3.83	–0.079	–1.17	–0.192	–6.25	–0.156	–5.04
D2sales	0.517	3.98	–0.368	–3.34	–0.026	–0.79	–0.004	–0.32
DS	–1.464	–1.07	–3.352	–1.03	–5.974	–6.24	–0.827	–0.89
FS	2.175	6.05	2.24	8.62	0.051	1.27	0.125	1.29
F-Statistic	8.94		18.38		14.89		17.52	
Adj R2	0.03		0.07		0.05		0.05	

TABLE 6.5 *(Continued)*

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.09	1.65	–0.009	–0.37	0.218	2.69	0.288	2.63
PKL	–0.021	–0.37	0.191	2.99	0.022	0.64	0.088	1.15
CAK	–0.007	–0.13	0.035	2.29	–0.228	–2.73	–0.007	–0.45
D2sales	–0.225	–3.11	–0.17	–3.77	–0.076	–0.71	–0.381	–5.04
DS	–0.316	–0.13	–3.816	–3.23	–10.485	–3.48	–18.812	–2.87
FS	1.813	6.24	1.855	19.64	1.194	5.1	1.141	2.34
F-Statistic	11.24		80.36		7.03		5.97	
Adj R2	0.03		0.19		0.02		0.01	

	2000		2001		2002	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.411	2.79	–0.008	–0.18	0.126	0.84
PKL	–0.002	–0.11	0.053	1.19	–0.019	–0.3
CAK	–0.109	–2.37	0	0.04	–0.065	–1.19
D2sales	–0.376	–2.29	–0.154	–3.33	0.014	0.35
DS	–22.817	–2.7	1.329	0.37	–7.946	–0.57
FS	0.578	1.04	2.473	6.49	2.8	2.12
F-Statistic	4.06		9.77		1.04	
Adj R2	0.01		0.02		0	

TABLE 6.6 Financing Equation 2SLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.006	–0.53	0.008	0.83	–0.034	–1.42	–0.029	–1.28
DE	0	0.84	0	–1.48	0.004	1.45	0	–0.09
INTE	0.135	1.7	0.018	0.3	0.237	1.58	0.399	1.99
DEPK	0.055	0.54	–0.033	–0.48	0.155	0.74	0.063	0.46
PK	–0.012	–0.62	0.002	0.17	–0.055	–1.2	0.019	0.6
DS	1.064	3.33	0.468	1.67	2.06	3.14	1.218	2.34
IS	0.071	1.12	0.171	3.8	0.12	1.09	0.171	2.54
F-Statistic	3.43		7.48		3.46		2.88	
Adj R2	0.09		0.2		0.08		0.06	

(Continued)

TABLE 6.6 *(Continued)*

	1956		1957		1958		1959	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.01	–0.75	0.011	0.68	0.006	0.31	0.024	2.23
DE	0.001	2.12	0.001	1.03	–0.001	–1.03	0	1.06
INTE	0.09	0.94	–0.054	–0.65	0.189	2.03	0.057	1.54
DEPK	0.134	1.5	–0.014	–0.11	0.1	0.59	–0.18	–1.53
PK	0.029	1.06	0.124	3.08	–0.08	–1.59	0.098	3.19
DS	0.916	3.05	–0.411	–1.2	1.073	2.98	–0.324	–1.33
IS	0.086	2.34	0.145	2.37	0.085	0.87	0.192	3.79
F-Statistic	4.86		2.62		2.06		4.54	
Adj R2	0.12		0.05		0.03		0.1	

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.011	0.54	–0.01	–0.58	0.028	1.21	0.018	0.68
DE	0	–0.19	0	0.65	–0.002	–0.63	0	–0.22
INTE	–0.01	–0.51	0.023	0.52	0.025	2.68	0.017	0.15
DEPK	–0.304	–1.51	–0.05	–0.27	–0.037	–0.18	–0.175	–0.31
PK	0.194	3.46	0.051	1.32	0.09	2.07	0.365	0.68
DS	–0.693	–1.24	0.528	1.23	–0.581	–1.4	–2.863	–0.58
IS	0.178	2.54	0.152	2.35	0.017	0.48	0.064	1.43
F-Statistic	3.1		2.02		2.83		1.29	
Adj R2	0.06		0.02		0.04		0.01	

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.011	–1.55	–0.004	–0.22	–0.007	–0.6	0.012	0.98
DE	0	0.27	0	–0.65	–0.001	–2.3	0	1.03
INTE	–0.078	–1.04	–0.031	–1.66	0.052	1.53	0.007	0.16
DEPK	0.507	2.74	0.08	0.38	–0.01	–0.06	–0.079	–0.5
PK	–0.206	–2.64	–0.094	–1.75	–0.017	–0.5	0.058	1.52
DS	2.87	4.11	2.411	4.37	1.454	3.94	0.593	2.03
IS	0.016	0.62	0.053	1.84	0.064	1.02	0.104	1.68
F-Statistic	7.71		5.71		5.77		2.5	
Adj R2	0.12		0.11		0.08		0.03	

TABLE 6.6 *(Continued)*

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.043	3.51	0.035	2.35	0.016	1.54	–0.048	–2.89
DE	0	–0.55	0	0.34	0	2.15	–0.001	–1
INTE	–0.003	–0.06	–0.004	–0.28	–0.001	–0.08	–0.001	–0.05
DEPK	–0.133	–0.94	–0.233	–1.36	–0.1	–1.06	0.001	0.01
PK	–0.048	–1.29	0.012	0.31	0.154	4.45	–0.046	–1.13
DS	0.818	2.72	0.62	1.71	–0.573	–1.16	1.353	2.03
IS	0.188	3.6	0.143	2.3	–0.031	–1.37	0.661	20.68
F-Statistic	5.76		1.61		6.51		81.45	
Adj R2	0.07		0.01		0.07		0.52	

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.052	2.44	0.053	2.24	0.04	2.33	0.033	3.2
DE	–0.005	–2.8	–0.001	–0.67	0	0.14	0	0.73
INTE	–0.108	–1.89	–0.052	–1.82	–0.002	–0.25	0.001	0.43
DEPK	–0.575	–3.11	–0.861	–4.46	–1.079	–5.8	–1.24	–10.4
PK	–0.135	–2.03	–0.142	–1.85	0.023	0.48	0.129	3.82
DS	0.93	1.6	1.479	1.82	–0.33	–0.38	–1.837	–3.32
IS	0.399	4.86	0.521	4.48	0.516	6.5	0.587	11.61
F-Statistic	9.42		7.77		10.15		30.25	
Adj R2	0.1		0.08		0.1		0.24	

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.025	2.17	0.011	0.84	0.061	1.26	0.063	3.24
DE	0	0.73	0	0.57	0	–0.24	0	–0.05
INTE	0	0	0.001	1.07	0.007	0.9	–0.001	–0.12
DEPK	–0.581	–5.98	–0.357	–3.58	–1.367	–2.59	–0.507	–4.34
PK	–0.037	–5.29	0.086	2.54	0.561	3.71	0.024	0.63
DS	–0.461	–0.88	–2.375	–2.82	–11.674	–4.56	–3.788	–2.91
IS	0.448	11.54	0.414	8.27	0.57	3.16	0.494	9.84
F-Statistic	25.08		16.03		4.92		17.16	
Adj R2	0.2		0.14		0.04		0.14	

(Continued)

TABLE 6.6 *(Continued)*

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.014	1.41	–0.028	–1.44	–0.01	–0.77	0.174	2.23
DE	0	–0.6	0	0.78	0	2.27	0	0.02
INTE	–0.001	–0.4	0.001	0.28	–0.002	–1.68	–0.068	–1.94
DEPK	–0.316	–3.22	0.07	0.42	–0.184	–2.24	–0.449	–1.93
PK	–0.007	–0.26	–0.052	–1.2	–0.028	–1.1	0.032	1.62
DS	–0.226	–0.45	2.076	2.42	1.247	1.94	–9.08	–2.21
IS	0.329	11.03	0.267	8.12	0.336	8.12	0.059	0.32
F-Statistic	21.99		13.99		12.51		1.48	
Adj R2	0.17		0.11		0.1		0	

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.031	1.5	0.093	3.59	0.082	1.98	0.004	0.16
DE	0.001	1.15	0	–0.78	–0.001	–0.93	0	–0.57
INTE	–0.009	–1.06	–0.045	–4.1	0.003	0.87	–0.006	–0.51
DEPK	–0.158	–4.42	–0.262	–3.91	–0.052	–0.84	0.003	0.21
PK	–0.144	–4.81	0.176	7.15	0.105	1.88	–0.042	–0.68
DS	0.444	0.38	–7.931	–5.4	–6.957	–2.62	0.43	0.44
IS	0.36	4.67	0.292	3.32	0.413	3.08	0.288	1.98
F-Statistic	12.75		26.81		3.84		1.53	
Adj R2	0.09		0.17		0.02		0	

	1988		1989		1990		1991	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.062	3	0.019	1.17	0.033	1.47	0.014	1.22
DE	0	0.06	0	–0.17	–0.001	–2.06	0	–0.23
INTE	–0.017	–2	–0.004	–2.24	0.003	0.93	0.001	1.65
DEPK	0.933	6.55	–0.092	–1.35	–0.438	–2.49	0.005	0.5
PK	–0.195	–6.4	0.081	1.28	0.13	1.67	0.017	0.7
DS	–2.376	–2.64	–2.962	–1.87	–2.266	–1.42	–1.782	–2.63
IS	–0.125	–1.61	0.361	6.3	0.222	3.63	0.163	5.67
F-Statistic	12.32		9.04		3.83		7.23	
Adj R2	0.07		0.05		0.02		0.03	

TABLE 6.6 *(Continued)*

	1992		1993		1994		1995	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.152	–3.05	0.045	1.77	0.096	0.41	0.15	2.27
DE	0	–0.51	0	–0.18	–0.002	–0.3	0	–0.02
INTE	–0.001	–1.55	0	–0.2	0	0.06	0	0.02
DEPK	1.211	2.47	–0.502	–2.72	–0.22	–0.15	–0.853	–1.8
PK	–0.444	–2.54	0.117	2.23	–0.889	–1.63	–0.504	–2.52
DS	8.527	2.79	–3.905	–2.8	14.589	1.31	6.276	1.18
IS	0.515	4.25	0.393	7.17	0.633	0.68	0.222	0.69
F-Statistic	3.85		10.61		0.85		1.97	
Adj R2	0.01		0.04		0		0	

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.07	3.56	0.017	0.99	0.04	0.93	0.214	4.32
DE	0	–0.35	0	–0.91	0	0.53	0	–0.29
INTE	0	–0.19	0	–0.59	0	–0.14	–0.001	–0.29
DEPK	–0.292	–2.08	–0.003	–0.2	–0.309	–1.18	–0.194	–2.82
PK	–0.018	–0.49	–0.006	–0.42	–0.163	–2.67	–0.095	–2.83
DS	–2.305	–2.41	0.281	0.34	4.34	2.22	–9.065	–2.69
IS	0.269	5.34	0.542	20.21	0.566	5.09	0.032	0.26
F-Statistic	8.52		72.44		8.9		2.88	
Adj R2	0.03		0.2		0.03		0.01	

	2000		2001		2002	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.055	2.78	0.03	1.84	0.063	0.75
DE	0	0.31	0	–0.75	0	–0.11
INTE	0	–0.64	–0.001	–1.28	–0.001	–0.25
DEPK	–0.115	–2.02	–0.039	–2.23	–0.177	–1.17
PK	–0.093	–3.4	–0.022	–1.58	0.072	0.68
DS	0.694	0.57	–1.538	–1.03	–6.129	–0.71
IS	0.176	2.29	0.342	6.47	0.221	1.46
F-Statistic	3.91		10.41		0.77	
Adj R2	0.01		0.03		0	

TABLE 6.7 Dividend Equation 3SLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.015	–0.82	0.022	1.86	–0.039	–2.38	0.021	2.2
PK	–0.006	–0.33	0.025	2.33	0.005	0.3	0.03	2.16
CAK	0.016	1.05	–0.013	–0.91	0.065	2.95	–0.01	–0.8
IK	0.029	0.9	–0.158	–7.43	0.054	1.71	–0.068	–3.63
FS	1.064	2.91	0.669	3.79	0.764	6.46	0.323	3.21

	1956		1957		1958		1959	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.007	0.84	0.042	5.62	–0.057	–2.45	0.059	6.24
PK	0.021	1.39	0.102	5.83	0.017	0.62	0.102	5.35
CAK	–0.002	–0.14	–0.04	–3.7	0.052	2.21	–0.054	–4.31
IK	–0.068	–3.39	–0.061	–2.51	0.112	2.53	–0.12	–4.68
FS	0.605	6.13	–0.314	–3.23	1.237	5.51	–0.419	–3.65

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.042	5.62	0.026	5.32	0.046	5.25	0.006	2.26
PK	0.058	3.39	0.027	2.42	0.05	2.18	0.109	6.68
CAK	–0.041	–3.54	–0.011	–1.36	–0.032	–2.07	0	0.2
IK	–0.117	–3.63	–0.108	–4.05	–0.013	–0.38	0.05	1.64
FS	0.208	1.84	0.417	6.76	–0.36	–3.08	–0.406	–6.02

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.003	1.27	0.012	2.34	0.035	7.24	0.046	9.67
PK	0.05	4.78	0.057	4.21	0.057	4.93	0.065	5.81
CAK	0.002	0.91	–0.014	–1.76	–0.042	–5.13	–0.059	–8.34
IK	–0.023	–1.49	–0.041	–2.98	–0.104	–6.06	–0.191	–12.56
FS	0.347	8.75	0.261	6.61	0.169	3.83	0.224	4.01

TABLE 6.7 *(Continued)*

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.022	4.13	0.036	7.41	0.029	10.34	0.032	7.57
PK	0.069	6.39	0.062	5.86	0.059	6.49	0.044	2.8
CAK	–0.04	–5.59	–0.047	–6.64	–0.032	–6.62	–0.019	–4.21
IK	–0.12	–8.72	–0.122	–7.65	–0.074	–7.52	–0.157	–3.56
FS	0.245	5.56	0.095	2.26	–0.053	–1.11	0.075	1.95

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.039	7.22	0.025	6.05	0.029	10.92	0.032	12.02
PK	0.075	4.67	0.09	6.97	0.028	4.73	0.037	5.35
CAK	–0.053	–6.83	–0.039	–7.11	–0.028	–6.54	–0.032	–6.83
IK	–0.158	–8.37	–0.157	–10.25	–0.088	–8.75	–0.136	–8.74
FS	0.069	1.87	0.099	3.69	0.084	3.88	0.149	6.06

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.025	9.61	0.018	8.05	0.009	3.33	0.019	11.59
PK	0	0.26	0.022	3.69	0.021	2.76	0.007	1.83
CAK	–0.014	–3.87	–0.01	–3.51	–0.001	–0.37	–0.007	–3.61
IK	–0.041	–3.52	–0.034	–3.2	0.013	1.27	–0.018	–2.71
FS	0.008	0.39	–0.032	–1.43	–0.076	–8.6	–0.003	–0.18

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.023	9.56	0.019	5.94	0.021	13.09	0.016	13.86
PK	0.037	5.09	0.03	3.73	0.018	4.66	0.004	1.97
CAK	–0.02	–5.27	–0.01	–1.72	–0.01	–3.8	–0.001	–0.47
IK	–0.084	–6.2	–0.08	–7.21	–0.062	–7.05	–0.014	–2.46
FS	0.16	3.78	0.217	6.25	0.118	3.74	–0.022	–9.67

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.029	7.06	0.016	16.08	0.015	11.47	0.024	2.84
PK	–0.025	–2.94	0.008	5.44	0.015	3.43	0.018	0.79
CAK	–0.004	–1.01	–0.004	–3.22	–0.002	–1.72	–0.004	–0.75
IK	–0.021	–3.83	–0.013	–3.38	–0.001	–0.26	–0.052	–3.3
FS	–0.143	–3.87	–0.032	–4.35	–0.07	–7.94	–0.046	–0.63

(Continued)

TABLE 6.7 *(Continued)*

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.028	14.43	0.009	3.39	0.014	5.34	0.013	7.6
PK	0.039	4.07	0.032	5.27	0.033	4.93	0.015	2.53
CAK	–0.002	–0.61	–0.005	–1.36	–0.002	–0.74	–0.001	–0.46
IK	–0.14	–13.51	0.022	1.84	–0.045	–3.91	0.001	0.04
FS	–0.067	–3.87	–0.107	–3.58	0.057	1.35	–0.096	–2.05

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.016	9.59	0.019	9.37	0.002	0.17	0.02	5.07
PK	0.033	7.89	0.019	3.13	0.051	2.06	0.025	4.58
CAK	0.005	4.08	–0.01	–2.78	0	–0.03	–0.026	–6.12
IK	–0.09	–8.17	–0.044	–3.53	–0.046	–2.26	–0.023	–2.52
FS	0.091	5.23	0.026	1.13	0.041	1.87	–0.014	–1

	1996		1997		1998		1999	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.018	7.68	0.026	11.1	0.019	5.49	0.018	12.53
PK	0.009	2.01	–0.017	–10.38	–0.01	–3.11	–0.002	–1.31
CAK	–0.009	–3.32	–0.013	–4.09	–0.004	–0.92	0.001	0.43
IK	0.002	0.21	–0.026	–5.08	–0.04	–4.28	–0.019	–2.14
FS	–0.075	–5.54	–0.014	–2.14	0.039	2.17	–0.056	–4.78

	2000		2001		2002	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.022	13.12	0.011	11.26	0.011	6.35
PK	–0.01	–4.43	0.006	4.67	0.009	2
CAK	–0.006	–3.97	–0.002	–3.17	–0.003	–1.6
IK	–0.021	–4.76	0.005	1.11	–0.044	–3.06
FS	–0.098	–4.3	–0.053	–4.01	0.106	1.8

TABLE 6.8 Investment Equation 3SLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.201	4.19	0.074	1.95	0.308	6.48	0.682	3.18
PKL	0.022	0.65	0.004	0.14	–0.035	–0.68	0.297	2.01
CAK	–0.265	–4.92	–0.082	–1.67	–0.444	–6.22	–0.692	–3.17
D2sales	0	–99	–0.02	–0.91	0.098	1.83	0.588	1.52
DS	0.839	1.06	–2.612	–5.5	2.857	2.89	–1.643	–1.03
FS	–1.168	–0.92	3.293	4.22	–2.693	–3.72	–7.923	–1.89
	1956		**1957**		**1958**		**1959**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.595	3.7	0.05	0.97	0.222	7.58	0.22	6.12
PKL	0.332	1.66	–0.33	–1.81	–0.001	–0.02	0.079	1.45
CAK	–0.751	–3.14	–0.092	–1.16	–0.259	–7.43	–0.282	–7.1
D2sales	0.443	1.17	–0.288	–2.24	0.013	0.31	0.026	0.33
DS	4.86	1.71	0.122	0.12	1.006	1.45	–1.543	–3.2
FS	–10.894	–2.14	5.211	3.65	–1.739	–3.72	0.124	0.16
	1960		**1961**		**1962**		**1963**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.266	4.15	0.207	2.52	0.224	2.92	0.031	0.59
PKL	0.108	0.75	0.064	0.3	–0.109	–0.83	–0.23	–1.43
CAK	–0.325	–3.42	–0.054	–0.49	–0.379	–4.04	–0.1	–0.83
D2sales	0.108	0.9	0.057	0.22	–0.122	–0.99	–0.798	–3.18
DS	–4.877	–3.33	–8.973	–4.35	–0.296	–0.21	–6.319	–2.33
FS	2.045	1.78	4.843	2.4	2.263	2.34	13.642	6.1
	1964		**1965**		**1966**		**1967**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.039	–0.6	0.101	0.75	0.243	8.19	0.238	12.75
PKL	–1.616	–3.11	0.065	0.41	0.007	0.11	0.047	0.98
CAK	0.384	1.8	0.031	0.14	–0.255	–5.37	–0.303	–10.79
D2sales	–2.313	–3.63	–0.26	–0.59	0.008	0.07	0.005	0.13
DS	–2.386	–0.5	–11.267	–2.73	–4.518	–5.55	–2.996	–8.88
FS	17.032	4.27	7.02	2.71	1.928	2.41	0.831	2

(Continued)

TABLE 6.8 *(Continued)*

	1968		1969		1970		1971	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.154	4.87	0.25	7.12	0.431	5.33	0.073	2.74
PKL	0.144	2.73	0.055	0.65	–0.103	–0.52	0.014	0.75
CAK	–0.272	–5.41	–0.345	–5.97	–0.54	–4.06	0.007	0.33
D2sales	0.059	0.98	0.132	1.42	–0.106	–0.57	–0.004	–0.28
DS	–4.21	–5.86	–4.768	–4.38	–7.094	–1.91	–1.589	–1.59
FS	1.772	4.04	0.863	1.31	1.955	1.26	1.529	19.13

	1972		1973		1974		1975	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.205	9.69	0.173	13.34	0.233	12.52	0.215	13.36
PKL	0.026	0.56	0.128	3.62	0.093	2.67	0.076	2.36
CAK	–0.248	–8.13	–0.232	–11.15	–0.279	–9.74	–0.233	–9.54
D2sales	0.04	2.15	0.024	1.24	0.027	1.18	–0.07	–4.54
DS	–2.485	–7	–2.516	–10.3	–5.648	–8.56	–4.194	–5.13
FS	0.603	4.12	0.354	3.9	0.706	5.22	1.046	8.38

	1976		1977		1978		1979	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.103	7.42	0.186	7	0.156	3.43	0.412	5.42
PKL	0.04	1.03	0	–0.17	0.158	1.5	0.293	1.77
CAK	–0.049	–4.32	–0.122	–5.51	–0.327	–5.69	–0.218	–3.97
D2sales	–0.027	–1.84	–0.059	–1.75	–0.308	–4.2	–0.07	–1.52
DS	–1.828	–2.1	–3.806	–3.09	4.932	1.85	–21.081	–3.72
FS	1.696	12.53	1.521	7.28	1.586	6.36	1.177	4.1

	1980		1981		1982		1983	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.186	6.25	0.16	3.32	0.205	7.31	0.377	3.26
PKL	0.051	1.16	0.006	0.13	–0.061	–1.02	0.606	1.92
CAK	–0.167	–4.26	0.002	0.03	–0.038	–1.03	–0.096	–2.62
D2sales	0.01	0.59	0.009	0.23	0.008	0.73	–0.494	–2.18
DS	–5.674	–3.92	–8.623	–4.31	–8.823	–5.19	–25.206	–2.6
FS	2.26	9.31	3.332	7.31	2.401	7.08	1.8	2.55

TABLE 6.8 *(Continued)*

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.203	6.59	0.388	11.67	0.099	2.1	0.12	4.91
PKL	0.002	0.52	0.172	3.81	0.196	2.75	0	0.04
CAK	–0.028	–2.04	–0.188	–7.41	–0.007	–0.69	–0.009	–1.66
D2sales	–0.021	–0.86	–0.137	–4.43	–0.048	–1.25	–0.039	–0.75
DS	–7.673	–4.76	–17.957	–7.9	–5.325	–1.68	–3.038	–2.65
FS	0.781	3.04	0.655	5.16	1.023	4.18	1.27	3.63

	1988		1989		1990		1991	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.203	11.45	0.085	2.69	0.187	5.34	–0.101	–2.39
PKL	–0.002	–0.24	0	0.14	0.18	2.24	–0.094	–2.17
CAK	0	0.14	–0.084	–2.83	–0.077	–2.65	–0.001	–0.27
D2sales	–0.009	–0.49	–0.037	–2.01	–0.019	–0.47	–0.11	–2.3
DS	–5.583	–6.41	0.453	0.31	–8.666	–4.37	11.975	4.85
FS	–0.392	–3.62	2.19	8.28	2.12	3.63	6.2	8.91

	1992		1993		1994		1995	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.11	3.51	0.238	3.34	0.242	9.84	0.161	4.59
PKL	0.042	1.29	–0.002	–0.22	–0.026	–1.46	–0.034	–0.81
CAK	–0.04	–2.01	–0.179	–3.57	–0.195	–6.35	–0.153	–4.94
D2sales	0.26	2.2	–0.195	–2.02	–0.011	–0.34	–0.001	–0.12
DS	–3.888	–3.12	–5.726	–1.79	–5.894	–6.21	–0.782	–0.85
FS	1.78	5.3	2.022	8.2	0.048	1.2	0.127	1.33

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.004	0.08	–0.016	–0.77	0.258	5.93	0.373	3.67
PKL	–0.03	–1.09	–0.052	–1.88	0.011	2.03	–0.016	–0.39
CAK	–0.035	–0.72	–0.011	–0.86	–0.131	–2.84	–0.012	–0.73
D2sales	–0.16	–2.47	0.029	1.61	–0.037	–1.59	–0.303	–4.14
DS	3.919	1.73	–0.438	–0.44	–1.837	–17.21	–2.159	–3.38
FS	2.41	9.19	1.816	19.29	1.628	7.94	0.59	1.36

(Continued)

TABLE 6.8 *(Continued)*

	2000		2001		2002	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.433	3.35	–0.078	–1.89	0.198	1.82
PKL	–0.006	–1.16	0.006	0.38	0	–0.02
CAK	–0.132	–3.07	–0.005	–0.53	–0.068	–1.31
D2sales	–0.102	–0.74	–0.018	–0.63	–0.002	–0.32
DS	–2.832	–3.85	7.232	2.23	–15.439	–1.62
FS	0.533	1.01	2.629	7.18	2.818	2.24

TABLE 6.9 Financing Equation 3SLS

	1952		1953		1954		1955	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.001	0.13	0.007	0.95	–0.054	–3	–0.019	–0.9
DE	0	0.3	0	–0.01	–0.003	–2.06	0	–0.34
INTE	0.021	0.61	–0.07	–1.86	0.2	2.64	0.097	0.6
DEPK	0	0.01	–0.079	–1.74	0.515	3.06	0.102	1.13
PK	–0.001	–0.04	0.015	1.42	–0.111	–2.85	–0.002	–0.09
DS	0.985	3.52	0.367	1.9	3.152	7.74	1.359	2.84
IS	0.045	0.98	0.269	12.36	–0.117	–1.36	0.168	3.01
	1956		**1957**		**1958**		**1959**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.013	–1.12	0.018	1.31	0.015	1.05	0.031	2.97
DE	0	0.55	0	–1.54	0.001	1.82	0	0.84
INTE	0.091	1.82	0.055	1.02	–0.067	–1.47	0.018	0.6
DEPK	0.156	2.3	–0.032	–0.34	0.258	2.37	–0.213	–2.1
PK	–0.017	–0.78	0.108	4.09	–0.055	–1.37	0.132	4.58
DS	1.473	5.87	–0.643	–2.26	1.187	6.44	–0.802	–3.66
IS	0.051	1.9	0.151	3.54	–0.188	–2.36	0.224	5.11
	1960		**1961**		**1962**		**1963**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.008	0.42	–0.029	–2.24	0.056	2.58	0.018	1.94
DE	0	–0.67	0	0.18	0	0.13	0	–0.39
INTE	–0.01	–1.31	0.001	0.1	0.005	0.59	–0.031	–2.48
DEPK	–0.357	–2.03	–0.063	–0.47	–0.288	–1.52	0.064	0.65
PK	0.176	3.99	0.011	0.58	0.113	3.01	0.339	3.69
DS	–0.385	–0.73	1.516	4.62	–1.623	–4.16	–3.004	–3.95
IS	0.192	3.06	0.19	3.43	0.195	7.38	0.061	1.76

TABLE 6.9 *(Continued)*

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.009	–1.41	–0.012	–0.79	–0.017	–1.62	0.011	0.91
DE	0	–0.59	0	–0.26	0	–1.44	0	0.13
INTE	0.001	0.07	0.004	0.47	–0.014	–0.62	–0.033	–0.86
DEPK	0.06	0.87	–0.084	–0.45	–0.308	–2.49	–0.311	–2.04
PK	–0.158	–3.24	–0.025	–0.52	0.097	3.63	0.116	3.14
DS	2.959	7.37	1.976	3.8	0.742	2.19	0.305	1.06
IS	0.036	1.63	0.134	6.53	0.273	6.52	0.225	3.81

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.035	3	0.031	2.11	0.017	1.66	–0.055	–4.07
DE	0	–1.49	0	0.08	0	1.35	0	0.31
INTE	–0.056	–2.05	–0.007	–0.72	–0.002	–0.4	0	0.08
DEPK	–0.37	–3.4	–0.397	–2.7	–0.225	–2.58	0.026	0.33
PK	0.026	0.97	0.051	1.52	0.225	6.83	–0.007	–0.36
DS	0.671	2.54	0.544	1.54	–1.486	–3.11	1.203	2.02
IS	0.303	8.28	0.199	3.67	0.048	2.28	0.66	21.43

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.008	0.43	0.014	0.65	0.019	1.13	0.033	3.25
DE	–0.004	–2.91	0	–0.06	0	–0.42	0	0.65
INTE	0.034	0.76	0.066	2.64	0.005	0.88	0.001	0.33
DEPK	–0.675	–3.94	–1.06	–5.66	–1.167	–6.31	–1.284	–10.83
PK	0.008	0.14	0.004	0.06	0.141	3.38	0.162	4.87
DS	0.026	0.05	–0.512	–0.68	–1.397	–1.68	–2.335	–4.28
IS	0.588	7.87	0.814	7.41	0.629	8.32	0.606	12.06

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.009	–1.04	0.015	1.23	0.13	3.29	0.095	5.31
DE	0	0.31	0	0.25	0	–0.96	0	–0.06
INTE	0.003	0.78	0.001	2.18	0	0.18	–0.005	–1.08
DEPK	–0.161	–2.09	–0.303	–3.15	–0.013	–0.06	–0.513	–4.51
PK	–0.001	–0.28	0.119	4.05	0.248	2.59	0.073	2.04
DS	–0.858	–1.86	–3.353	–4.25	–13.224	–9.45	–6.703	–6.01
IS	0.518	14.07	0.397	8.32	0.221	1.48	0.493	10.14

(Continued)

TABLE 6.9 *(Continued)*

	1980		1981		1982		1983	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0	0	–0.048	–2.72	–0.054	–4.86	0.264	3.79
DE	0	–0.23	0	0.17	0	0.48	0	0.01
INTE	–0.001	–1.42	0	–0.03	–0.001	–1.14	–0.025	–0.85
DEPK	–0.335	–3.54	0.006	0.05	–0.091	–1.2	–0.597	–3.04
PK	0.048	2.64	–0.006	–0.37	0.017	1.57	0.043	2.46
DS	–0.397	–0.83	2.584	3.42	2.735	5.03	–14.993	–4.12
IS	0.36	13.01	0.297	11.73	0.389	9.96	0.035	0.2

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.003	–0.18	0.17	9.17	0.103	3.07	–0.025	–1.11
DE	0	0.03	0	2.16	0	0.94	0	0.28
INTE	–0.001	–0.21	–0.019	–3.75	–0.004	–1.8	–0.001	–0.22
DEPK	–0.106	–3.17	–0.319	–4.97	–0.054	–1.24	–0.008	–0.57
PK	–0.103	–3.59	0.162	7.02	0.114	2.52	0.006	0.09
DS	0.891	0.79	–12.751	–14.26	–8.611	–4.02	0.243	0.25
IS	0.497	6.78	0.19	2.4	0.432	4.62	0.512	4.37

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.177	9.67	0.012	0.72	0.059	2.76	0.031	3.44
DE	0	0.09	0	0	0	–2.32	0	0.31
INTE	–0.014	–2.28	0.001	1.33	0.006	2.5	–0.001	–1.92
DEPK	0.559	4.82	0.071	2.04	–0.578	–3.72	0.005	0.83
PK	–0.116	–4.66	0.173	3.09	0.257	3.96	0.014	2.41
DS	–5.701	–6.9	–4.793	–3.28	–5.302	–3.76	–2.649	–5.52
IS	–0.671	–10.79	0.376	7.27	0.258	4.65	0.143	5.4

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.131	–2.72	0.066	2.69	0.001	0	0.001	0.01
DE	0	0.58	0	–1.29	0	0.19	0	0.08
INTE	0.001	1.41	0	–1.35	0	0.25	0	–0.07
DEPK	–0.042	–0.12	–0.525	–2.86	1.05	0.96	–0.775	–1.64
PK	0.008	0.06	0.136	2.74	–1.199	–2.59	–0.079	–0.4
DS	4.729	1.7	–5.394	–3.94	22.947	9.08	–3.221	–0.61
IS	0.77	7.15	0.376	7.4	0.199	0.32	1.909	6.26

TABLE 6.9 *(Continued)*

	1996		1997		1998		1999	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.049	2.8	0.026	1.79	–0.068	–1.99	0.262	6.37
DE	0	0.07	0	–1.54	0	1.43	0	–0.11
INTE	0	–0.04	0	0.13	0	0.11	0	0.14
DEPK	0.019	0.14	–0.012	–0.74	–0.218	–1.91	–0.054	–0.93
PK	0.09	2.72	–0.009	–1.04	–0.015	–0.51	–0.027	–0.93
DS	–5.196	–5.89	–0.276	–0.41	8.758	6.7	–14.776	–5.55
IS	0.386	13.02	0.534	19.96	0.561	6.32	–0.031	–0.29

	2000		2001		2002	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.056	2.85	0.041	2.66	0.048	0.59
DE	0	–0.59	0	0.27	0	–0.58
INTE	0	0.65	0	0.43	0	0.25
DEPK	–0.157	–2.82	0.007	0.76	–0.17	–1.19
PK	–0.067	–2.49	0.01	1.02	0.115	1.21
DS	–0.199	–0.16	–3.964	–2.92	–6.088	–0.73
IS	0.242	3.23	0.371	8.18	0.28	2.06

TABLE 6.10 Dividend Equation OLS

	1952		1953		1954		1955	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.012	0.9	–0.005	–0.22	0.007	0.35	0.012	1.09
DIVL	0.924	15.61	0.912	11.9	1.094	10.19	1.015	16.21
CAK	–0.022	–1.28	0.008	0.27	–0.017	–0.56	–0.014	–0.8
PK	0	0.02	–0.006	–0.46	0.014	0.89	–0.005	–0.42
IS	–0.022	–0.7	0.012	0.3	–0.05	–1.13	–0.028	–0.77
FS	0.024	0.57	0.047	0.75	0.009	0.22	–0.035	–0.6
RDS	–0.097	–1.72	0.042	0.59	0.037	0.43	0.018	0.24
F-Statistic	68.91		48.98		35.71		83.85	
Adj R2	0.96		0.93		0.89		0.94	

(Continued)

TABLE 6.10 *(Continued)*

	1956		1957		1958		1959	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.007	–0.93	–0.007	–1.57	–0.005	–0.99	–0.007	–1.54
DIVL	0.956	21.65	0.965	34.84	1.039	32.98	1.032	38.97
CAK	0.004	0.28	0.005	0.58	0.008	0.92	0.01	1.39
PK	0.013	1.42	0.013	1.65	0.002	0.19	–0.001	–0.08
IS	0.013	0.52	0.027	1.78	–0.009	–0.41	0.003	0.19
FS	0.017	0.67	–0.016	–0.85	0.014	0.65	–0.028	–1.47
RDS	0.079	1.41	0.012	0.32	0.016	0.51	0.052	2.13
F-Statistic	106.61		272.85		245.38		295.83	
Adj R2	0.95		0.98		0.97		0.98	

	1960		1961		1962		1963	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.006	1.13	0	–0.12	–0.002	–0.65	0	0.01
DIVL	0.91	33.7	1.073	58.37	0.963	46.21	0.993	21.54
CAK	–0.008	–0.88	0.004	0.77	–0.002	–0.46	0.003	0.45
PK	0.012	2.08	–0.011	–2.06	0.008	1.95	0.003	0.24
IS	0.008	0.45	–0.006	–0.61	0.005	0.5	–0.025	–0.87
FS	–0.013	–1.18	0.003	0.5	0.006	0.59	0.032	1.3
RDS	–0.045	–1.75	–0.003	–0.15	0.003	0.18	–0.052	–2
F-Statistic	263.18		639.9		460.27		246.53	
Adj R2	0.97		0.99		0.98		0.98	

	1964		1965		1966		1967	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.011	–1.04	0.001	0.17	0	0	0.004	0.77
DIVL	1.033	10.82	0.85	17.17	0.988	46.55	0.99	28.52
CAK	0.01	0.71	–0.004	–0.4	0	0	–0.003	–0.43
PK	0.018	0.76	0.014	1	–0.009	–1.6	–0.015	–1.69
IS	0.075	1.17	–0.037	–0.81	–0.007	–0.52	–0.021	–1.2
FS	–0.1	–1.46	0.019	0.35	0.048	8.31	0.048	3.18
RDS	0.08	1.5	0.064	2	–0.004	–0.2	–0.01	–0.34
F-Statistic	47.53		123.98		1,425.56		691.99	
Adj R2	0.91		0.96		1		0.99	

TABLE 6.10 *(Continued)*

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.002	–0.81	0	0.23	–0.004	–1.83	–0.005	–2.74
DIVL	0.968	47.22	0.994	51.58	0.937	40.63	0.976	46.89
CAK	0	–0.12	–0.001	–0.26	0.003	0.77	0.005	1.9
PK	0.001	0.13	–0.002	–0.37	0.011	2.43	0.004	1.07
IS	0.005	0.65	–0.013	–2.18	0.013	1.48	0.01	1.16
FS	–0.005	–0.43	0.011	1.69	–0.017	–1.82	0.005	0.54
RDS	0.03	1.88	0.013	0.8	0.018	1.28	0.008	0.51
F-Statistic	640.21		727.93		470.9		581.88	
Adj R2	0.99		0.99		0.98		0.96	

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0	–0.4	0.001	0.61	–0.005	–1.83	–0.006	–4.79
DIVL	0.877	214.17	0.742	104.52	0.555	31.8	0.846	64.06
CAK	0	0.28	–0.003	–1.81	0.004	1.04	0.01	5.01
PK	0.004	2.33	0.014	4.95	0.024	4.62	0.005	1.72
IS	0.002	0.6	–0.008	–2.67	0.018	2.15	0.051	10.88
FS	–0.005	–1.13	0.025	18.52	0.033	7.67	0.011	2.01
RDS	–0.003	–0.37	0.01	0.77	0.003	0.09	–0.034	–2.38
F-Statistic	8,477.94		2,889.18		263.02		796.59	
Adj R2	1		0.98		0.84		0.94	

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.001	–0.93	–0.001	–1.89	–0.001	–1.27	0.002	2.15
DIVL	0.889	102.15	1.002	83.68	1.023	66.06	1.009	87.61
CAK	0.002	2.5	0	0.27	0	–0.01	–0.001	–1.5
PK	0.004	2.98	0.007	3.9	0.006	2.3	–0.002	–1.4
IS	0.01	3.73	0.001	0.29	–0.015	–2.86	–0.007	–2.51
FS	–0.011	–3.83	0	0.01	0.026	4.2	0.006	2.25
RDS	–0.016	–1.85	0.004	0.42	0.006	0.44	–0.001	–0.08
F-Statistic	1,873.33		1,528.53		847.67		1,510.98	
Adj R2	0.97		0.96		0.94		0.96	

(Continued)

TABLE 6.10 *(Continued)*

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0	0.51	–0.001	–2.27	0	–0.31	0	0.95
DIVL	1.077	97.33	0.983	82.42	1.093	110.33	0.994	78.95
CAK	–0.001	–1.08	0.001	1.5	0.001	1.41	0	–0.17
PK	–0.002	–0.96	0.005	3.6	–0.002	–1.46	0	–0.18
IS	–0.015	–3.61	0	–0.19	–0.008	–3.57	–0.002	–1.26
FS	0.002	0.52	–0.002	–0.78	0	0.16	–0.002	–1.35
RDS	0.027	2.74	0.001	0.23	0.002	0.55	0.001	0.16
F-Statistic	1,715.94		1,314.18		2,179.97		1,080.92	
Adj R2	0.97		0.96		0.97		0.95	
	1984		**1985**		**1986**		**1987**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.001	–1.57	0	0.13	0.001	0.42	0.011	5.68
DIVL	0.907	59.67	1.012	83.74	0.913	9.71	0.204	8.67
CAK	0.002	2.73	0	0.39	–0.004	–2.14	–0.009	–2.9
PK	0.005	3.03	0.001	0.68	0.017	2.45	0.015	3.28
IS	0.002	0.54	0.001	0.38	0.011	0.53	–0.016	–1.65
FS	0.005	1.15	0.003	3.02	–0.069	–5.74	0.004	0.61
RDS	0	–0.12	–0.001	–0.38	0.005	0.38	0.008	0.69
F-Statistic	619.77		1,275.05		25.56		20.5	
Adj R2	0.91		0.95		0.26		0.21	
	1988		**1989**		**1990**		**1991**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.004	0.54	0.008	1.61	0.012	2.46	0.006	4.7
DIVL	0.111	2.06	0.091	2.34	0.184	4.67	0.289	14.68
CAK	–0.021	–2.18	–0.006	–0.9	–0.007	–1.09	–0.001	–2.85
PK	0.077	4.72	0.028	2.35	0.007	0.88	0.01	2.98
IS	–0.083	–2.38	0.038	1.64	0.013	0.42	0.017	1.33
FS	0.115	5.78	–0.126	–6.98	0.006	0.49	–0.01	–1.17
RDS	0.052	1.49	–0.005	–0.59	–0.001	–0.31	–0.002	–0.67
F-Statistic	12.19		11.95		4.73		39.52	
Adj R2	0.12		0.12		0.04		0.3	

TABLE 6.10 *(Continued)*

Variable	1992 Coeff	1992 T-Stat	1993 Coeff	1993 T-Stat	1994 Coeff	1994 T-Stat	1995 Coeff	1995 T-Stat
Intercept	0.001	2.94	0.02	4.51	0.017	4.82	0.005	1.98
DIVL	0.84	52.07	0.389	6.44	0.156	5.55	0.898	14.83
CAK	–0.001	–1.8	–0.017	–2.42	–0.014	–2.83	–0.009	–2.31
PK	0	0.91	–0.001	–0.29	0	0	0.008	1.81
IS	0.003	0.75	–0.068	–2.32	–0.013	–0.66	–0.026	–1.58
FS	0.014	6.02	0.126	5.72	0.003	0.2	0	0.04
RDS	–0.001	–0.36	0.006	0.81	0	0.07	0.002	0.54
F-Statistic	455.51		13.05		7.17		45.47	
Adj R2	0.82		0.1		0.05		0.27	

Variable	1996 Coeff	1996 T-Stat	1997 Coeff	1997 T-Stat	1998 Coeff	1998 T-Stat	1999 Coeff	1999 T-Stat
Intercept	0.009	4.52	0.002	2.99	0.005	3.17	0.001	0.69
DIVL	0.177	8.52	0.461	22.18	0.537	25.7	0.805	23.7
CAK	–0.013	–4.59	–0.005	–6.06	–0.008	–3.62	0.001	0.46
PK	0.017	3.59	0.018	6.44	0.01	3.22	0.002	0.57
IS	0.005	0.52	0.001	0.37	–0.001	–0.39	0	–0.04
FS	–0.015	–4.13	–0.003	–0.93	0	–0.55	0.002	0.55
RDS	0.002	0.75	0.002	2.23	0.008	1.99	0	0
F-Statistic	28.35		110.13		126.68		96.59	
Adj R2	0.17		0.43		0.45		0.37	

Variable	2000 Coeff	2000 T-Stat	2001 Coeff	2001 T-Stat	2002 Coeff	2002 T-Stat
Intercept	0.007	3.59	0.003	2.94	0.004	3.92
DIVL	0.537	18.1	0.467	31.11	0.6	24.42
CAK	–0.006	–1.94	0	0.32	–0.001	–1.06
PK	0.002	0.41	0.009	4.76	0.001	0.43
IS	–0.009	–0.96	0.001	0.14	–0.003	–0.46
FS	0.002	0.46	–0.001	–0.25	0.003	0.97
RDS	–0.003	–0.3	–0.001	–0.25	0	–0.06
F-Statistic	57.93		174.93		102.14	
Adj R2	0.25		0.49		0.35	

TABLE 6.11 Investment Equation OLS

	1952		1953		1954		1955	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.221	2.6	0.482	5.28	0.373	8.44	0.268	6.04
PKL	–0.106	–1.02	–0.104	–1.11	–0.09	–1.37	0.009	0.15
CAK	–0.308	–2.69	–0.67	–5.73	–0.559	–8.13	–0.398	–5.9
D2sales	0	–99	–0.008	–0.1	0.1	1.4	–0.043	–0.62
DS	0.588	1.02	–1.087	–1.61	–0.829	–2.11	–0.912	–2.67
FS	0.146	0.4	–0.339	–0.78	–0.088	–0.41	0.616	2.26
RDS	0.093	0.18	0.493	0.94	0.699	1.84	0.207	0.49
F-Statistic	6.29		10.59		17.33		14.32	
Adj R2	0.58		0.71		0.79		0.73	

	1956		1957		1958		1959	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.245	6.74	0.225	6.78	0.199	8.46	0.175	5.74
PKL	0.11	1.6	0.023	0.31	0.13	1.87	0.101	1.21
CAK	–0.389	–5.68	–0.369	–5.15	–0.364	–6.85	–0.321	–6.33
D2sales	0.004	0.07	0.016	0.24	–0.033	–0.82	–0.021	–0.52
DS	–0.291	–0.81	0.093	0.27	–0.365	–1.16	–0.155	–0.58
FS	0.235	1.2	0.353	1.59	0.436	2.39	0.365	2.01
RDS	–0.555	–1.28	–0.079	–0.19	0.157	0.61	0.313	1.34
F-Statistic	10.89		10.53		11.94		8.61	
Adj R2	0.64		0.61		0.63		0.53	

	1960		1961		1962		1963	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.237	7.62	0.231	6.59	0.199	5.74	0.104	4.09
PKL	0.17	1.99	–0.001	–0.01	0.031	0.53	0.055	0.62
CAK	–0.457	–8.78	–0.397	–6.36	–0.335	–5.3	–0.128	–3.43
D2sales	–0.039	–0.74	0.039	0.62	0.02	0.34	–0.047	–0.82
DS	–0.382	–1.32	–0.262	–0.78	0.145	0.4	0.096	0.3
FS	0.39	4.16	0.167	1.71	0.214	1.19	–0.047	–0.23
RDS	0.294	1.24	0.689	2.32	0.174	0.6	0.136	0.71
F-Statistic	23.66		11.11		10.31		2.6	
Adj R2	0.76		0.58		0.56		0.28	

TABLE 6.11 *(Continued)*

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.135	5.26	0.136	6.15	0.206	7.87	0.22	9.69
PKL	–0.098	–1.15	–0.048	–0.64	0.191	3.45	0.111	1.89
CAK	–0.145	–3.7	–0.154	–4.37	–0.274	–6.66	–0.294	–8.05
D2sales	0.044	1.11	0.037	0.89	–0.161	–2.88	–0.085	–2
DS	–0.013	–0.05	0.094	0.33	–0.586	–2.56	–0.5	–1.83
FS	0.222	0.88	0.097	0.35	0.095	1.19	0.053	0.39
RDS	0.03	0.15	0.009	0.05	0.108	0.47	0.127	0.53
F-Statistic	5.05		3.79		13.26		12.14	
Adj R2	0.48		0.37		0.65		0.55	

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.18	6.4	0.205	7.05	0.171	7.21	0.136	11.98
PKL	0.019	0.24	0.088	0.94	–0.062	–0.89	–0.011	–0.29
CAK	–0.235	–4.89	–0.314	–6.17	–0.279	–7.01	–0.195	–9.55
D2sales	–0.059	–0.98	–0.089	–1.36	0.071	1.23	–0.003	–0.16
DS	0.124	0.33	–0.266	–0.59	0.292	0.86	0.43	2.16
FS	0.341	1.54	0.396	2.55	0.282	1.83	0.416	5.78
RDS	–0.106	–0.35	0.154	0.43	0.524	2.5	0.371	2.68
F-Statistic	6.95		9.53		13.75		30.98	
Adj R2	0.39		0.45		0.54		0.55	

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.153	10.34	0.168	9.04	0.152	9.35	0.13	10.29
PKL	–0.026	–0.61	0.024	0.46	0.031	0.8	0.087	2.86
CAK	–0.225	–8.93	–0.276	–9.3	–0.255	–10.9	–0.227	–10.63
D2sales	0.038	2.44	0.081	2.54	0.046	1.74	–0.001	–0.05
DS	–0.021	–0.21	–0.668	–3.78	–0.064	–0.33	–0.068	–0.36
FS	1.063	15.22	0.081	2.96	–0.095	–2.95	0.63	11.11
RDS	0.334	1.72	0.713	2.85	0.911	4.53	0.593	3.37
F-Statistic	72.57		16.83		24.42		48.71	
Adj R2	0.64		0.25		0.32		0.48	

(Continued)

TABLE 6.11 *(Continued)*

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.109	9.45	0.117	8.16	0.092	8.36	0.067	4.64
PKL	0.056	1.66	–0.018	–0.51	0.097	3.35	–0.126	–2.98
CAK	–0.163	–9.29	–0.155	–7.87	–0.147	–9.45	–0.045	–3.81
D2sales	0.046	1.94	–0.056	–2.15	0.007	0.42	0.107	4.4
DS	–0.438	–2.26	1.443	6.42	–0.654	–4.34	1.508	7.1
FS	0.672	16.57	0.886	18.72	1.018	30.48	0.74	20.13
RDS	0.576	3.41	0.824	4.66	0.479	3.41	0.183	0.96
F-Statistic	79.92		81.27		200.33		78.05	
Adj R2	0.58		0.58		0.78		0.58	

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.095	10.55	0.096	5.63	0.123	8.62	0.026	2.19
PKL	0.039	1.79	0.01	0.22	–0.033	–0.81	0.106	2.54
CAK	–0.131	–8.25	–0.08	–3.03	–0.124	–5.87	–0.01	–2.15
D2sales	0.012	0.89	–0.087	–3.24	0.054	2.86	–0.036	–2.35
DS	–0.154	–1.18	0.777	2.08	0.259	1.16	0.429	1.23
FS	0.786	17	0.983	17.7	0.545	10.83	0.493	12.59
RDS	0.565	4.44	0.364	2.04	0.102	1.11	0.388	4
F-Statistic	73.99		75.05		39.45		30.64	
Adj R2	0.56		0.56		0.4		0.33	

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.051	6.21	0.069	11.76	0.062	7.85	0.084	10.17
PKL	0.007	2.94	0.093	6.68	0.013	0.46	–0.008	–0.89
CAK	–0.001	–0.15	–0.088	–8.33	–0.004	–2	–0.08	–5.59
D2sales	–0.008	–0.41	0.011	0.96	0.006	0.47	0.027	1.98
DS	0.343	1.13	0.178	0.82	0.106	0.96	–0.345	–1.65
FS	0.685	10.41	0.137	6.4	0.07	2.28	0.191	6.45
RDS	0.355	10.76	0.418	8.42	0.291	9.33	0.606	12.68
F-Statistic	39.75		23.32		20.72		36.31	
Adj R2	0.38		0.25		0.22		0.32	

TABLE 6.11 *(Continued)*

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.088	12.05	0.095	10.19	0.086	15.15	0.053	11.67
PKL	0.01	0.6	–0.008	–0.32	0.011	0.8	0.009	0.65
CAK	–0.087	–7.45	–0.065	–5.47	–0.062	–6.97	0	0.61
D2sales	0.01	0.85	–0.025	–3.95	0.006	1.35	0.011	1.49
DS	–0.15	–2.59	0.141	1.67	0.014	0.23	0.176	1.4
FS	0.164	6.5	0.258	7.44	0.028	1.46	0.098	3.51
RDS	0.409	9.63	0.129	9.22	0.055	13.87	0.075	6.54
F-Statistic	31.94		28.88		39.13		10.17	
Adj R2	0.28		0.25		0.3		0.09	

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.056	9.61	0.084	18.12	0.077	15.54	0.076	12.84
PKL	0.006	0.63	–0.003	–1.81	–0.004	–0.89	–0.001	–0.09
CAK	–0.003	–0.84	–0.061	–6.7	–0.061	–6.41	–0.06	–6.95
D2sales	–0.024	–1.44	0.01	0.92	0.041	4.14	0.059	5.13
DS	0.101	0.47	–0.114	–2.09	–0.024	–0.33	0.031	0.39
FS	0.039	1.41	0.202	6.5	0.243	10.64	0.007	1.01
RDS	0.258	17.26	0.138	16.61	0.099	10.23	0.021	3.03
F-Statistic	49.84		59.97		55.53		12.48	
Adj R2	0.33		0.36		0.33		0.09	

	1996		1997		1998		1999	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.097	14.19	0.097	8.36	0.132	9.08	0.105	14.33
PKL	–0.025	–2.15	–0.099	–3.01	–0.007	–0.94	–0.01	–0.73
CAK	–0.086	–7.76	–0.008	–1.57	–0.079	–2.74	–0.026	–2
D2sales	0.037	2.72	–0.012	–0.59	–0.073	–2.59	–0.148	–16.1
DS	0.089	0.67	0.056	0.17	–0.736	–2.22	–0.294	–2.3
FS	0.093	6.7	0.252	6.97	0.076	7.46	0.027	1.62
RDS	0.107	8.89	0.052	4.45	–0.084	–2.08	0.06	4.22
F-Statistic	30.16		16.97		12.88		50.39	
Adj R2	0.18		0.1		0.07		0.24	

(Continued)

TABLE 6.11 *(Continued)*

	2000		2001		2002	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.072	12.71	0.056	11.41	0.05	12.89
PKL	0.008	0.65	0.017	1.69	–0.001	–0.17
CAK	–0.031	–3.29	–0.006	–1.58	–0.006	–1.62
D2sales	0.018	1.84	0.017	1.63	–0.002	–0.2
DS	–0.112	–1.17	–0.069	–0.51	0.007	0.06
FS	0.068	5.11	0.041	2.73	0.047	3.64
RDS	0.01	0.33	0.117	3.45	0.146	8.86
F-Statistic	8.54		5.59		15.15	
Adj R2	0.04		0.03		0.07	

TABLE 6.12 Financing Equation OLS

	1952		1953		1954		1955	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.025	0.64	0.027	1.01	0.018	0.54	0.001	0.05
DE	–0.002	–0.38	0	–0.74	0.005	1.67	0	0.09
INTE	0.297	0.65	–0.187	–0.32	0.291	0.59	0.064	0.28
PKL	–0.065	–0.78	–0.017	–0.25	–0.017	–0.25	–0.002	–0.04
DS	0.361	0.7	0.431	1.28	0.658	1.93	0.469	2.1
IS	0.341	2.07	0.148	1.69	0.123	1.14	0.262	3.15
RDS	–0.159	–0.36	–0.099	–0.3	–0.165	–0.46	0.365	1.25
F-Statistic	1.96		1.93		1.83		2.95	
Adj R2	0.23		0.19		0.16		0.29	
	1956		**1957**		**1958**		**1959**	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.025	–1.19	–0.03	–1.13	0.002	0.06	0.021	0.9
DE	0.002	4.13	–0.001	–0.27	–0.01	–1.66	–0.004	–1.01
INTE	0.195	0.86	0.261	1	0.169	0.73	–0.079	–0.55
PKL	0.109	2.44	0.147	2.75	0.011	0.17	0.155	2
DS	0.453	1.63	0.011	0.04	0.304	0.96	–0.195	–0.76
IS	0.385	3.58	0.274	2.89	0.325	2.43	0.206	1.86
RDS	–0.068	–0.2	0.18	0.53	0.097	0.38	–0.15	–0.66
F-Statistic	6.67		3.06		2.24		1.52	
Adj R2	0.51		0.25		0.16		0.07	

TABLE 6.12 *(Continued)*

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.034	–0.87	–0.004	–0.1	0.012	0.55	–0.037	–2.33
DE	0.003	0.44	–0.006	–0.47	0.002	0.56	–0.002	–0.83
INTE	–0.161	–1.16	0.036	0.26	–0.026	–0.43	0.145	2.38
PKL	0.22	1.59	0.064	0.54	0.079	1.49	0.297	4.19
DS	–0.901	–2.11	–0.247	–0.48	–0.527	–1.57	–0.3	–0.85
IS	0.531	4.32	0.352	2.11	0.388	3.73	0.029	0.15
RDS	0.474	1.38	0.389	0.84	0.288	1.12	0.139	0.7
F-Statistic	4.41		1.12		2.64		7.59	
Adj R2	0.32		0.02		0.18		0.61	

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.051	–2.25	–0.006	–0.45	0.033	0.81	0.003	0.11
DE	0	0.65	0	–0.93	0.024	2.53	0.001	0.74
INTE	0.249	1.55	–0.017	–2.54	0.147	1.68	0.008	0.1
PKL	0.217	2.96	0.218	4.13	–0.196	–1.57	0.002	0.03
DS	–0.106	–0.41	–0.339	–1.63	2.755	9.38	1.778	12.68
IS	0.437	3.11	0.106	0.87	–0.21	–0.8	–0.047	–0.45
RDS	0.301	1.63	0.078	0.63	–0.694	–1.33	0.237	0.87
F-Statistic	3.77		3.72		16.41		28.23	
Adj R2	0.39		0.36		0.7		0.75	

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.02	1.27	0.005	0.27	–0.03	–1.35	–0.007	–0.68
DE	0	–0.66	0.001	0.31	–0.001	–0.21	0.003	2.52
INTE	–0.011	–0.18	–0.028	–0.55	0.016	0.65	–0.015	–0.93
PKL	0.072	1.35	0.126	1.55	0.242	3.55	–0.041	–1.16
DS	–0.178	–0.69	–0.623	–1.67	–0.03	–0.09	0.179	0.84
IS	0.163	2.08	0.211	2.18	0.186	1.85	0.308	4.76
RDS	0.316	1.58	0.528	1.67	–0.184	–0.92	0.182	1.23
F-Statistic	1.53		2.09		3.67		7.7	
Adj R2	0.05		0.1		0.2		0.21	

(Continued)

TABLE 6.12 *(Continued)*

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.014	–1.73	0.029	1.08	0.028	1.34	–0.008	–1.02
DE	–0.001	–1.33	–0.003	–1.38	0	0.4	0.001	1.45
INTE	–0.023	–1.14	–0.25	–10.97	–0.023	–3.73	–0.001	–0.24
PKL	0.011	0.42	–0.411	–4.49	–0.135	–1.99	–0.053	–2.12
DS	–0.132	–1.56	5.806	17.2	3.394	11.27	0.586	3.65
IS	0.427	16.18	0.235	2.52	–0.268	–3.1	0.388	10.44
RDS	–0.025	–0.2	0.779	1.79	0.365	1.05	–0.072	–0.49
F-Statistic	46.46		51.43		22.67		24.3	
Adj R2	0.54		0.51		0.31		0.31	

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.013	–1.34	–0.01	–1.08	–0.01	–1.3	–0.022	–1.59
DE	0	–0.58	0.001	0.42	0	1.33	0	0.12
INTE	–0.009	–0.66	0.001	1.39	–0.004	–0.65	–0.005	–0.48
PKL	–0.071	–2.26	0.061	2.12	–0.082	–3.36	0.047	1.08
DS	0.682	3.55	–1.686	–9.49	0.592	4.58	–1.524	–6.89
IS	0.624	17.41	0.533	18.29	0.665	29.44	0.733	19.2
RDS	–0.335	–2	–0.546	–3.78	–0.145	–1.2	–0.243	–1.22
F-Statistic	56.81		66.23		157.63		64.86	
Adj R2	0.5		0.53		0.73		0.53	

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.014	–2.37	–0.036	–3.53	–0.051	–4.46	0.034	2.55
DE	0	–0.99	0	–0.29	0	0.53	0	–0.11
INTE	–0.007	–1	–0.004	–0.23	–0.002	–1.73	–0.022	–1.77
PKL	–0.043	–2.62	0.033	1.06	0.05	1.4	–0.213	–4.78
DS	0.295	2.61	–0.029	–0.1	–0.229	–1.14	–0.377	–0.95
IS	0.538	16.51	0.547	19.05	0.458	11.58	0.621	12.21
RDS	0.025	0.23	–0.139	–1.01	0.582	7.62	–0.096	–0.86
F-Statistic	52		65.04		43.51		30.77	
Adj R2	0.47		0.52		0.42		0.33	

TABLE 6.12 *(Continued)*

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.001	0.15	–0.024	–1.43	0.006	0.46	0.007	0.79
DE	0.001	2.55	0	–0.02	0.003	3.75	0	–0.63
INTE	–0.004	–0.95	–0.008	–0.25	–0.004	–1.74	–0.003	–0.6
PKL	–0.008	–4.88	0.019	0.84	0.035	0.8	–0.002	–0.14
DS	–0.308	–1.53	0.314	0.57	–0.916	–5.39	–0.015	–0.05
IS	0.33	10.42	0.347	2.87	0.162	2.06	0.436	6.47
RDS	–0.097	–3.79	0.071	0.53	0.203	3.79	–0.517	–6.56
F-Statistic	23.55		2.05		13.54		9.98	
Adj R2	0.27		0.02		0.15		0.11	

	1988		1989		1990		1991	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.002	–0.24	–0.006	–0.57	0.008	0.64	–0.002	–0.28
DE	0	–0.93	0	0.27	–0.001	–2.68	–0.001	–1.16
INTE	–0.02	–2.52	–0.002	–0.4	–0.001	–0.06	–0.005	–0.82
PKL	–0.041	–1.47	0.038	1.2	–0.025	–0.75	–0.006	–0.31
DS	0.492	5.03	–0.756	–7.5	0.033	0.23	–0.369	–1.93
IS	0.507	7.05	0.356	6.88	0.11	1.1	0.231	3.58
RDS	–0.131	–1.69	–0.046	–2.46	0.002	0.2	–0.013	–0.73
F-Statistic	13.98		17.67		1.83		3.15	
Adj R2	0.14		0.17		0.01		0.02	

	1992		1993		1994		1995	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.01	1.07	–0.016	–3.23	–0.032	–5.35	0.047	1.93
DE	0	–0.09	0	–1.82	0	–0.74	0	0.1
INTE	–0.002	–0.52	0	0.07	0	0.11	0	0.02
PKL	–0.021	–1.44	–0.002	–0.82	0.004	0.57	–0.171	–2.95
DS	–0.452	–1.33	0.352	5.21	0.036	0.32	–0.004	–0.01
IS	0.078	1.21	0.29	5.66	0.601	11.19	0.186	1.03
RDS	–0.031	–1.08	–0.02	–1.59	0.02	1.24	0.415	13.29
F-Statistic	0.97		12.3		26.87		35.66	
Adj R2	0		0.1		0.19		0.22	

(Continued)

TABLE 6.12 *(Continued)*

	1996		1997		1998		1999	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.011	–0.85	0.033	3.42	–0.084	–2.64	0.088	7.73
DE	0.001	1.48	0	0.11	0.002	2.67	0	0.05
INTE	0	–0.07	0	–0.93	0	–0.12	0	–0.02
PKL	0.037	1.3	–0.023	–0.8	0.007	0.29	–0.133	–5.26
DS	–1.54	–4.88	–0.382	–1.31	0.25	0.22	0.103	0.41
IS	0.572	6.94	0.211	7.04	0.734	7.39	–0.048	–0.85
RDS	–0.052	–1.69	0.018	1.66	1.918	17.58	0.017	0.6
F-Statistic	12.09		11.27		64.63		5.26	
Adj R2	0.08		0.07		0.29		0.03	

	2000		2001		2002	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.039	–3.23	–0.023	–2.22	–0.015	–1.6
DE	0	–0.25	0	–0.37	0.001	0.7
INTE	0	–0.41	0	–0.71	–0.001	–0.53
PKL	–0.016	–0.59	0.016	0.8	0.007	0.76
DS	0.185	0.86	0.234	0.86	0.344	1.34
IS	0.39	5.37	0.18	2.92	0.249	3.58
RDS	0.91	13.65	0.537	8.03	–0.096	–2.43
F-Statistic	39.49		13.55		3.17	
Adj R2	0.18		0.07		0.01	

TABLE 6.13 R&D Equation OLS

	1952		1953		1954		1955	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.003	–0.44	0.005	1.25	–0.001	–0.29	–0.001	–0.19
RDL	0.985	12.4	0.89	18.83	1.074	19.34	0.877	9.21
Size	0.13	0.6	0.064	0.65	0.117	1.23	–0.106	–1
PKL	0.003	0.19	0.004	0.46	–0.003	–0.36	0.024	1.67
IS	0.008	0.22	0.016	1.05	–0.004	–0.31	0.044	1.2
DS	0.118	1.22	0.038	0.77	0.053	1.21	0.048	0.65
FS	–0.044	–0.86	–0.139	–3.59	–0.016	–0.62	–0.169	–2.19
F-Statistic	29.09		82.86		93.6		19.84	
Adj R2	0.9		0.96		0.96		0.8	

TABLE 6.13 *(Continued)*

	1956		1957		1958		1959	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.005	0.92	–0.003	–0.71	–0.004	–0.47	–0.005	–1.29
RDL	0.781	7.92	0.968	14.93	1.031	8.69	1.202	25.3
Size	0.041	0.42	0.023	0.24	0.426	2.52	0.049	0.54
PKL	0.004	0.26	0.013	1.29	–0.003	–0.14	–0.014	–1.02
IS	–0.04	–1.43	0.016	0.81	0.029	0.66	0.051	2.7
DS	0.003	0.04	–0.003	–0.05	0.147	1.34	–0.011	–0.28
FS	0.023	0.5	–0.021	–0.59	–0.193	–2.65	–0.041	–1.42
F-Statistic	18.42		56.14		16.57		126.46	
Adj R2	0.76		0.9		0.71		0.95	

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.005	1.4	–0.008	–2.11	–0.005	–1.33	0.003	0.39
RDL	1.003	30.52	0.944	20.51	1	25.49	1.048	11.53
Size	–0.158	–2.75	0.34	1.94	–0.006	–0.09	0.201	0.89
PKL	0.005	0.48	0.034	3.04	0.012	1.53	–0.024	–0.6
IS	–0.025	–1.79	0.016	0.92	0.031	1.72	0.039	0.49
DS	–0.015	–0.42	–0.12	–2.33	–0.002	–0.03	–0.12	–0.84
FS	0.017	1.07	–0.003	–0.18	–0.051	–2.02	–0.014	–0.17
F-Statistic	174.98		81.41		119.13		35.66	
Adj R2	0.96		0.92		0.94		0.89	

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.004	0.5	0.013	1.49	–0.004	–0.66	–0.003	–0.51
RDL	1.058	12.21	0.978	12.91	0.919	13.9	0.887	13.4
Size	–0.149	–0.84	–0.335	–1.49	0.102	0.74	0.152	1.2
PKL	–0.008	–0.22	–0.018	–0.52	–0.002	–0.11	0.032	2.06
IS	–0.067	–0.97	–0.107	–1.46	0.014	0.46	0.007	0.27
DS	–0.025	–0.21	–0.038	–0.29	0.056	0.84	–0.168	–2.33
FS	–0.024	–0.24	0.019	0.18	0.013	0.6	–0.018	–0.49
F-Statistic	41.52		34.04		39.4		36.71	
Adj R2	0.9		0.87		0.86		0.8	

(Continued)

TABLE 6.13 *(Continued)*

	1968		1969		1970		1971	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.002	–0.58	–0.008	–2.93	–0.012	–2.26	–0.002	–0.87
RDL	0.927	18.57	0.9	23.63	1.119	16.25	0.793	22.38
Size	–0.171	–2.17	0.001	0.01	0.409	6.44	–0.049	–1.48
PKL	0.023	1.74	0.031	3.07	0.012	0.69	0.029	2.99
IS	–0.013	–0.68	0.011	0.89	0.037	1.56	0.017	0.9
DS	–0.041	–0.66	0.025	0.51	0.056	0.66	–0.062	–1.03
FS	0.011	0.33	0.003	0.17	–0.105	–3.18	0.033	1.49
F-Statistic	76.14		129.78		74.55		86.54	
Adj R2	0.89		0.93		0.87		0.77	
	1972		**1973**		**1974**		**1975**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.002	1.21	0.001	0.42	–0.002	–1.41	–0.002	–1.51
RDL	0.853	46.94	0.86	40.24	0.844	36.22	1.007	54.4
Size	–0.044	–2.68	0.122	8.13	–0.102	–5.55	0.038	2.94
PKL	0.006	1.47	0	–0.04	0.018	3.8	0.004	1.26
IS	–0.003	–0.45	–0.002	–0.5	–0.001	–0.1	0.004	0.81
DS	–0.001	–0.12	–0.01	–0.64	–0.008	–0.34	–0.008	–0.4
FS	0.006	0.58	–0.004	–1.43	0.003	0.83	–0.007	–1.04
F-Statistic	372.68		313.88		242.01		533.52	
Adj R2	0.9		0.87		0.83		0.91	
	1976		**1977**		**1978**		**1979**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0	–0.23	–0.006	–3.95	0	0.07	0	0.44
RDL	0.903	54.26	0.967	38.69	0.81	30.01	0.991	65.47
Size	–0.013	–3.18	–0.006	–0.64	0.036	2.35	–0.036	–2.94
PKL	0.005	1.64	0.021	4.61	0.008	1.39	0.001	0.41
IS	0.006	1.13	0.043	6.74	0.014	1.35	0.004	0.96
DS	–0.006	–0.31	–0.116	–3.69	0.037	1.17	–0.019	–1.09
FS	–0.005	–0.82	–0.047	–5.56	–0.045	–3.47	–0.005	–1.19
F-Statistic	511.76		274.6		167.33		770.37	
Adj R2	0.9		0.83		0.74		0.93	

TABLE 6.13 *(Continued)*

	1980		1981		1982		1983	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.001	–0.81	–0.002	–2.42	0.004	2.48	0	–0.45
RDL	0.996	79.51	1.121	73.17	0.885	88.59	0.938	120.41
Size	0.033	2.86	–0.07	–4.49	0.062	2.67	–0.031	–2.5
PKL	0.005	2.58	0.01	3.25	0.005	1.09	0.012	3.47
IS	0.002	0.33	0.001	0.17	0.016	2.44	–0.006	–1.31
DS	–0.014	–1.12	–0.047	–1.66	–0.038	–1.43	0.021	0.71
FS	0	–0.03	0.001	0.11	–0.026	–3.35	0.008	2.06
F-Statistic	1,156.26		919		1,813.05		2,584.59	
Adj R2	0.95		0.94		0.97		0.98	

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.012	5.53	0.016	5.81	–0.023	–2.72	0.006	1.49
RDL	0.615	80.96	0.448	36.81	0.938	16.45	0.41	20.57
Size	–0.018	–0.3	0.036	0.44	2.451	14.46	0.543	4.96
PKL	0	0.52	–0.001	–0.38	–0.027	–1.01	–0.029	–5.4
IS	0.027	1.75	0.083	4.03	0.144	3.12	0.23	8.79
DS	–0.083	–0.96	–0.144	–1.47	0.213	2.07	0.171	1.32
FS	0.029	1.31	0.013	1.54	0.048	1.64	–0.114	–6.01
F-Statistic	1,759.43		291.38		170.93		136.78	
Adj R2	0.97		0.81		0.71		0.64	

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.002	–1.03	0.025	6.88	–0.051	–9.61	0.019	5.41
RDL	0.828	84.18	0.673	56.56	1.361	34.99	0.42	56.79
Size	–0.194	–4.06	–0.789	–7.15	2.862	30.45	–0.67	–5.24
PKL	0.022	5.02	–0.028	–2.52	0.121	8.06	–0.018	–1.8
IS	0.031	2.83	0.017	0.93	–0.148	–3.29	0.225	6.45
DS	–0.016	–1.09	–0.037	–0.99	0.097	1.49	–0.106	–1.19
FS	0.008	1.22	–0.019	–1.18	–0.161	–6.77	0.004	0.22
F-Statistic	1,489.83		4,526.7		9,392.71		2,502.2	
Adj R2	0.95		0.98		0.99		0.96	

(Continued)

TABLE 6.13 *(Continued)*

	1992		1993		1994		1995	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.02	–5.42	0	0	–0.001	–0.49	–0.04	–7.55
RDL	1.267	60.51	1.207	36.99	0.992	112.89	1.165	76.23
Size	–1.631	–9.64	–3.031	–8.14	–1.658	–13.6	4.458	26.16
PKL	–0.002	–0.35	0	–0.09	–0.003	–0.88	0.058	4.56
IS	0.314	9.31	0.098	1.53	0.109	4.6	–0.062	–1.57
DS	–0.124	–0.97	0.007	0.08	–0.019	–0.42	0.092	1.16
FS	–0.06	–3.85	–0.067	–1.35	–0.02	–1.29	–0.04	–3.44
F-Statistic	2,069.2		817.12		4,575.6		3,756.27	
Adj R2	0.95		0.89		0.98		0.97	

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.005	–0.55	–0.081	–6.49	0.036	9.3	–0.074	–10.48
RDL	0.336	21.75	1.715	51.33	0.356	52.24	0.812	47.78
Size	4.55	13.96	1.985	10.59	0.084	0.84	1.596	8.52
PKL	–0.002	–0.07	0.134	3.66	0	–0.17	0.249	15.32
IS	0.148	2.23	–0.041	–1.03	–0.133	–10.12	0.182	5.74
DS	–0.177	–0.73	0.21	0.59	–0.242	–1.88	–0.062	–0.45
FS	0.317	8.45	–0.027	–0.63	0.084	22.52	–0.061	–3.39
F-Statistic	211.32		853.92		710.73		583.1	
Adj R2	0.61		0.85		0.82		0.78	

	2000		2001		2002	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.025	5.08	0.01	2.89	–0.076	–14.98
RDL	0.203	18.9	0.577	36.8	0.829	25.21
Size	5.239	5.12	1.37	1.62	42.218	24.77
PKL	0.009	0.85	0.031	4.97	0.005	1.27
IS	0.007	0.28	0.057	3.18	0.208	6.43
DS	–0.146	–1.84	–0.118	–1.48	0.293	2.4
FS	0.081	7.03	0.025	2.84	–0.04	–2.85
F-Statistic	123.69		277.08		334.57	
Adj R2	0.42		0.61		0.64	

TABLE 6.14 Dividend Equation 2SLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.023	1.23	–0.017	–0.64	–0.005	–0.2	0.017	1.11
DIVL	0.923	14.66	0.924	11.4	1.113	9.85	1.061	12.41
CAK	–0.035	–1.49	0.024	0.67	0	0.01	–0.024	–1.01
PK	–0.008	–0.47	–0.001	–0.08	0.016	1.01	0.009	0.56
IS	–0.025	–0.72	0.022	0.5	–0.027	–0.53	–0.028	–0.5
FS	–0.029	–0.42	0.106	1.31	0.037	0.51	–0.156	–1.4
RDS	–0.105	–1.73	0.025	0.33	0.018	0.2	0.013	0.15
F-Statistic	61.22		46.73		34.48		67.52	
Adj R2	0.95		0.92		0.89		0.93	

	1956		1957		1958		1959	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.005	0.38	–0.009	–1.1	–0.006	–1	–0.004	–0.64
DIVL	0.967	18.56	0.96	32.02	1.047	31.61	1.03	37.63
CAK	–0.016	–0.76	0.005	0.41	0.01	0.9	0.005	0.5
PK	0.023	1.77	0.02	2.06	0.004	0.39	–0.004	–0.36
IS	–0.026	–0.66	0.042	1.23	–0.002	–0.1	–0.016	–0.64
FS	–0.018	–0.38	–0.056	–1.44	–0.005	–0.2	–0.003	–0.07
RDS	0.057	0.89	0.026	0.64	0.018	0.54	0.061	2.28
F-Statistic	86.91		236.3		239.21		277.83	
Adj R2	0.94		0.97		0.97		0.98	

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.016	2.23	0.001	0.15	–0.001	–0.36	0.002	0.36
DIVL	0.901	28.48	1.071	57.1	0.959	44.01	0.964	16.14
CAK	–0.027	–2.05	0.003	0.45	–0.003	–0.58	–0.001	–0.1
PK	0.016	2.27	–0.012	–2.1	0.008	2.03	0.014	0.76
IS	–0.039	–1.41	–0.008	–0.67	0.005	0.46	–0.048	–1.43
FS	0.011	0.59	–0.001	–0.07	–0.001	–0.05	0.006	0.16
RDS	–0.034	–1.13	0.002	0.09	0.006	0.33	–0.035	–1.09
F-Statistic	216.87		629.38		454.9		226	
Adj R2	0.97		0.99		0.98		0.98	

(Continued)

TABLE 6.14 *(Continued)*

	1964		1965		1966		1967	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.006	–0.51	0.002	0.23	–0.002	–0.5	–0.003	–0.37
DIVL	1.016	10.1	0.865	16.51	1.018	36.78	1.114	16.58
CAK	0.002	0.1	–0.004	–0.42	0.003	0.52	0.007	0.63
PK	0.03	0.96	0.007	0.43	–0.012	–2.02	–0.022	–2.02
IS	0.057	0.77	–0.05	–1	0.006	0.36	0.008	0.29
FS	–0.167	–1.32	0.064	0.89	0.039	4.81	–0.01	–0.3
RDS	0.094	1.59	0.06	1.84	–0.006	–0.28	0.002	0.04
F-Statistic	44.26		120.34		1,275.78		498.26	
Adj R2	0.91		0.96		0.99		0.98	
	1968		**1969**		**1970**		**1971**	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.002	–0.62	0	0.08	–0.003	–0.88	–0.001	–0.37
DIVL	0.97	44.5	0.998	49.13	0.943	38.92	0.977	40.72
CAK	0	–0.13	–0.001	–0.17	0.001	0.24	–0.001	–0.19
PK	0	–0.05	–0.002	–0.52	0.014	2.52	0.006	1.28
IS	0.003	0.31	–0.014	–2.03	0.004	0.29	–0.021	–1.29
FS	0.001	0.04	0.019	1.51	–0.032	–1.77	0.038	1.65
RDS	0.028	1.59	0.009	0.52	0.021	1.4	0.015	0.89
F-Statistic	636.36		710.18		432.03		510.78	
Adj R2	0.99		0.99		0.98		0.95	
	1972		**1973**		**1974**		**1975**	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.001	0.57	0.007	3.35	0.012	2.06	0.003	1.44
DIVL	0.876	199.96	0.697	57.32	0.419	10.12	0.822	44.6
CAK	–0.001	–0.62	–0.014	–4.3	–0.026	–2.68	–0.005	–1.28
PK	0.005	2.41	0.019	4.92	0.04	4.47	0.009	2.24
IS	–0.006	–0.58	–0.047	–5.42	–0.087	–2.95	–0.008	–0.65
FS	0.003	0.16	0.039	12.74	0.096	5.79	0.029	2.13
RDS	–0.001	–0.06	0.033	1.78	0.086	1.67	0.004	0.21
F-Statistic	8,224.67		1,530.41		108.79		469.04	
Adj R2	1		0.97		0.69		0.9	

TABLE 6.14 *(Continued)*

	1976		1977		1978		1979	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.001	0.98	–0.001	–0.72	–0.001	–0.39	0.002	1.92
DIVL	0.879	69.7	1.002	50.22	1.021	52.9	1.019	71.85
CAK	0	0.09	–0.001	–0.5	–0.001	–0.47	–0.001	–1.5
PK	0.005	2.83	0.007	3.74	0.006	1.81	–0.002	–1.37
IS	–0.006	–0.62	–0.004	–0.53	–0.02	–1.38	–0.012	–2.29
FS	0.003	0.28	–0.001	–0.07	0.029	1.49	0.012	1.99
RDS	–0.006	–0.51	0.007	0.6	0.009	0.62	0.001	0.08
F-Statistic	1,679.04		1,500.19		839.35		1,486.66	
Adj R2	0.97		0.96		0.94		0.96	

	1980		1981		1982		1983	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.001	0.45	–0.001	–1.71	–0.001	–0.94	0	0.06
DIVL	1.071	75.2	0.986	78.54	1.091	107.25	0.987	74.18
CAK	–0.002	–0.88	0.001	1.3	0.002	2.01	0	0.38
PK	–0.001	–0.5	0.005	3.48	–0.002	–1.51	0	0.26
IS	–0.019	–1.38	–0.004	–1.37	–0.004	–1.11	0.005	1.35
FS	0.013	0.6	0.003	0.67	0.004	0.9	–0.01	–2.54
RDS	0.027	2.38	0.002	0.37	–0.003	–0.63	–0.001	–0.25
F-Statistic	1,684.73		1,293.04		2,105.6		1,006.36	
Adj R2	0.97		0.96		0.97		0.94	

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.001	–1.43	0.001	1.1	0.001	0.33	0.015	6.08
DIVL	0.897	54.18	1.016	82.42	0.92	9.46	0.196	8.06
CAK	0.002	2.52	0	–0.27	–0.003	–1.82	–0.013	–3.7
PK	0.005	2.88	0.001	0.6	0.015	1.98	0.016	3.33
IS	0.01	1.55	–0.006	–1.49	0.011	0.37	–0.065	–3.09
FS	–0.016	–1.4	0.005	2.19	–0.06	–1.87	0.017	0.82
RDS	–0.003	–0.97	0.001	0.38	0.003	0.21	0.04	2.12
F-Statistic	575.45		1,251.9		20.62		20.63	
Adj R2	0.9		0.95		0.22		0.21	

(Continued)

TABLE 6.14 *(Continued)*

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.015	1.42	0.009	1.41	0.017	3.11	0.006	2.39
DIVL	0.102	1.83	0.097	2.38	0.182	4.6	0.245	6.92
CAK	–0.031	–2.61	–0.008	–1.13	–0.011	–1.56	–0.001	–1.62
PK	0.068	3.43	0.038	2.81	0.007	0.8	0.009	1.8
IS	–0.14	–2.44	–0.022	–0.52	–0.043	–1.01	0.056	1.78
FS	0.058	0.64	–0.004	–0.08	0.001	0.03	–0.232	–2.5
RDS	0.077	1.93	0.004	0.46	0.002	0.58	–0.004	–0.75
F-Statistic	7.29		3.55		4.8		17.55	
Adj R2	0.07		0.03		0.04		0.15	
	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.002	3.7	0.012	1.77	0.021	5.25	0.006	1.87
DIVL	0.842	37.28	0.383	5.28	0.154	5.3	0.898	14.83
CAK	–0.001	–1.1	–0.005	–0.53	–0.017	–3.3	–0.01	–2.3
PK	0	0.77	–0.002	–0.48	0	–0.01	0.007	1.71
IS	–0.006	–1.54	0.028	0.44	–0.068	–1.63	–0.03	–1.25
FS	0.015	1.19	–0.24	–2.55	0.025	0.37	–0.002	–0.53
RDS	0.002	1.07	–0.002	–0.2	0.005	0.83	0.003	0.83
F-Statistic	444.04		6.64		7.91		45.32	
Adj R2	0.82		0.05		0.06		0.27	
	1996		1997		1998		1999	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.013	5.46	0.003	3.31	0.005	3.18	0.001	0.51
DIVL	0.175	8.37	0.461	21.89	0.535	25.33	0.806	23.62
CAK	–0.016	–5.25	–0.005	–5.29	–0.008	–3.7	0.001	0.55
PK	0.015	3.23	0.016	5.29	0.008	2.21	0.002	0.36
IS	–0.027	–1.99	–0.004	–0.73	–0.004	–0.92	0.005	0.6
FS	–0.016	–3.41	–0.015	–1.11	0.001	0.36	–0.005	–0.34
RDS	0.006	1.62	0.003	2.62	0.005	0.66	0	–0.1
F-Statistic	28.03		107.58		126.34		96.13	
Adj R2	0.17		0.42		0.45		0.37	

TABLE 6.14 *(Continued)*

Variable	2000 Coeff	2000 T-Stat	2001 Coeff	2001 T-Stat	2002 Coeff	2002 T-Stat
Intercept	0.007	3.03	0.004	3.66	0.004	3.43
DIVL	0.546	17.04	0.458	26.71	0.602	23.39
CAK	–0.006	–1.92	0	–0.09	–0.001	–0.96
PK	0	0.01	0.007	3.35	0.001	0.4
IS	–0.01	–0.69	–0.018	–1.84	–0.002	–0.16
FS	–0.046	–2.95	0.039	2.41	–0.006	–0.21
RDS	0.042	2.47	–0.022	–2.05	–0.001	–0.2
F-Statistic	52.15		141.15		101.2	
Adj R2	0.23		0.44		0.35	

TABLE 6.15 Investment Equation 2SLS

Variable	1952 Coeff	1952 T-Stat	1953 Coeff	1953 T-Stat	1954 Coeff	1954 T-Stat	1955 Coeff	1955 T-Stat
Intercept	0.213	2.01	0.484	5.04	0.395	7.47	0.27	6.01
PKL	–0.102	–0.93	–0.105	–1.13	–0.096	–1.4	0.008	0.13
CAK	–0.298	–2.17	–0.67	–5.29	–0.591	–7.35	–0.4	–5.86
D2sales	0	–99	–0.011	–0.14	0.122	1.54	–0.049	–0.61
DS	0.605	1.05	–1.133	–1.63	–0.686	–1.47	–0.954	–2.4
FS	0.187	0.36	–0.323	–0.6	–0.373	–0.97	0.649	1.5
RDS	0.092	0.18	0.496	0.94	0.713	1.79	0.218	0.52
F-Statistic	6.29		10.58		15.95		13.85	
Adj R2	0.58		0.71		0.78		0.73	

Variable	1956 Coeff	1956 T-Stat	1957 Coeff	1957 T-Stat	1958 Coeff	1958 T-Stat	1959 Coeff	1959 T-Stat
Intercept	0.275	5.82	0.202	5.19	0.203	8.07	0.176	4.93
PKL	0.183	1.97	–0.041	–0.47	0.11	1.47	0.01	0.07
CAK	–0.437	–4.97	–0.299	–3.4	–0.362	–6.4	–0.326	–5.49
D2sales	0.037	0.47	–0.044	–0.57	0.009	0.17	–0.073	–1.09
DS	0.018	0.04	–0.011	–0.03	–0.036	–0.09	–0.339	–0.98
FS	–0.507	–1.12	0.906	2.42	0.083	0.28	1	1.57
RDS	–0.648	–1.2	–0.197	–0.42	0.174	0.64	0.332	1.22
F-Statistic	7.16		9.37		9.84		6.25	
Adj R2	0.53		0.58		0.58		0.44	

(Continued)

TABLE 6.15 *(Continued)*

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.239	7.46	0.23	6.14	0.206	5.21	0.088	2.9
PKL	0.163	1.84	–0.004	–0.05	0.037	0.61	0.22	1.56
CAK	–0.448	–7.98	–0.397	–5.96	–0.347	–4.91	–0.136	–3.15
D2sales	–0.069	–1.15	–0.006	–0.07	0.03	0.46	0.015	0.19
DS	–0.444	–1.47	–0.294	–0.82	0.109	0.29	–0.437	–0.9
FS	0.505	3.09	0.391	1.38	0.131	0.46	–0.55	–1.46
RDS	0.231	0.9	0.602	1.81	0.193	0.66	0.349	1.39
F-Statistic	21.59		9.65		10.05		2.3	
Adj R2	0.74		0.54		0.55		0.24	
	1964		**1965**		**1966**		**1967**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.132	4.77	0.145	5.87	0.202	7	0.224	8.89
PKL	–0.101	–0.9	–0.019	–0.23	0.221	3.57	0.116	1.79
CAK	–0.14	–2.98	–0.167	–4.29	–0.249	–5.41	–0.291	–7.21
D2sales	0.035	0.54	0.081	1.39	–0.224	–3.35	–0.137	–2.48
DS	–0.071	–0.23	0.077	0.25	–0.98	–3.23	–1.229	–2.37
FS	0.325	0.5	–0.378	–0.75	0.298	2.42	0.49	1.7
RDS	0.021	0.07	0.114	0.58	0.107	0.43	0.04	0.15
F-Statistic	4.93		3.45		11.74		10.31	
Adj R2	0.48		0.34		0.62		0.5	
	1968		**1969**		**1970**		**1971**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.137	2.34	0.196	4.75	0.211	4.46	0.127	9.28
PKL	0.005	0.05	0.026	0.19	–0.107	–1.11	0.057	1.2
CAK	–0.185	–2.28	–0.293	–4.02	–0.307	–6.08	–0.193	–8
D2sales	–0.19	–1.17	–0.295	–1.92	–0.072	–0.46	–0.033	–1.24
DS	0.22	0.46	0.026	0.04	–0.153	–0.29	0.045	0.18
FS	1.427	1.15	1.548	2.16	0.88	1.39	0.96	5.58
RDS	–0.509	–0.88	–0.254	–0.45	0.354	1.21	0.242	1.45
F-Statistic	4.67		5.03		10.76		23.11	
Adj R2	0.28		0.28		0.47		0.47	

TABLE 6.15 *(Continued)*

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.133	7.66	0.164	8.49	0.178	8.03	0.143	10.92
PKL	–0.015	–0.35	0.059	1.08	0.112	2.09	0.1	3.22
CAK	–0.193	–6.63	–0.277	–9	–0.288	–9.06	–0.243	–11.01
D2sales	0.02	1.13	0.077	2.34	–0.021	–0.57	–0.002	–0.1
DS	0.073	0.63	–1.022	–4.95	–1.679	–4.28	–0.64	–3.16
FS	1.41	9.49	0.199	4.68	0.386	3.75	0.578	6.02
RDS	0.332	1.63	0.719	2.78	0.881	3.29	0.608	3.38
F-Statistic	45.74		18.02		15.57		32.38	
Adj R2	0.53		0.26		0.23		0.38	

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.088	6.45	0.091	4.69	0.08	6.48	0.022	1.03
PKL	0.095	2.47	–0.056	–1.21	0.108	3.59	–0.166	–3.08
CAK	–0.127	–6.08	–0.104	–3.79	–0.133	–7.88	–0.021	–1.31
D2sales	0.013	0.47	–0.113	–3.18	0.007	0.4	0.192	5.19
DS	–0.929	–4.06	2.499	6.91	–0.683	–4.2	2.258	7.16
FS	1.039	12.52	1.605	10.33	1.151	17.37	1.248	9.24
RDS	0.659	3.48	0.965	4.18	0.467	3.25	0.119	0.5
F-Statistic	53.38		31.37		93.59		21.04	
Adj R2	0.48		0.34		0.62		0.26	

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.077	5.9	0.06	2.54	0.121	7.49	–0.013	–0.78
PKL	0.101	3.1	0.167	2.46	–0.006	–0.13	0.255	4.25
CAK	–0.111	–5	0.002	0.05	–0.156	–6.21	–0.012	–1.93
D2sales	–0.032	–1.53	–0.275	–5.37	0.062	2.91	–0.065	–3.22
DS	–0.597	–2.84	–0.676	–1.16	0.359	1.42	0.361	0.79
FS	1.606	9.27	1.883	9.87	0.062	0.48	1.064	9.29
RDS	0.307	1.67	0.273	1.15	0.515	3.64	0.35	2.84
F-Statistic	28.13		29.39		15.98		17.24	
Adj R2	0.32		0.33		0.2		0.22	

(Continued)

TABLE 6.15 *(Continued)*

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.023	1.91	0.08	11.6	0.06	7.32	0.101	8.02
PKL	0.016	4.31	0.133	7.44	0.003	0.1	0.001	0.07
CAK	0.004	0.59	–0.129	–8.56	–0.004	–1.93	–0.095	–5.79
D2sales	–0.014	–0.52	0	0.02	0.008	0.54	0.008	0.48
DS	0.802	1.83	–0.147	–0.58	0.38	1.55	–1.499	–3.01
FS	1.836	8.79	0.324	6.43	0.094	1.2	0.394	3.95
RDS	0.324	7.21	0.43	7.91	0.284	8.02	0.664	11.08
F-Statistic	24.68		20.51		20.11		29.27	
Adj R2	0.28		0.23		0.22		0.27	

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.12	6.87	0.088	6.39	0.104	10.81	0.028	1.36
PKL	0.055	2.03	–0.006	–0.15	0.031	1.61	–0.006	–0.11
CAK	–0.128	–5.09	–0.061	–3.76	–0.078	–6.12	0	–0.17
D2sales	–0.009	–0.49	–0.04	–4.7	0	0	–0.038	–1.11
DS	–1.532	–3.98	–0.025	–0.04	–1.196	–3.09	2.012	1.98
FS	0.094	0.62	0.825	6.66	0.131	3.23	2.577	3.4
RDS	0.439	6.64	0.131	7.26	0.054	10.13	0.067	1.46
F-Statistic	14.66		21.23		25.22		2.44	
Adj R2	0.15		0.2		0.22		0.02	

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.053	7.4	0.106	7.82	0.103	5.72	0.069	9.79
PKL	0.016	1.41	–0.002	–0.46	–0.006	–0.57	–0.007	–0.56
CAK	–0.015	–2.25	–0.072	–3.81	–0.05	–2.04	–0.056	–6.23
D2sales	–0.021	–1.09	–0.142	–3.92	–0.046	–1.7	0.074	5.49
DS	0.376	1.11	–0.643	–1.49	–1.751	–2.55	0.337	2.13
FS	0.364	2.46	1.599	6.35	1.374	7.15	–0.004	–0.35
RDS	0.263	15.61	0.12	6.92	–0.004	–0.14	0.027	3.5
F-Statistic	40.84		19.6		16.13		12.78	
Adj R2	0.29		0.15		0.12		0.09	

TABLE 6.15 *(Continued)*

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.122	12.11	0.055	2.97	0.142	9.19	0.132	10.45
PKL	–0.01	–0.77	–0.024	–0.51	–0.007	–0.9	–0.05	–2.25
CAK	–0.108	–8.09	0	–0.03	–0.089	–3.03	–0.031	–2
D2sales	0.021	1.33	–0.087	–2.66	–0.08	–2.78	–0.121	–7.78
DS	–1.324	–3.14	–0.4	–0.6	–1.285	–2.92	–0.505	–2.02
FS	0.024	1.1	1.198	5.46	0.066	2.79	–0.302	–2.4
RDS	0.109	8.38	0.023	1.37	–0.065	–1.11	0.069	3.97
F-Statistic	22.33		10.04		5.29		36.54	
Adj R2	0.14		0.06		0.03		0.18	

	2000		2001		2002	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.087	11.39	0.083	6.28	0.063	2.82
PKL	0.016	1.16	–0.002	–0.08	–0.016	–0.79
CAK	–0.034	–3.08	–0.005	–0.56	–0.023	–1.17
D2sales	–0.02	–1.35	–0.067	–2.21	–0.106	–2.15
DS	–0.662	–2.91	–0.972	–2.04	–0.814	–0.8
FS	0.301	4.9	1.13	5.09	2.292	3.91
RDS	–0.197	–3.06	–0.48	–3.3	0.267	2.86
F-Statistic	7.73		5.09		3.01	
Adj R2	0.04		0.02		0.01	

TABLE 6.16 Financing Equation 2SLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.027	0.69	0.025	0.93	0.016	0.5	0.002	0.12
DE	–0.002	–0.38	0	–0.71	0.005	1.71	0	0.07
INTE	0.269	0.59	–0.186	–0.32	0.325	0.66	0.071	0.31
PKL	–0.062	–0.74	–0.017	–0.25	–0.02	–0.3	–0.001	–0.02
DS	0.291	0.56	0.443	1.3	0.73	2.03	0.483	2.12
IS	0.347	2.06	0.16	1.78	0.109	0.98	0.243	2.7
RDS	–0.162	–0.36	–0.085	–0.26	–0.182	–0.5	0.342	1.16
F-Statistic	1.86		2.05		1.87		2.52	
Adj R2	0.21		0.22		0.17		0.24	

(Continued)

TABLE 6.16 *(Continued)*

	1956		1957		1958		1959	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.016	–0.71	–0.041	–1.46	0.013	0.42	0.022	0.93
DE	0.002	3.37	0	–0.13	–0.007	–1.06	–0.003	–0.74
INTE	0.237	1.02	0.221	0.82	0.132	0.56	–0.078	–0.54
PKL	0.115	2.52	0.148	2.72	0.001	0.01	0.162	2.06
DS	0.525	1.79	–0.092	–0.31	0.411	1.21	–0.105	–0.4
IS	0.275	2.1	0.382	3.41	0.183	1.13	0.127	0.98
RDS	–0.237	–0.63	0.306	0.88	0.08	0.3	–0.144	–0.63
F-Statistic	4.84		3.53		1.35		1.07	
Adj R2	0.41		0.29		0.05		0.01	

	1960		1961		1962		1963	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.029	–0.74	0.002	0.07	0.013	0.58	–0.032	–1.98
DE	0.002	0.35	–0.005	–0.42	0.002	0.55	–0.002	–0.79
INTE	–0.154	–1.1	0.027	0.19	–0.027	–0.45	0.13	2.08
PKL	0.226	1.61	0.072	0.6	0.079	1.49	0.314	4.35
DS	–0.804	–1.85	–0.266	–0.52	–0.556	–1.63	–0.369	–1.02
IS	0.45	3.33	0.272	1.51	0.386	3.45	–0.109	–0.52
RDS	0.44	1.27	0.404	0.87	0.294	1.14	0.171	0.85
F-Statistic	3.04		0.76		2.32		7.48	
Adj R2	0.22		–0.03		0.15		0.61	

	1964		1965		1966		1967	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.048	–2.12	–0.002	–0.16	0.025	0.61	–0.001	–0.02
DE	0	0.57	0	–0.95	0.021	2.09	0.001	0.69
INTE	0.247	1.53	–0.018	–2.62	0.14	1.59	0.011	0.14
PKL	0.21	2.83	0.217	4.02	–0.207	–1.64	0.002	0.03
DS	–0.045	–0.16	–0.317	–1.47	2.672	9.01	1.748	12.36
IS	0.404	2.76	0.042	0.32	–0.079	–0.26	–0.006	–0.05
RDS	0.273	1.46	0.067	0.53	–0.585	–1.1	0.236	0.87
F-Statistic	3.41		3.52		15.09		26.7	
Adj R2	0.36		0.34		0.68		0.74	

TABLE 6.16 *(Continued)*

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.025	1.53	0.013	0.64	–0.027	–1.21	–0.004	–0.36
DE	0	–0.74	0.001	0.65	0	–0.09	0.003	2.53
INTE	–0.015	–0.24	–0.028	–0.54	0.016	0.68	–0.017	–1.02
PKL	0.07	1.31	0.133	1.62	0.238	3.47	–0.046	–1.29
DS	–0.132	–0.51	–0.586	–1.53	0.034	0.1	0.242	1.08
IS	0.115	1.31	0.118	1.1	0.146	1.2	0.264	3.35
RDS	0.292	1.45	0.482	1.51	–0.182	–0.91	0.193	1.3
F-Statistic	1.08		1.51		3.33		5.71	
Adj R2	0.01		0.05		0.17		0.16	

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.014	–1.63	–0.002	–0.06	–0.004	–0.16	–0.007	–0.76
DE	–0.001	–1.34	–0.003	–1.31	0	0.46	0.001	1.37
INTE	–0.024	–1.18	–0.229	–9.69	–0.02	–3.08	–0.001	–0.28
PKL	0.011	0.41	–0.383	–4.07	–0.136	–1.91	–0.05	–1.99
DS	–0.126	–1.48	5.409	15.34	3.269	9.68	0.545	3.28
IS	0.425	11.15	0.607	4.21	0.204	1.59	0.364	6.57
RDS	–0.025	–0.19	0.709	1.58	0.221	0.61	–0.075	–0.51
F-Statistic	23.55		43.05		16.12		9.66	
Adj R2	0.36		0.47		0.24		0.14	

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.017	–1.71	–0.004	–0.44	–0.004	–0.5	–0.004	–0.24
DE	0	–0.59	0.001	0.37	0	1.22	0	0.02
INTE	–0.009	–0.69	0.001	1.31	–0.004	–0.71	–0.007	–0.62
PKL	–0.077	–2.43	0.063	2.17	–0.084	–3.36	0.034	0.76
DS	0.809	4.13	–1.697	–9.19	0.534	3.93	–1.461	–6.1
IS	0.667	13.41	0.444	9.72	0.606	16.92	0.544	7.68
RDS	–0.319	–1.9	–0.522	–3.56	–0.141	–1.15	–0.222	–1.08
F-Statistic	36.87		26.78		57.83		13.26	
Adj R2	0.39		0.31		0.5		0.18	

(Continued)

TABLE 6.16 *(Continued)*

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.009	–1.42	–0.037	–3.56	–0.036	–2.85	0.037	2.66
DE	0	–1.05	0	–0.31	0	0.44	0	–0.11
INTE	–0.009	–1.24	–0.004	–0.24	–0.002	–1.44	–0.022	–1.8
PKL	–0.041	–2.48	0.032	1.02	0.047	1.23	–0.215	–4.8
DS	0.362	3.03	0.016	0.05	–0.017	–0.08	–0.326	–0.79
IS	0.442	8.52	0.557	12.69	0.183	2.59	0.573	7.39
RDS	0.077	0.69	–0.139	–1.01	0.724	8.36	–0.075	–0.66
F-Statistic	19.49		32.05		19.72		15.04	
Adj R2	0.24		0.35		0.24		0.19	

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.001	–0.2	–0.004	–0.19	0.012	0.79	0.018	1.27
DE	0.001	2.51	0	–0.03	0.003	3.84	0	–0.54
INTE	–0.003	–0.92	–0.016	–0.49	–0.004	–1.73	–0.004	–0.71
PKL	–0.008	–4.87	0.021	0.95	0.031	0.67	0	–0.03
DS	–0.461	–2.18	0.246	0.43	–0.742	–1.99	–0.547	–0.83
IS	0.391	7.85	0.068	0.38	0.058	0.5	0.372	2.98
RDS	–0.121	–4.12	0.165	1.16	0.235	3.93	–0.492	–5.16
F-Statistic	16		0.59		8.67		4.76	
Adj R2	0.19		–0.01		0.1		0.05	

	1988		1989		1990		1991	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.013	1.05	0.001	0.11	0.001	0.04	0.002	0.26
DE	0	–0.68	0	0.13	–0.001	–2.28	–0.001	–1.02
INTE	–0.021	–2.52	–0.002	–0.45	0.001	0.05	–0.005	–0.86
PKL	–0.017	–0.52	0.078	1.89	–0.016	–0.46	0.001	0.06
DS	–0.22	–0.62	–1.852	–3.12	–0.964	–1.42	–0.773	–2.34
IS	0.341	2.98	0.347	4.02	0.4	2.9	0.215	2.59
RDS	–0.074	–0.84	–0.045	–2.03	–0.014	–1.14	–0.012	–0.66
F-Statistic	3.19		5.19		3.41		2.47	
Adj R2	0.03		0.05		0.03		0.02	

TABLE 6.16 *(Continued)*

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.026	2.5	0.005	0.53	–0.029	–3.36	0.069	2.5
DE	0	0.28	0	–1.54	0	–0.72	0	0.16
INTE	–0.003	–0.7	0	–0.17	0	0.11	0	–0.03
PKL	–0.018	–1.24	–0.002	–0.78	0.004	0.6	–0.167	–2.85
DS	–1.523	–4.02	–0.82	–3.11	0.319	0.81	–0.327	–0.52
IS	0.04	0.5	0.249	2.64	0.502	7.01	–0.104	–0.39
RDS	–0.024	–0.78	–0.02	–1.1	0.032	1.91	0.419	13.34
F-Statistic	3.18		5.13		14.12		35.39	
Adj R2	0.02		0.04		0.1		0.22	

	1996		1997		1998		1999	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.039	2.24	0.039	3.62	–0.057	–1.59	0.105	8.49
DE	0.001	1.5	0	0.22	0.001	1.85	0	0.09
INTE	0	–0.31	0	–0.93	0	–0.17	0	–0.08
PKL	0.082	2.52	–0.024	–0.81	0.003	0.11	–0.132	–5.14
DS	–5.755	–7.08	–0.559	–1.22	1.602	0.96	–0.106	–0.26
IS	0.367	2.73	0.158	2.96	0.249	1.64	–0.27	–3.54
RDS	–0.04	–1.13	0.021	1.91	1.948	17.58	0.034	1.19
F-Statistic	10.24		4.52		54.61		7.12	
Adj R2	0.07		0.02		0.26		0.04	

	2000		2001		2002	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.023	–1.72	–0.034	–3.04	–0.016	–1.62
DE	0	–0.3	0	–0.42	0.001	0.69
INTE	0	–0.47	0	–0.71	–0.001	–0.52
PKL	–0.013	–0.47	0.01	0.49	0.007	0.75
DS	–0.219	–0.57	0.724	1.9	0.38	0.88
IS	0.207	2.1	0.314	3.36	0.278	3.09
RDS	0.919	13.68	0.524	7.72	–0.1	–2.48
F-Statistic	35.15		14.31		2.46	
Adj R2	0.17		0.07		0.01	

TABLE 6.17 R&D Equation 2SLS

	1952		1953		1954		1955	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.002	–0.3	0.005	1.24	–0.001	–0.15	–0.002	–0.25
RDL	0.98	12.16	0.899	17.79	1.067	18.46	0.992	8.07
Size	0.137	0.63	0.074	0.7	0.125	1.27	–0.144	–1.17
PKL	0.002	0.11	0.004	0.41	–0.003	–0.37	0.026	1.57
IS	0.015	0.4	0.028	1.63	–0.001	–0.06	0.101	1.94
DS	0.122	1.24	0.063	1.15	0.075	1.45	0.126	1.36
FS	–0.067	–1.02	–0.195	–3.98	–0.042	–1.01	–0.369	–2.85
F-Statistic	28.7		74.26		88.97		16.06	
Adj R2	0.9		0.95		0.95		0.76	

	1956		1957		1958		1959	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.006	0.98	–0.008	–1.33	–0.001	–0.09	–0.004	–0.78
RDL	0.776	7.25	0.993	11.9	1.086	7.33	1.183	18.9
Size	0.036	0.36	0.165	1.03	0.775	3.11	0.145	1.08
PKL	0.003	0.21	0.03	1.72	–0.013	–0.46	0.005	0.23
IS	–0.047	–1.55	0.066	1.53	0.006	0.11	0.069	2.52
DS	–0.001	–0.01	0.006	0.09	0.389	2.34	0.004	0.07
FS	0.032	0.39	–0.158	–1.45	–0.462	–3.35	–0.178	–1.99
F-Statistic	18.43		37.37		12.11		77.61	
Adj R2	0.76		0.86		0.64		0.92	

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.006	1.66	–0.008	–2.1	–0.005	–1.31	0.002	0.33
RDL	0.992	28.01	0.947	19.87	1.02	24.03	1.052	10.69
Size	–0.193	–2.91	0.422	1.42	0.013	0.19	0.203	0.89
PKL	0.002	0.16	0.035	2.96	0.016	1.86	–0.02	–0.38
IS	–0.038	–2.17	0.022	1.01	0.051	2.29	0.038	0.43
DS	–0.007	–0.18	–0.119	–2.21	–0.024	–0.43	–0.13	–0.78
FS	0.043	1.55	–0.025	–0.4	–0.099	–2.69	–0.024	–0.19
F-Statistic	162.6		78.07		109.27		35.64	
Adj R2	0.96		0.91		0.94		0.89	

TABLE 6.17 *(Continued)*

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.003	0.37	0.013	1.53	−0.004	−0.61	−0.004	−0.7
RDL	1.072	11.64	0.98	12.67	0.923	13.82	0.911	12.81
Size	−0.178	−0.95	−0.339	−1.51	0.08	0.56	0.234	1.59
PKL	0.004	0.09	−0.016	−0.43	0	−0.01	0.031	1.91
IS	−0.054	−0.67	−0.115	−1.51	0.009	0.27	0.018	0.59
DS	−0.042	−0.33	−0.043	−0.32	0.025	0.3	−0.048	−0.38
FS	−0.083	−0.51	0.009	0.07	0.027	0.89	−0.091	−1.3
F-Statistic	40.77		34.03		39.04		34.15	
Adj R2	0.9		0.87		0.85		0.78	

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	−0.003	−0.6	−0.008	−2.97	−0.019	−2.77	−0.003	−0.95
RDL	0.919	17.52	0.895	22.4	1.224	13.63	0.784	20.16
Size	−0.171	−2.16	0.002	0.04	0.292	3.41	−0.044	−1.19
PKL	0.021	1.53	0.028	2.62	0.057	2.24	0.036	3.26
IS	−0.018	−0.83	0.011	0.8	0.06	1.76	−0.003	−0.11
DS	−0.037	−0.58	0.033	0.62	−0.005	−0.05	−0.105	−1.5
FS	0.035	0.55	0.018	0.55	−0.282	−4.24	0.149	2.96
F-Statistic	75.44		127.83		52.1		73.6	
Adj R2	0.89		0.92		0.82		0.74	

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.002	1.52	0.001	0.45	−0.002	−1.03	−0.002	−1.53
RDL	0.855	45.73	0.857	39.6	0.846	34.89	1.006	54.1
Size	−0.046	−2.71	0.13	8.21	−0.112	−5.67	0.037	2.89
PKL	0.006	1.28	−0.002	−0.4	0.02	3.98	0.003	1.04
IS	−0.018	−1.33	−0.001	−0.09	−0.008	−0.87	0.009	1.16
DS	0.005	0.43	0.008	0.39	−0.059	−1.58	−0.002	−0.11
FS	0.041	1.47	−0.01	−2.25	0.021	2.06	−0.018	−1.68
F-Statistic	355.78		308.18		225.92		528.81	
Adj R2	0.9		0.87		0.82		0.91	

(Continued)

TABLE 6.17 *(Continued)*

	1976		1977		1978		1979	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.001	–1.11	–0.008	–2.48	0.001	0.17	0	0.35
RDL	0.89	46.93	0.904	16.83	0.838	19.23	0.987	62.65
Size	–0.01	–2.14	–0.022	–1.19	0.105	3.92	–0.038	–3
PKL	0.003	0.69	0.034	3.46	–0.019	–1.84	0.002	0.56
IS	0.036	2.62	0.185	7.08	0.145	4.41	0.015	1.98
DS	0.027	1	–0.603	–5.86	0.194	3.37	–0.048	–2.15
FS	–0.046	–2.42	–0.335	–6.59	–0.319	–6.2	–0.024	–2.54
F-Statistic	442.69		69.31		72.08		717.7	
Adj R2	0.89		0.54		0.55		0.93	

	1980		1981		1982		1983	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.001	–0.84	–0.002	–2.23	0	0.04	–0.001	–0.9
RDL	0.994	77.25	1.121	72.65	0.999	36.08	0.951	78.38
Size	0.033	2.86	–0.071	–4.51	–0.116	–2.34	–0.081	–3.75
PKL	0.005	2.39	0.01	3.25	0.011	1.47	0.025	4.18
IS	0.003	0.23	0.001	0.15	0.057	3.53	–0.053	–3.79
DS	–0.018	–1.16	–0.053	–1.76	–0.076	–1.76	0.032	0.7
FS	0.003	0.15	0.003	0.26	–0.189	–5.61	0.09	4.58
F-Statistic	1,153.31		917.92		760.17		1,183.97	
Adj R2	0.95		0.94		0.93		0.95	

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.009	2.95	0.01	3.08	–0.035	–3.53	0.03	1.58
RDL	0.631	44.3	0.434	33.18	0.905	13.13	0.342	5.98
Size	0.024	0.3	0.019	0.22	1.962	8	–1.243	–2.76
PKL	0.003	2.32	–0.003	–0.62	–0.052	–1.73	–0.023	–1.55
IS	–0.064	–1.17	0.174	5.66	0.245	3.16	0.59	5.27
DS	0.07	0.53	–0.194	–1.84	0.833	3.29	–1.136	–1.34
FS	0.375	3.15	0.044	2.98	0.301	3.47	–1.102	–5.81
F-Statistic	1,043.25		270.26		140.48		26.21	
Adj R2	0.94		0.8		0.67		0.25	

TABLE 6.17 *(Continued)*

	1988		1989		1990		1991	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.004	–1.71	0.032	4.34	–0.069	–5.23	0.01	2.09
RDL	0.829	65.29	0.697	31.08	2.127	16.79	0.446	34.07
Size	–0.196	–3.35	–1.072	–5.12	0.982	3.14	–1.301	–4.64
PKL	0.026	4.77	0.012	0.51	0.042	1.31	–0.029	–2.19
IS	0.033	1.55	0.078	1.47	0.085	0.69	0.566	4.16
DS	–0.086	–1.42	–1.19	–3.08	0.903	1.57	–0.544	–1.6
FS	0.096	3.53	–0.217	–2.73	–1.03	–8.21	–0.287	–0.86
F-Statistic	1,058.45		1,535.45		2,423.27		1,664.37	
Adj R2	0.93		0.95		0.97		0.95	

	1992		1993		1994		1995	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.035	–4.66	0.002	0.12	–0.015	–2.5	–0.061	–3.12
RDL	1.36	37.8	1.216	24.45	1.005	70.53	0.705	6.96
Size	–3.258	–9.08	–3.65	–6.56	–1.783	–9.91	14.774	7.2
PKL	–0.012	–1.41	–0.002	–0.58	–0.001	–0.32	0.027	0.66
IS	0.785	9.03	0.447	3.01	0.364	5.19	0.416	1.96
DS	–0.818	–3.27	–0.976	–2.21	0.026	0.12	0.229	0.54
FS	–0.48	–6.38	–1.029	–3.91	–0.418	–3.53	–0.965	–5.33
F-Statistic	826.18		414.11		2,352.24		390.02	
Adj R2	0.89		0.8		0.95		0.76	

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.083	–3.44	–0.053	–3.16	0.04	5.98	0.143	2.28
RDL	0.134	3.73	1.78	40.19	0.298	25.91	0.872	11.97
Size	15.125	12.31	1.838	7.3	0.063	0.39	4.089	3.96
PKL	0.103	2.24	0.111	2.6	0.001	0.17	0.008	0.09
IS	–0.525	–2.53	–0.027	–0.28	–0.207	–6.53	–0.451	–1.72
DS	1.596	1.35	0.112	0.18	–0.884	–3.38	–0.416	–0.44
FS	2.091	10.97	–0.636	–2.76	0.223	22.64	–2.332	–4.27
F-Statistic	72.95		687.69		336.76		36.12	
Adj R2	0.35		0.82		0.68		0.18	

(Continued)

TABLE 6.17 *(Continued)*

	2000		2001		2002	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.039	2.54	0.038	2.91	–0.121	–3.92
RDL	–0.175	–3.17	0.224	2.69	0.821	4.64
Size	3.667	1.15	1.552	0.59	32.796	3.44
PKL	–0.025	–0.77	–0.002	–0.12	0.021	0.95
IS	–0.206	–1.85	–0.182	–1.76	0.891	3.44
DS	0.019	0.04	–0.729	–2.04	1.692	1.5
FS	1.101	8.7	0.875	5.2	–2.515	–4.22
F-Statistic	25.78		33.73		14.72	
Adj R2	0.13		0.15		0.07	

TABLE 6.18 Dividend Equation 3SLS

	1952		1953		1954		1955	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.01	0.66	–0.011	–0.41	0.008	0.36	0.029	1.99
DIVL	0.947	15.5	0.888	11.16	1.059	9.65	1.058	12.84
CAK	–0.018	–0.99	0.014	0.39	–0.02	–0.62	–0.039	–1.81
PK	0.005	0.44	–0.002	–0.17	0.01	0.61	0.012	0.78
IS	–0.002	–0.07	0	0.01	–0.055	–1.15	–0.056	–1.08
FS	–0.023	–0.39	0.14	1.78	0.049	0.68	–0.202	–1.87
RDS	–0.141	–2.44	0.041	0.56	0.075	0.86	0	0
	1956		**1957**		**1958**		**1959**	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.012	1.08	–0.008	–1.14	–0.006	–1.02	–0.001	–0.09
DIVL	0.96	18.49	0.951	31.92	1.055	31.92	1.028	37.64
CAK	–0.027	–1.43	0.004	0.29	0.01	0.97	–0.001	–0.16
PK	0.023	1.89	0.024	2.6	0.003	0.31	–0.006	–0.52
IS	–0.054	–1.43	0.052	1.6	0.001	0.04	–0.041	–1.63
FS	–0.018	–0.38	–0.082	–2.19	–0.022	–0.82	0.026	0.59
RDS	0.068	1.08	0.027	0.68	0.024	0.72	0.071	2.7

TABLE 6.18 *(Continued)*

	1960		1961		1962		1963	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.027	4.05	0.002	0.47	–0.001	–0.25	0.002	0.46
DIVL	0.896	29.02	1.069	57.11	0.956	43.95	0.91	16.36
CAK	–0.046	–3.78	0.001	0.14	–0.004	–0.66	–0.003	–0.46
PK	0.017	2.69	–0.013	–2.33	0.009	2.17	0.033	1.96
IS	–0.087	–3.6	–0.009	–0.85	0.006	0.56	–0.081	–2.73
FS	0.043	2.38	–0.005	–0.43	–0.007	–0.48	–0.041	–1.15
RDS	–0.028	–0.94	0.011	0.58	0.006	0.36	0.003	0.09

	1964		1965		1966		1967	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.002	0.19	0.003	0.38	–0.003	–0.76	–0.01	–1.5
DIVL	1.063	10.76	0.876	16.8	1.036	37.76	1.201	18.66
CAK	–0.007	–0.5	–0.005	–0.51	0.005	0.8	0.016	1.69
PK	0.026	0.87	0.003	0.17	–0.014	–2.36	–0.023	–2.17
IS	0.009	0.13	–0.057	–1.16	0.013	0.78	0.043	1.55
FS	–0.165	–1.35	0.087	1.21	0.034	4.23	–0.049	–1.6
RDS	0.055	0.96	0.047	1.44	–0.009	–0.4	–0.012	–0.32

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.002	–0.9	0	0	–0.001	–0.37	0.002	0.8
DIVL	0.969	45.32	1.002	49.5	0.941	39.16	0.981	41.26
CAK	0.001	0.16	0	–0.06	–0.002	–0.3	–0.004	–0.98
PK	0.002	0.4	–0.002	–0.55	0.016	2.93	0.006	1.4
IS	0.002	0.2	–0.016	–2.29	–0.001	–0.08	–0.049	–3.18
FS	0.009	0.39	0.025	2.03	–0.038	–2.22	0.079	3.6
RDS	0.009	0.52	0.002	0.14	0.018	1.2	0.005	0.31

	1972		1973		1974		1975	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.002	1.25	0.01	7.19	0.023	7.67	0.011	6
DIVL	0.877	200.38	0.663	61.36	0.269	9.85	0.788	44.79
CAK	–0.002	–1.08	–0.014	–6.46	–0.029	–5.77	–0.018	–5.62
PK	0.005	2.34	0.014	4.99	0.028	5.3	0.014	3.99
IS	–0.014	–1.33	–0.075	–12.55	–0.158	–10.17	–0.069	–6.83
FS	0.015	0.92	0.051	19.35	0.163	15.65	0.075	6.17
RDS	–0.003	–0.36	0.042	2.39	0.034	0.76	0.041	2.17

(Continued)

TABLE 6.18 *(Continued)*

	1976		1977		1978		1979	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.002	1.74	–0.001	–0.65	0	–0.02	0.002	1.88
DIVL	0.866	70.52	0.991	50	1.014	52.64	1.023	72.18
CAK	0	–0.28	–0.001	–0.55	–0.002	–0.81	–0.001	–1.37
PK	0.006	3.27	0.008	3.98	0.007	2.07	–0.002	–1.23
IS	–0.022	–2.29	0	–0.01	–0.031	–2.11	–0.013	–2.6
FS	0.023	2.06	–0.007	–0.65	0.042	2.22	0.015	2.41
RDS	0.01	0.87	–0.003	–0.29	0.016	1.09	–0.002	–0.25

	1980		1981		1982		1983	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.001	0.56	–0.001	–1.44	–0.001	–1.6	0	–0.51
DIVL	1.068	75.34	0.986	78.63	1.089	107.11	0.981	73.92
CAK	–0.002	–0.81	0.001	1.36	0.003	2.78	0	0.35
PK	–0.001	–0.27	0.005	3.49	–0.003	–1.79	0	0.2
IS	–0.025	–1.86	–0.007	–2.37	0.001	0.17	0.012	3.45
FS	0.026	1.15	0.008	1.82	0.01	2.06	–0.018	–4.5
RDS	0.026	2.28	0.001	0.21	–0.01	–1.79	–0.001	–0.16

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.002	–1.78	0.001	1.32	0	0.16	0.023	10.08
DIVL	0.893	54.12	1.016	82.46	0.857	8.95	0.159	7.07
CAK	0.002	2.77	0	–0.63	–0.005	–2.84	–0.02	–6.08
PK	0.005	3.06	0.002	1.07	0.024	3.35	0.014	3.48
IS	0.016	2.67	–0.01	–2.49	0.008	0.27	–0.144	–8.03
FS	–0.029	–2.57	0.006	2.72	–0.146	–4.7	0.05	2.49
RDS	–0.003	–1.19	0.003	1	0.054	3.63	0.093	5.4

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.068	7.91	0.02	4.07	0.048	11.47	0.005	2.83
DIVL	0.026	0.85	0.012	0.45	0.059	1.63	0.152	5.88
CAK	–0.073	–6.85	–0.016	–3.35	–0.034	–6.08	0	–1.16
PK	0.019	1.14	0.019	1.64	0.002	0.37	0.004	1.25
IS	–0.436	–12.32	–0.002	–0.05	–0.329	–10.51	0.128	7.28
FS	–0.082	–0.96	–0.113	–2.35	–0.034	–1.73	–0.398	–7.61
RDS	0.171	4.79	–0.026	–2.85	0.019	5.77	–0.02	–3.91

TABLE 6.18 *(Continued)*

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.002	4.35	–0.003	–0.53	0.023	6.59	0.004	1.35
DIVL	0.833	36.96	0.105	2.12	0.088	4.26	0.887	14.66
CAK	0	–0.61	–0.003	–0.66	–0.018	–3.47	–0.01	–2.32
PK	0	0.57	0	–0.12	0.012	2.56	0.009	1.99
IS	–0.011	–2.66	0.385	7.3	–0.147	–4.22	–0.008	–0.34
FS	0.008	0.64	–0.529	–9.45	0.159	2.6	–0.007	–1.54
RDS	0.003	1.74	–0.087	–9.12	0.006	0.94	0.005	1.38

	1996		1997		1998		1999	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.024	12.43	0.004	3.57	0.007	4.05	0.002	0.91
DIVL	0.096	5.36	0.457	21.81	0.525	24.87	0.802	23.5
CAK	–0.019	–7.42	–0.005	–5.47	–0.009	–4.07	0.002	0.57
PK	0.005	1.32	0.016	5.5	0.008	2.14	0.002	0.35
IS	–0.105	–8.65	0.001	0.16	–0.014	–3.6	–0.003	–0.31
FS	–0.059	–14.31	–0.03	–2.19	0.004	1.83	–0.01	–0.64
RDS	0.014	4.14	0.003	2.69	–0.002	–0.31	–0.002	–0.73

	2000		2001		2002	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.006	2.86	0.009	8.1	0.004	3.44
DIVL	0.518	16.52	0.427	25.61	0.602	23.39
CAK	–0.008	–2.62	0	–0.24	–0.001	–0.95
PK	0	–0.05	0.006	3.31	0.001	0.41
IS	0.001	0.07	–0.054	–6.41	–0.001	–0.07
FS	–0.082	–5.67	0.083	5.92	–0.008	–0.29
RDS	0.079	4.98	–0.068	–7.46	–0.002	–0.41

TABLE 6.19 Investment Equation 3SLS

	1952		1953		1954		1955	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.162	1.61	0.434	4.64	0.418	8.03	0.251	5.82
PKL	–0.069	–0.64	–0.092	–0.99	–0.09	–1.32	–0.011	–0.18
CAK	–0.243	–1.87	–0.605	–4.9	–0.625	–7.89	–0.372	–5.65
D2sales	0	–99	–0.02	–0.25	0.098	1.3	–0.075	–1.02
DS	0.499	0.87	–1.313	–1.95	–0.742	–1.61	–1.165	–3.05
FS	0.565	1.17	0.227	0.45	–0.493	–1.3	1.1	2.72
RDS	0.177	0.35	0.482	0.92	0.828	2.09	0.217	0.52

	1956		1957		1958		1959	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.273	6.14	0.138	4.24	0.208	8.31	0.14	4.16
PKL	0.162	1.87	–0.139	–1.84	0.126	1.69	–0.106	–0.89
CAK	–0.403	–4.92	–0.172	–2.59	–0.352	–6.33	–0.264	–4.79
D2sales	–0.009	–0.15	–0.026	–0.51	–0.029	–0.6	–0.043	–0.76
DS	–0.064	–0.13	0.24	0.66	–0.106	–0.28	–0.223	–0.67
FS	–0.344	–0.79	1.468	5.56	0.063	0.22	1.4	2.55
RDS	–0.793	–1.48	–0.311	–0.69	0.024	0.09	0.489	1.8

	1960		1961		1962		1963	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.223	7.3	0.201	5.62	0.181	4.78	0.058	2.1
PKL	0.088	1.1	–0.028	–0.36	0.016	0.26	0.355	2.77
CAK	–0.388	–7.3	–0.344	–5.49	–0.316	–4.69	–0.105	–2.66
D2sales	–0.078	–1.57	–0.002	–0.03	0.066	1.09	0.028	0.44
DS	–0.269	–0.93	–0.16	–0.46	0.215	0.58	–0.767	–1.73
FS	0.726	4.97	0.609	2.4	0.281	1.04	–0.91	–2.76
RDS	0.061	0.24	0.5	1.54	0.153	0.53	0.478	2

	1964		1965		1966		1967	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.124	4.69	0.145	5.9	0.19	6.7	0.218	8.75
PKL	–0.128	–1.17	–0.02	–0.23	0.233	3.79	0.102	1.62
CAK	–0.124	–2.81	–0.163	–4.22	–0.241	–5.45	–0.286	–7.32
D2sales	0.052	0.87	0.072	1.25	–0.201	–3.25	–0.133	–2.7
DS	–0.02	–0.07	0.084	0.27	–1.316	–4.53	–1.795	–3.78
FS	0.41	0.67	–0.343	–0.69	0.43	3.7	0.828	3.16
RDS	–0.027	–0.1	0.059	0.3	0.176	0.7	0.12	0.45

TABLE 6.19 *(Continued)*

	1968		1969		1970		1971	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.099	1.95	0.132	3.67	0.202	4.66	0.106	8.59
PKL	–0.062	–0.65	–0.099	–0.77	–0.24	–2.65	0.029	0.67
CAK	–0.138	–2	–0.178	–3.19	–0.262	–5.48	–0.126	–6.27
D2sales	–0.107	–0.8	–0.196	–1.8	–0.084	–0.6	–0.015	–0.82
DS	0.398	0.85	0.789	1.3	–0.078	–0.16	0.114	0.46
FS	1.784	1.73	2.024	3.98	1.322	2.35	1.328	9.55
RDS	–0.706	–1.37	–0.813	–1.59	0.512	1.86	–0.126	–0.77
	1972		**1973**		**1974**		**1975**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.088	6.37	0.153	8.81	0.147	8.25	0.129	10.34
PKL	–0.038	–0.9	–0.039	–0.89	0.07	2.1	0.034	1.36
CAK	–0.079	–4.21	–0.203	–7.06	–0.193	–7.09	–0.2	–9.36
D2sales	0.01	0.96	0.09	3.67	0.05	2.32	0.051	2.94
DS	0.262	2.41	–1.215	–5.98	–2.715	–8.33	–0.668	–3.32
FS	1.829	17.01	0.279	6.9	0.694	9.15	0.816	9.05
RDS	–0.029	–0.15	0.735	2.87	0.293	1.12	0.61	3.4
	1976		**1977**		**1978**		**1979**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.047	4.36	0.01	0.67	0.038	3.79	0.026	1.48
PKL	0.055	1.6	–0.147	–3.28	0.092	3.14	–0.108	–2.09
CAK	–0.032	–3.19	–0.004	–0.39	–0.053	–5.04	–0.004	–0.53
D2sales	0.008	0.73	–0.034	–2.61	–0.008	–0.76	0.053	2.52
DS	–0.958	–4.31	3.21	10.47	–0.704	–4.39	2.239	7.84
FS	1.268	22.36	1.84	18.5	1.364	25.82	1.315	14.08
RDS	0.946	5.13	2.304	12.21	0.892	6.69	0.532	2.27
	1980		**1981**		**1982**		**1983**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.04	4.18	0.068	3.75	0.114	7.17	–0.015	–1.05
PKL	0.086	3.18	–0.049	–0.85	0.019	0.41	0.27	5.25
CAK	–0.023	–2.34	0	–0.01	–0.161	–6.65	–0.003	–1.04
D2sales	–0.007	–1	–0.024	–0.94	0.064	3.18	–0.019	–2.17
DS	–0.552	–2.83	0.1	0.19	0.368	1.45	0.448	1
FS	1.79	15.61	1.698	13.86	–0.252	–2.06	1.238	17.33
RDS	0.015	0.09	0.281	1.21	0.71	5.16	0.013	0.11

(Continued)

TABLE 6.19 *(Continued)*

	1984		1985		1986		1987	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.019	2.08	0.076	11.31	0.05	6.22	0.079	7
PKL	0.018	5.34	0.119	6.99	0.039	1.31	–0.003	–0.32
CAK	0.001	0.89	–0.115	–8.2	–0.004	–1.84	–0.066	–4.64
D2sales	0.002	0.24	–0.012	–1.02	–0.001	–0.04	0.014	1.21
DS	0.886	2.14	–0.128	–0.51	0.283	1.16	–1.227	–2.6
FS	2.161	19.79	0.445	9.51	0.027	0.35	0.592	6.88
RDS	0.223	5.02	0.491	9.12	0.393	11.36	0.738	13.26

	1988		1989		1990		1991	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.139	8.51	0.076	6.25	0.108	12.22	–0.019	–1.22
PKL	0.026	1.57	–0.018	–0.48	0.019	1.17	0.036	1.06
CAK	–0.142	–6.18	–0.044	–3.64	–0.077	–6.71	0	–0.09
D2sales	–0.001	–0.1	–0.012	–2.12	0.002	0.6	–0.004	–0.82
DS	–1.754	–5.92	0.133	0.23	–1.368	–3.71	3.989	5.24
FS	–0.103	–0.71	0.871	8.66	0.174	4.42	2.755	14.28
RDS	0.43	6.7	0.132	7.32	0.056	10.45	0.187	4.16

	1992		1993		1994		1995	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.05	7.13	0.036	3.55	0.064	5.84	0.071	10.22
PKL	0.002	0.15	0.001	0.21	0.004	0.38	–0.01	–0.85
CAK	0.017	3.12	–0.009	–0.71	–0.012	–1.41	–0.058	–6.56
D2sales	–0.036	–2.34	0.004	0.2	0.018	2.48	0.071	5.34
DS	0.055	0.17	1.007	2.8	–1.218	–2.19	0.337	2.14
FS	0.091	0.73	1.018	5.84	1.362	13.6	–0.019	–1.89
RDS	0.291	17.47	0.216	13.08	0.063	2.7	0.033	4.39

	1996		1997		1998		1999	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.131	13.41	0.012	0.78	0.15	9.84	0.162	15.29
PKL	–0.013	–1.09	0.016	0.36	–0.019	–2.55	–0.117	–5.96
CAK	–0.111	–8.45	–0.001	–0.15	–0.106	–3.71	–0.023	–1.93
D2sales	0.022	1.53	–0.015	–0.7	–0.044	–1.57	–0.074	–6.05
DS	–1.909	–4.64	0.169	0.26	–1.737	–3.96	–0.401	–1.62
FS	–0.044	–2.07	1.472	9.95	0.089	3.78	–0.643	–6.68
RDS	0.117	9.04	0.074	4.57	–0.123	–2.11	–0.047	–3.13

TABLE 6.19 *(Continued)*

Variable	2000 Coeff	2000 T-Stat	2001 Coeff	2001 T-Stat	2002 Coeff	2002 T-Stat
Intercept	0.081	11.52	0.13	12.2	0.017	0.86
PKL	0.012	0.92	–0.037	–1.75	–0.012	–0.58
CAK	–0.024	–2.61	–0.001	–0.21	0	0.12
D2sales	0.005	0.45	–0.006	–0.66	0.001	0.21
DS	–0.352	–1.64	–1.726	–3.84	–0.469	–0.48
FS	0.428	8.25	1.216	16.15	2.27	20.42
RDS	–0.347	–6.33	–1.234	–22.05	0.85	27.27

TABLE 6.20 Financing Equation 3SLS

Variable	1952 Coeff	1952 T-Stat	1953 Coeff	1953 T-Stat	1954 Coeff	1954 T-Stat	1955 Coeff	1955 T-Stat
Intercept	0.04	1.06	0.026	1.01	0.021	0.64	0.01	0.52
DE	0.001	0.26	0	–0.83	0.004	1.46	0	0.11
INTE	0.15	0.38	–0.362	–0.71	0.272	0.58	–0.061	–0.3
PKL	–0.081	–1.03	–0.018	–0.28	–0.015	–0.22	0.004	0.09
DS	–0.001	0	0.398	1.21	0.744	2.08	0.409	1.84
IS	0.449	2.79	0.211	2.44	0.092	0.83	0.267	3.01
RDS	–0.244	–0.56	–0.117	–0.37	–0.271	–0.75	0.188	0.65

Variable	1956 Coeff	1956 T-Stat	1957 Coeff	1957 T-Stat	1958 Coeff	1958 T-Stat	1959 Coeff	1959 T-Stat
Intercept	–0.01	–0.48	–0.024	–1.01	0.029	0.97	0.009	0.38
DE	0.002	4.24	–0.001	–0.65	–0.007	–1.13	–0.001	–0.41
INTE	0.245	1.26	0.03	0.18	0.103	0.49	–0.036	–0.34
PKL	0.108	2.39	0.129	2.49	–0.004	–0.07	0.176	2.32
DS	0.523	1.88	–0.256	–0.94	0.48	1.49	–0.069	–0.28
IS	0.246	1.98	0.446	4.34	0.088	0.57	0.265	2.23
RDS	–0.228	–0.63	0.185	0.55	–0.156	–0.61	–0.301	–1.36

(Continued)

TABLE 6.20 *(Continued)*

	1960		1961		1962		1963	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.037	–0.96	–0.012	–0.33	0.008	0.37	–0.022	–1.41
DE	0	0.07	0.003	0.29	0.002	0.57	–0.001	–0.42
INTE	–0.092	–0.74	–0.029	–0.23	–0.041	–0.74	0.091	1.67
PKL	0.189	1.4	0.101	0.86	0.086	1.64	0.348	4.99
DS	–0.752	–1.77	–0.357	–0.7	–0.639	–1.89	–0.485	–1.41
IS	0.526	3.95	0.469	2.69	0.48	4.4	–0.393	–2.05
RDS	0.559	1.62	0.232	0.5	0.242	0.95	0.242	1.22

	1964		1965		1966		1967	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.045	–2.03	–0.003	–0.23	0.013	0.31	–0.004	–0.18
DE	0	0.36	0	–0.94	0.018	1.96	0.001	1.21
INTE	0.166	1.1	–0.019	–2.89	0.096	1.19	–0.027	–0.36
PKL	0.198	2.69	0.224	4.17	–0.221	–1.76	0.021	0.32
DS	–0.03	–0.11	–0.329	–1.53	2.614	8.88	1.723	12.24
IS	0.483	3.36	0.015	0.11	0.089	0.31	0.067	0.57
RDS	0.223	1.2	0.104	0.83	–0.342	–0.65	0.097	0.36

	1968		1969		1970		1971	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.001	0.07	–0.012	–0.59	–0.037	–1.7	–0.029	–2.91
DE	0	–0.96	0.002	1.09	0	0.13	0	0.27
INTE	–0.018	–0.37	–0.021	–0.61	0.006	0.33	–0.01	–0.89
PKL	0.075	1.41	0.107	1.33	0.278	4.17	–0.011	–0.3
DS	–0.298	–1.16	–0.752	–2.01	–0.171	–0.5	–0.038	–0.17
IS	0.327	4.36	0.361	4.14	0.286	2.48	0.455	6.47
RDS	0.489	2.49	0.751	2.43	–0.395	–2.06	0.509	3.6

	1972		1973		1974		1975	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.024	–3.03	–0.074	–2.82	–0.065	–3.67	–0.01	–1.17
DE	0	–0.41	0	0.3	0	–0.51	0.001	1.27
INTE	–0.002	–0.17	–0.192	–9.01	–0.014	–3.08	–0.001	–0.2
PKL	0.02	0.77	–0.153	–1.97	–0.07	–1.49	–0.049	–1.93
DS	–0.18	–2.43	5.112	15.13	3.588	11.59	0.527	3.17
IS	0.47	13.11	0.969	7.05	0.569	5.06	0.434	7.98
RDS	0.1	0.79	0.048	0.11	0.694	1.94	–0.157	–1.06

TABLE 6.20 *(Continued)*

	1976		1977		1978		1979	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.022	–2.37	0.001	0.08	–0.005	–0.6	–0.023	–1.54
DE	0	0.05	0	–0.28	0	–0.7	0	–0.42
INTE	0	0.02	0	–0.83	0.002	0.84	0.002	0.32
PKL	–0.043	–1.41	0.089	3.07	–0.047	–1.92	0.067	1.49
DS	0.731	3.76	–1.777	–9.75	0.446	3.33	–1.677	–7.13
IS	0.742	17.1	0.549	15.61	0.668	20.1	0.758	14.66
RDS	–0.736	–4.5	–1.391	–11.47	–0.84	–7.79	–0.542	–2.64

	1980		1981		1982		1983	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.016	–2.71	–0.041	–4.11	–0.023	–1.87	0.008	0.65
DE	0	–0.03	0	0	0	–0.32	0	–0.02
INTE	0	0.08	0	0.04	–0.001	–1.18	0.005	1.09
PKL	–0.044	–2.69	0.04	1.27	0.044	1.16	–0.203	–4.69
DS	0.294	2.51	–0.106	–0.36	0.026	0.12	–0.4	–0.98
IS	0.544	13.5	0.597	19.01	0.075	1.1	0.799	16.78
RDS	0.045	0.41	–0.148	–1.08	0.615	7.22	0.067	0.62

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.01	–2.06	–0.031	–1.75	0.001	0.09	–0.012	–0.89
DE	0	–0.9	0	0.24	0.002	2.79	0	0.07
INTE	0	0.45	–0.036	–1.29	–0.002	–1.16	0	–0.23
PKL	–0.008	–4.96	0.025	1.12	0.107	2.39	0.002	0.16
DS	–0.387	–1.83	0.162	0.28	–0.675	–1.81	–0.211	–0.32
IS	0.455	18.28	0.414	2.43	–0.224	–1.99	0.866	8.66
RDS	–0.09	–3.68	0.278	1.99	0.556	10.02	–0.831	–13.98

	1988		1989		1990		1991	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.023	1.84	–0.02	–1.65	–0.013	–0.81	0.007	1.19
DE	0	–0.04	0	0.16	0	–0.2	0	0.45
INTE	–0.02	–2.8	–0.001	–0.37	0.001	0.2	0.001	0.84
PKL	–0.003	–0.1	0.044	1.17	–0.038	–1.11	–0.013	–1.02
DS	–0.392	–1.11	–1.863	–3.37	–0.856	–1.28	–1.499	–5.19
IS	0.051	0.45	0.818	10.76	0.665	4.91	0.37	19.43
RDS	0.22	2.55	–0.159	–7.49	–0.035	–2.87	–0.069	–3.96

(Continued)

TABLE 6.20 *(Continued)*

	1992		1993		1994		1995	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.01	–1	–0.022	–2.98	–0.04	–5.24	0.092	3.32
DE	0	–0.34	0	0.62	0	–1.06	0	0.27
INTE	–0.005	–1.96	0	0.58	0	0.26	0	–0.06
PKL	–0.023	–1.57	0	–0.14	0	0	–0.173	–2.96
DS	–1.504	–3.99	–1.329	–6.27	0.532	1.38	–0.451	–0.72
IS	0.78	10.94	0.877	12.99	0.688	16.65	–0.359	–1.36
RDS	–0.273	–9.36	–0.194	–13.11	–0.04	–2.6	0.389	12.47

	1996		1997		1998		1999	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.081	4.87	0.006	0.65	–0.131	–3.79	0.18	15.16
DE	0	–0.7	0	–0.4	–0.001	–1.43	0	–0.1
INTE	0	–0.04	0	–0.08	0	0.02	0	0.06
PKL	0.063	2.26	–0.027	–0.91	0.035	1.49	–0.201	–8
DS	–6.259	–7.97	–0.274	–0.62	5.582	4.01	–0.196	–0.48
IS	–0.139	–1.05	0.597	16.57	0.408	2.69	–0.822	–12.95
RDS	0.108	3.23	–0.059	–5.49	2.172	20.17	–0.261	–15.42

	2000		2001		2002	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.088	–7.24	–0.108	–12.13	–0.008	–0.88
DE	0	0.09	0	0.07	0	–0.05
INTE	0	0.05	0	0.07	0	0.14
PKL	–0.018	–0.71	0.033	1.84	0.005	0.59
DS	–0.325	–0.87	1.436	3.83	0.208	0.49
IS	1.171	13.99	0.797	24.92	0.44	26.14
RDS	0.929	38.02	1.064	47.9	–0.373	–29.68

TABLE 6.21 R&D Equation 3SLS

	1952		1953		1954		1955	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.003	0.43	0.006	1.44	–0.001	–0.27	0	0.03
RDL	0.982	12.57	0.889	17.79	1.057	18.88	1.029	8.58
Size	0.174	0.96	0.101	1.01	0.155	1.77	–0.196	–1.74
PKL	–0.011	–0.84	0.003	0.26	–0.001	–0.18	0.025	1.51
IS	0.03	0.82	0.037	2.21	0.007	0.47	0.146	2.91
DS	0.114	1.2	0.092	1.71	0.098	1.91	0.178	1.96
FS	–0.103	–1.62	–0.247	–5.32	–0.074	–1.81	–0.519	–4.27

	1956		1957		1958		1959	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.006	1.04	–0.01	–1.7	0.008	0.77	–0.003	–0.66
RDL	0.763	7.27	1.013	12.57	1.031	7.24	1.14	19.02
Size	0.024	0.24	0.163	1.15	0.782	3.5	0.13	1.23
PKL	0.006	0.38	0.04	2.47	–0.015	–0.52	0.027	1.42
IS	–0.053	–1.76	0.107	2.68	–0.031	–0.55	0.104	3.95
DS	0.002	0.02	–0.019	–0.31	0.513	3.28	–0.003	–0.05
FS	0.031	0.37	–0.246	–2.53	–0.621	–4.94	–0.3	–4.23

	1960		1961		1962		1963	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.007	1.88	–0.009	–2.32	–0.005	–1.5	0.001	0.17
RDL	0.978	27.85	0.953	20.07	1.037	24.57	1.046	10.84
Size	–0.193	–3.04	0.541	1.86	0.027	0.41	0.298	1.42
PKL	–0.002	–0.14	0.036	3	0.022	2.48	–0.025	–0.48
IS	–0.05	–2.87	0.037	1.76	0.085	3.91	0.057	0.65
DS	0.008	0.19	–0.116	–2.17	–0.059	–1.05	–0.113	–0.7
FS	0.066	2.5	–0.063	–1.05	–0.156	–4.43	–0.016	–0.13

	1964		1965		1966		1967	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.006	0.81	0.016	1.88	–0.004	–0.66	–0.005	–0.83
RDL	1.058	11.79	0.962	12.59	0.926	13.91	0.913	12.95
Size	–0.151	–0.91	–0.399	–1.9	0.075	0.53	0.218	1.53
PKL	–0.008	–0.17	–0.031	–0.84	0.001	0.03	0.032	1.96
IS	–0.104	–1.31	–0.161	–2.16	0.012	0.35	0.03	0.98
DS	–0.039	–0.31	–0.016	–0.12	0.001	0.01	0.029	0.24
FS	–0.03	–0.19	0.103	0.77	0.037	1.22	–0.136	–1.99

(Continued)

TABLE 6.21 *(Continued)*

	1968		1969		1970		1971	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.003	–0.78	–0.008	–2.93	–0.024	–3.66	0	0.13
RDL	0.908	17.73	0.883	22.22	1.122	13.64	0.734	19.47
Size	–0.164	–2.25	0.004	0.1	0.303	4.32	–0.04	–1.23
PKL	0.021	1.58	0.026	2.4	0.097	4.2	0.035	3.23
IS	–0.024	–1.11	0.005	0.4	0.116	3.52	–0.052	–1.97
DS	–0.036	–0.57	0.046	0.88	–0.036	–0.35	–0.097	–1.4
FS	0.063	1	0.038	1.18	–0.415	–7.5	0.257	5.58

	1972		1973		1974		1975	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	0.003	2.27	0	0.1	0	–0.27	–0.002	–1.71
RDL	0.853	45.73	0.856	39.74	0.835	34.74	1.004	54.05
Size	–0.047	–2.89	0.124	7.97	–0.108	–5.69	0.038	2.96
PKL	0.004	0.99	–0.002	–0.38	0.021	4.2	0.002	0.79
IS	–0.035	–2.72	0.005	0.67	–0.018	–1.94	0.016	2.11
DS	0.012	0.99	0.02	1.05	–0.114	–3.13	0.005	0.24
FS	0.078	2.88	–0.013	–3.1	0.036	3.77	–0.032	–2.99

	1976		1977		1978		1979	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.002	–2.04	–0.005	–1.46	–0.001	–0.25	0	–0.04
RDL	0.859	46.29	0.503	13	0.643	16.82	0.977	62.24
Size	–0.01	–2.29	–0.009	–1.26	0.082	4.65	–0.037	–3.06
PKL	0.001	0.2	0.048	5.01	–0.027	–2.75	0.003	0.97
IS	0.07	5.46	0.282	19.16	0.291	11.93	0.029	4.07
DS	0.06	2.3	–0.914	–12.72	0.272	5.05	–0.081	–3.66
FS	–0.091	–5.24	–0.511	–20.45	–0.515	–14.55	–0.044	–4.79

	1980		1981		1982		1983	
Variable	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Intercept	–0.001	–0.76	–0.002	–2.17	–0.003	–1.09	–0.002	–1.38
RDL	0.994	77.23	1.121	72.65	1.08	45.91	0.946	80.54
Size	0.033	2.86	–0.071	–4.49	–0.14	–3.62	–0.084	–5.55
PKL	0.005	2.47	0.01	3.16	0.017	2.39	0.041	7.43
IS	0.001	0.07	0.001	0.15	0.067	4.55	–0.115	–10.78
DS	–0.019	–1.24	–0.053	–1.76	–0.077	–1.8	0.062	1.38
FS	0.007	0.31	0.003	0.26	–0.33	–12.83	0.169	12.12

TABLE 6.21 *(Continued)*

	1984		1985		1986		1987	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.012	4.08	0.006	1.86	–0.04	–4.16	–0.011	–0.75
RDL	0.645	50.79	0.406	31.84	0.579	10.19	0.047	1.73
Size	0.026	0.41	0.119	1.51	1.392	7.09	–0.123	–0.75
PKL	0.006	4.61	–0.004	–0.92	–0.085	–2.95	–0.001	–0.06
IS	–0.196	–4.26	0.228	7.53	0.603	8.41	0.998	10.4
DS	0.185	1.47	–0.208	–1.98	0.656	2.62	–0.329	–0.46
FS	0.68	6.97	0.081	5.63	0.479	6.33	–1.162	–12.66
	1988		**1989**		**1990**		**1991**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.004	–1.9	0.032	4.73	–0.107	–8.36	0.013	2.79
RDL	0.811	65.34	0.654	44.53	2.048	23.42	0.433	38.64
Size	–0.172	–3.51	–0.974	–7.9	0.92	4.34	–1.212	–5.16
PKL	0.024	4.4	0.027	1.59	0.017	0.57	–0.031	–2.69
IS	0.025	1.23	0.26	5.17	0.86	7.85	0.65	5.68
DS	–0.06	–0.99	–1.997	–6.94	0.845	1.49	–0.966	–3.21
FS	0.163	6.66	–0.5	–8.54	–1.546	–17.21	–0.557	–1.97
	1992		**1993**		**1994**		**1995**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.047	–7.17	–0.022	–1.92	–0.029	–5.59	–0.048	–2.51
RDL	1.126	39.68	0.961	24.64	0.989	82.93	0.773	9.84
Size	–2.749	–11.7	–2.835	–7.26	–1.771	–13.55	18.145	11.4
PKL	–0.02	–2.3	–0.002	–0.61	–0.001	–0.27	–0.049	–1.24
IS	1.214	20.44	1.282	10.56	0.621	11.65	0.593	2.99
DS	–1.308	–5.51	–2.178	–5.78	0.193	0.87	0.146	0.35
FS	–0.833	–15.44	–1.873	–10.1	–0.793	–9.16	–1.63	–11.64
	1996		**1997**		**1998**		**1999**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	–0.139	–5.86	–0.048	–2.94	0.053	7.88	0.44	13.85
RDL	0.119	4.15	1.719	41.16	0.182	23.11	0.355	9.2
Size	13.384	12.49	1.779	7.77	0.034	0.45	1.559	4.81
PKL	0.031	0.68	0.091	2.15	–0.008	–1.66	–0.428	–6.97
IS	–0.204	–1.02	0.309	3.37	–0.259	–8.39	–1.9	–11.51
DS	6.01	5.2	0.006	0.01	–1.501	–5.78	–0.599	–0.63
FS	2.607	15.87	–1.176	–5.6	0.317	49.95	–3.038	–17.38

(Continued)

TABLE 6.21 *(Continued)*

	2000		2001		2002	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Intercept	0.094	7.13	0.097	11.8	–0.027	–1.17
RDL	–0.006	–0.55	0.012	0.77	0.057	1.57
Size	–0.177	–0.3	0.36	0.74	1.928	1.13
PKL	0.018	0.62	–0.029	–1.81	0.014	0.63
IS	–1.232	–13.37	–0.704	–18.74	1.163	19.64
DS	0.34	0.83	–1.31	–3.89	0.638	0.59
FS	1.083	29.4	0.933	25.76	–2.678	–22.22

THE DATA

The financial variables are divided by total assets to alleviate heteroscedasticity; hence, an "S" denotes standardized variables. We also use annual financial data for all U.S. firms during the 1952–2003 period.

ESTIMATED SIMULTANEOUS EQUATIONS RESULTS

The ordinary least squares (OLS) technique is used to initially estimate equations (6.2) through (6.5). The simultaneous equation results reported in this study are produced with the use of two-stage (2SLS) and three-stage (3SLS) least squares analysis. Although Dhrymes and Kurz (1967) found that the insignificantly negative association between capital expenditures and dividends in the two-stage least squares regression estimation became a significantly negative association in the three-stage least squares estimations, we found no statistically significant differences in the limited-information (two-stage least squares) and full-information (three-stage least squares) procedures. The two-stage least squares regression equation residuals were not highly correlated, providing the statistical basis for the insignificant coefficient differences in the two- and three-stage least squares estimations. The highest correlations were found in the annual regression residuals between the new debt and capital expenditures equations. We found little difference in the 2SLS and 3SLS results; the OLS, 2SLS, and 3SLS squares regression results are reported in Table 6.1 through Table 6.9. In the Dhrymes and Kurz equation system, using equations (6.2), (6.3), and (6.4), dividend, capital investment, and new debt issues are estimated annually, cross-sectionally over the entire period.

The estimated system equations following the Guerard, Bean, and Andrews (1987) four-equation system, equations (6.2) through (6.5), are estimated annually for the U.S. firms on the WRDS database and are shown in Table 6.10 through Table 6.21. Here we find stronger evidence of the interdependencies of financial decisions in the larger universe than in the original Guerard, Bean, and Andrews (1987) study. In the estimated capital expenditures investment equation, dividends are an alternative use of funds (large negative and statistically significant coefficient), whereas investments are positively associated with increasing research activities and net effective debt financing at the 10 percent level of significance. Net income and depreciation have positive and statistically significant coefficients in the investment equation. The change in sales does not positively influence investment, the accelerator position, as was the case in the study presented in Chapter 4 using the WRDS database and traditionally issued long-term debt. The change in sales is a positive and statistically significant determinant of investment when the largest firms in the United States are analyzed. In the estimated dividend equation, dividends are negatively associated with capital expenditures and positively associated with R&D and net income. We do not find a positive coefficient on the effective debt variable as one would expect according to the imperfect markets hypothesis. New effective debt financing is significantly associated with higher capital expenditures, dividends, and R&D variables; the larger coefficient is found on the capital investment variable, as was the case in Guerard, Bean, and Andrews (1987). R&D is associated with higher effective debt financing and negatively associated with capital expenditures and dividends. There are significant violations of the independence (perfect markets) hypothesis in the capital expenditures, dividends, new debt issues, and research activities equation estimations.

The statistically significant and positive coefficient on the external funds issued variable is convincing in the investment equation and complements the work of McCabe (1979), Peterson and Benesh (1983), and Guerard and McCabe (1992). Dhrymes and Kurz (1967) and Switzer (1984) did not always find a significantly positive relationship between new debt and investments. Mueller (1967) found an inverse relationship between investments and research in his earlier investigation and no relationship between the variables in his later work with Grabowski (1972). Switzer found no significant association between R&D and investment. Decreases in net liquidity are associated with rising investment and dividends. Net income and depreciation positively affect investment and negatively affect new debt financing. Dividends are positively associated with rising net income and last year's dividends, supporting the positions of Lintner (1956), Fama and Babiak (1968), and Switzer (1984).

The rejection of the perfect markets hypothesis is found in (1) the influence of dividends and effective debt financing on the investment decision; (2) evidence that increasing capital expenditures lowers dividends, whereas R&D is positively associated with increasing dividends; and (3) the interdependence between investment and effective debt variables. The empirical evidence concerning U.S. firms in the WRDS universe confirms the necessity of using simultaneous equations to econometrically model the interdependencies of financial decisions. The evidence is more supportive of the existence of imperfect markets in the larger universe than in the original Guerard, Bean, and Andrews (1987) and Guerard and McCabe (1992) 303-firm sample.

CHAPTER 7

Comparing Census/National Science Foundation R&D Data with Compustat R&D Data

This chapter[1] reviews the results of a project in which research and development (R&D) data drawn from National Science Foundation (NSF) and U.S. Census Bureau studies were substituted in several financial models for R&D data drawn from the 1975–1982 Compustat tapes. The result using the Compustat data did not differ significantly from that based on the NSF/Census data in the aggregate, but significant differences were observed for certain industries and certain years. This chapter discusses the financial models and determinants of corporate R&D expenditures using the different databases, and suggests further questions for research.

The general objective of this chapter is to review and summarize findings as to whether R&D expenditures should be included in a set of financial decisions that influence the market value of a firm, as reflected in the price of its stock (Weston and Copeland 1986). A rigorous theoretical position, known as the perfect markets hypothesis, has guided research on this issue for many years, as discussed in the preceding chapter. The perfect markets hypothesis asserts that the value of a firm's stock is determined by the firm's ability to invest in opportunities that will produce enhanced earnings, dividends, or cash flow. It further asserts that dividend policy is independent of these investment decisions; however, the investment decision and the decision to issue new capital stock are interdependent. Thus, the perfect markets hypothesis asserts that the stock market value of a firm is not affected by dividend policy, only by opportunities for further returns, as described in Chapter 6. This chapter considers whether federal financing of R&D influences a firm's financial decision-making process.

INNOVATION, R&D, AND STOCKHOLDER WEALTH

It is well known that there is substantial underinvestment in R&D in the United States economy, primarily because social benefits exceed private rates of return from innovative activities (Mansfield, Rappaport, Romeo, Wagner, and Beardsley 1977). Furthermore, underinvestment in R&D diminishes potential stockholder wealth because R&D activities have been associated with the market value of major industrial firms (Ben-Zion 1984; Guerard, Bean, and Stone 1990; and Guerard and Mark (2003). It is helpful to model the R&D budgetary process of major industrial companies, since empirical evidence supports the hypothesis that decisions on R&D expenditures are made simultaneously with a firm's other financial decisions (Switzer 1984; Guerard and McCabe 1992), as discussed in Chapter 6. A firm's decision to increase its R&D expenditures impacts its decisions on dividends, investments, and new debt issuance. Thus, there is a need to understand how corporate decisions on expenditure reallocation may affect a firm's stock price.

As discussed earlier, in Chapter 6, the empirical research on the perfect markets hypothesis has yielded mixed results since its formulation by Miller and Modigliani (1961), although the majority of studies published in the 1970s support the existence of imperfect markets. A review of this research led Guerard, Bean, and Stone (1990) to formulate a revised model of the stock price valuation process that allows interdependencies that were precluded by the perfect markets hypothesis. One of the goals of this study was to revive the Mueller (1967) hypothesis that research and development expenditures should be included in tests of the perfect markets hypothesis. Guerard, Bean, and Stone (1990) used data obtained from Compustat and U.S. Patent Office tapes to estimate such a model.

In July 1984, the National Science Foundation and the U.S. Bureau of the Census announced the availability of a longitudinal database that would enable researchers to explore the relationship between R&D and other economic variables on an enterprise basis. This chapter compares the results obtained from the NSF data with those derived from the Compustat/Patent Office data. The model used in the Guerard and McCabe (1992) study assumes interdependence between several financial decisions. It employs investment, dividends, and new capital financing equations to describe the firm's budget constraint. The manager may use available funds for research and development (R&D), capital investment (CE), or dividends (DIV), or to increase net working capital (LIQ). The sources of funds are represented by net income (NI), depreciation (DEP), and new debt financing (EF). Thus, the budget constraint is:

$$R\&D + CE + DIV + LIQ = NI + DEP + EF$$

Research and development expenditures are modeled in terms of investments, dividends, and new capital issues (to reflect the imperfect markets hypothesis) and previous research and development expenditures (to serve as a surrogate for previous patents and R&D activities). We use Compustat R&D data as well as NSF/Census R&D data in this chapter. We also use a three-year lag on the R&D variable, as was done in Guerard, Bean, and Andrews (1987). There is little difference between the three-year lag structure and the use of a one-year lag, as was done in Chapter 4. This result is consistent with the Guerard, Bean, and McCabe (1986) results in which the authors found no significant differences between using contemporary and distributed lag variables of investment, dividends, and R&D. The investment equation (CE) uses the rate of profit theory (Tinbergen 1939; Dhrymes and Kurz 1967) in which net income positively affects investment. The accelerator position on investment is also examined through the two-year growth in sales (DSAL) variable. Depreciation is normally included in the investment analysis because depreciation describes the deterioration of capital in the productive process. This study uses cash flows (CF) to incorporate both net income and depreciation effects; moreover, other noncash expenditures are included in the firm's cash flows. The investment, dividend, and external financing equations used here were discussed in Chapter 6. The variables are again divided by assets to reduce heteroscedasticity.

It is expected that the price of common stock (PCS) would be positively correlated with research and development expenditures, patents, lagged patents, book value of equity, and investment (Ben-Zion 1984).

FINANCIAL DECISION ESTIMATION RESULTS

Guerard and McCabe (1992) used a sample of 303 very large U.S. firms drawn from 12 industries to model a firm's financial decisions. This database covered the 1971–1982 time period and was constructed from Compustat and Patent Office data. Cross-sectional regressions were used to estimate the model. Industry dummy variables, based on Standard Industrial Code (SIC) classifications, were developed to examine industry financial differences. Our econometric estimations of the R&D, capital expenditures, dividends, new debt, and stock price decisions use only contemporaneous variables because the use of distributed lags of the investment, dividend, and R&D variables did not enhance the regression models. Higgins (1972) and McCabe (1979) previously employed models in which composite investments and dividend variables used three-to-four-year weights with lagged variables having weights of 0.65, 0.35, and 0.10 for one-, two-, and three-year lags.

The three-stage least squares regression estimates indicated that R&D expenditures were positively associated with the previous year's R&D expenditures and (current) net income. Dividends were an alternative use to R&D funds in most years, whereas investments were most often positively associated with increasing R&D activities. The lack of statistically significant relationships among R&D, depreciation, and external funds was quite surprising; only the dividend variable significantly violated the perfect markets hypothesis in the R&D activities equation. The electronics industry tended to spend more on R&D activities, holding everything else constant, than other industries.

The three-stage least squares estimate of the investment (CE) equation indicated that the dividend variable was generally positive in the investment equation (contrary to the imperfect markets hypothesis). The statistically significant positive coefficient of the new debt variable in the investment equation complemented the work of McCabe (1979), Peterson and Benesh (1983), and Guerard and McCabe (1992). Similarly, Dhrymes and Kurz (1967) did not always find a significant positive association between new debt and investments. R&D expenditures were positive in the investment equation; Mueller (1967) found an inverse relationship between investments and R&D in his earlier work, and no relationship between the variables in his later work with Grabowski (Grabowski and Mueller 1972). Decreases in net liquidity were associated with rising investment. Cash flow positively affected investment, while the tax rate had statistically significant negative coefficients in 1976 and 1977 in the investment equation. The positive coefficients on the R&D and dividend variables were counter to the imperfect markets hypothesis.

Dividends (DIV) were positively associated with rising net income and previous dividends, supporting the positions of Lintner (1956) and Fama and Babiak (1968). There was a slight tendency for rising investment to accompany increasing dividends. The hypothesized (negative) relationship between investments and dividends was never realized in the dividend equation estimates. Little support for the imperfect markets hypothesis was found in the dividend equation. R&D was often negatively associated with dividends, but the relationship was not statistically significant. The petroleum industry had a very unstable dividend policy (the industry dummy variable was usually significant, whether positive or negative).

While external funds (EF) are normally issued in response to increasing investments, the hypothesized (positive) relationships among new debt, dividends, and research and development were not found. The relationship found between new debt and investment was consistent with the perfect markets hypothesis. New debt financing was negatively associated with cash flow. Furthermore, debt-to-equity ratio coefficients were (unexpectedly) positive. One would expect that as cash flow increased, there would be less need to issue capital. In addition, a higher debt-to-equity ratio would raise the risk to the firm's creditors and normally reduce future capital issues. The rubber, machinery, chemical, and drug industries tended to be new debt issues intensive. Support for the imperfect markets hypothesis was indicated by the positive interdependencies of new debt issues and investments (contrary to the perfect markets hypothesis). Moreover, the alternative uses of funds concept was found in the significant negative interdependencies between R&D expenditures and dividends. Furthermore, R&D expenditures and investment decisions were interrelated.

In a follow-up study by Guerard, Bean, and McCabe (1986), the price of common stock (PCS) was positively affected by dividends, investment, R&D, and the book value of common stock, in agreement with Ben-Zion (1984), who studied the relationship between R&D and the firm's market value for 157 firms during the 1969–1977 period. However, patents issued to a firm did not appear to increase the value of the firm's equity (only in 1982), as was found by Ben-Zion. Lagged patents were positively associated with the stock price in most years. The significance levels for the dividend, capital expenditures, and R&D variables tended to decline in the latter years of the study (1980–1982). The firm's measure of systematic risk (its beta) is incorrectly positive in the estimated stock price equation. A positive coefficient was also found by Ben-Zion (1984). It is noteworthy that the book value of equity variable dominates the stock price equation, as Ben-Zion found, except for 1981.[2] Common stock in the machinery industry appeared to be overpriced relative to that of other industries.

These findings cast additional doubt on the perfect markets hypothesis. They also suggest that R&D expenditures (but not necessarily patents) are among the variables that influence the stock market value of a firm.

Against this background, the announced availability of the NSF/Census data series provided an opportunity to replicate the preceding analysis. Such a replication was seen as a way of reviewing the perfect markets hypothesis one more time, and of testing the sensitivity of the empirical model to alternative data. If the empirical results using the NSF/Census data set were very similar to the Compustat/Patent Office results, it would encourage further work on the linkages between the data sets (National Science Foundation 1985).

The current work attempts to replicate the previous (Compustat) study by substituting the R&D expenditure data from the NSF/Census database for the R&D expenditure data in the Compustat database over the 1975–1982 time period. Census Bureau employees performed the substitutions and provided results of the computer runs to the authors. Whereas the prior work covered 303 firms from 1972 to 1982, the present study uses a sample of 158 to 188 firms over the 1975–1982 time period. The matching procedure created by substituting the NSF/Census data for the Compustat data reduced the original 303-firm sample to 158 to 188 firms by eliminating (nonmanufacturing) firms not engaged in R&D activities.[3] This procedure permitted comparisons to be made at several different levels:

1. Annual comparisons of the aggregate R&D data across the whole sample.
2. Annual comparisons of industry-level data across several subsamples.
3. Examination of the sensitivity of the models to the substitution of NSF/Census data for Compustat data.
4. Examination of the impact of the compressed time frame on results.

While there are several results that are worthy of detailed discussion, the overall results suggest that the substitution of the NSF/Census data had little effect on the model structure, thus indicating a good linkage between the NSF/Census data set and the more business-oriented Compustat data.[4]

Comparison of R&D Expenditure Data

When the process of matching was finished, samples ranging in number from 158 to 188 were obtained for the years 1975 through 1982. Examination of variances (Table 7.1) and means (Table 7.2) of the complete sample shows that the R&D expenditure data are not statistically different in six of the eight years, but that the 1978 and 1979 samples are significantly different. The variance (Table 7.1) of the Compustat data is

TABLE 7.1 Comparison of R&D Expenditure Data for Matched Samples of Firms: Compustat versus NSF/Census Data, 1975–1982. Test of Significance for Differences in Sample Variances: *F* ratio

		1975	1976	1977	1978	1979	1980	1981	1982
Complete Sample	*F* =	1.08	1.09	1.15	1.29*	2.55*	1.16	1.08	1.04
	N =	(188)	(188)	(188)	(188)	(180)	(177)	(162)	(158)
Industries									
Construction	*F* =	1.50	1.50	1.50	1.67	2.00	1.33	1.33	2.00
	N =	(16)	(16)	(16)	(16)	(16)	(16)	(17)	(17)
Petroleum	*F* =	11.5**	14.5**	16**	15**	18**	1.50	1.25	1.20
	N =	(12)	(12)	(12)	(12)	(12)	(11)	(11)	(11)
Machinery	*F* =	1.17	1.00	1.08	1.15	1.06	1.06	1.05	1.09
	N =	(16)	(16)	(16)	(16)	(16)	(16)	(15)	(15)
Electronics	*F* =	1.29	1.19	1.18	1.83	1.23	1.06	1.12	1.09
	N =	(21)	(21)	(21)	(21)	(22)	(22)	(17)	(15)
Drugs	*F* =	1.08	1.31	1.40	1.57	1.37	1.47	1.50	1.44
	N =	(25)	(25)	(25)	(25)	(25)	(24)	(23)	(23)
Chemicals	*F* =	1.00	1.09	1.05	1.23	1.18	1.28	1.24	1.02
	N =	(24)	(24)	(24)	(24)	(24)	(24)	(23)	(23)

*Significant at 0.05 level; Compustat variance > Census variance.
**Significant at 0.01 level; Compustat variance < Census variance.

1.29 times greater than that of the NSF/Census data in 1978, which is significant at the 0.05 level (F-test), while it is significantly less than that of the Compustat data in 1979. Clearly, the reversal of the direction of the differences and the level of significance attained (0.05 in 1978 and 0.01 in 1979) suggest that R&D expenditures were reported very differently by some firms in these two years.[5] The sample means (Table 7.2) further suggest that 1979 was unusual for R&D reporting purposes, for the sample as a whole. Firms tended to report higher R&D expenditures in the Compustat format than they did in the NSF/Census survey, except for 1979 and 1982. The size of the difference was particularly great in 1982. Since it is well known (National Science Foundation 1985) that the Securities and Exchange Commission (SEC) Forms 10-K and 10-Q data used to develop the Compustat data permit certain activities (e.g., engineering and technical service) to be included in R&D that are excluded under the NSF definitions, one would expect the Compustat means to be greater than the NSF/Census means.[6]

The industry-level data in Tables 7.1 and 7.2 suggest strong differences between the two data sources in the petroleum industry from 1975 to 1979. The differences in R&D reporting in the petroleum industry could result from the accounting treatment of exploration activities and other noncash expenditures. The variances are significantly different for these

TABLE 7.2 Comparison of R&D Expenditure Data for Matched Samples of Firms: Compustat versus NSF/Census Data, 1975–1982. Z Scores for Differences in Means*

		1975	1976	1977	1978	1979	1980	1981	1982
Complete Sample	*F* =	0.004	0.014	0.315	0.308	0.858	0.395	0.200	0.266
	N =	(188)	(188)	(188)	(188)	(180)	(177)	(162)	(158)
Industries									
Construction	*F* =	0.222	0.816	0.097	0.029	0.328	0.531	0.360	0.643
	N =	(16)	(16)	(16)	(16)	(16)	(16)	(17)	(17)
Petroleum	*F* =	1.549	–1.229	–1.348	–1.382	–1.148	–1.344	–1.161	–1.500
	N =	(12)	(12)	(12)	(12)	(12)	(11)	(11)	(11)
Machinery	*F* =	0.063	–0.031	–0.018	–0.362	–0.225	–0.490	–0.085	–0.236
	N =	(16)	(16)	(16)	(16)	(16)	(16)	(15)	(15)
Electronics	*F* =	0.003	–0.134	0.364	0.578	0.424	0.375	0.150	0.443
	N =	(21)	(21)	(21)	(21)	(22)	(22)	(17)	(15)
Drugs	*F* =	0.092	–0.027	0.192	0.377	0.319	0.460	0.383	0.313
	N =	(25)	(25)	(25)	(25)	(25)	(24)	(23)	(23)
Chemicals	*F* =	1.076	0.825	1.230	1.008	0.616	0.752	0.793	0.063
	N =	(24)	(24)	(24)	(24)	(24)	(24)	(23)	(23)

*A positive score indicates that the Compustat mean exceeds the NSF/Census mean; a negative score indicates that the NSF/Census mean exceeds the Compustat mean.

years, with the Compustat data showing the greater variance but a lower mean value. Thus, the petroleum industry reported higher mean R&D expenditures under the more restrictive NSF/Census definitions than under the broader SEC definitions.[7] Other than for the petroleum group, the industry-level data are well behaved. Industry groupings with fewer than 10 cases were not analyzed separately because of sample size. (There were only seven cases in the next largest industry after petroleum.)

In summary, the R&D expenditure data for the complete sample are comparable for all years except 1978 and 1979. When specific industry data are examined, the petroleum industry data have dissimilar variances in 1975–1979, and the mean values are uniformly different throughout. Moreover, the differences in the petroleum industry mean R&D expenditures are in the opposite direction from the complete sample differences in all years except 1979 and 1982. This suggests that the industry consistently underreported its R&D expenditures on SEC Forms 10-K and 10-Q, while the firms in the complete sample tended to overreport, relative to the NSF/Census figures.

Comparison of Regression Results

The question addressed by the regression results is whether the support for the imperfect markets hypothesis is strengthened or weakened by substituting the NSF/Census data for the Compustat data. Because of the losses in sample size due to the pairwise matching of firms and the reduced time frame (1978–1982 vs. 1975–1982), it is necessary to examine changes in the results due to sample size and time frame reduction, as well as those due to differences in data sources. These results are presented in Tables 7.3 through 7.6.

When the R&D expenditures equation (Table 5.3) is reestimated using the reduced Compustat sample (a decrease from 303 firms to 158–188 firms), the model that most closely fits the data is:

$$\text{RCOMP(78}-\text{82): R\&D} = f(\overset{+}{\text{R\&D}}_{t-1}, \overset{+}{\text{R\&D}}_{t-2}, \overset{+}{\text{R\&D}}_{t-3})$$

The rationale for this judgment is that, in order to be retained in the model, a variable must be statistically significant and have the same sign in at least three of the five periods studied. Applying the same criteria to the NSF/Census data yields the following result:

$$\text{CENS(78}-\text{82): R\&D} = f(\overset{+}{\text{R\&D}})_{t-1}$$

TABLE 7.3 Comparative Two-Stage Regression Results. Dependent Variable: R&D Expenditures (R&D)

	Constant	RD_{t-1}	RD_{t-2}	RD_{t-3}	NI	DEP	EF	CE	DIV
1978: 303	0.000	1.454*	–0.050	–0.317*	–0.036	–0.004	–0.012*	0.013*	–0.134*
188 Cens	0.000	0.511*	0.502*	–0.107	0.001	0.020	–0.002	–0.012	0.056
188 Comp	0.002**	0.956*	0.093	–0.076	0.008	0.028	–0.001	0.001	–0.012
1979: 303	0.000	1.490*	–0.223	–0.190	0.042*	0.012	–0.010	0.033*	–0.177*
180 Cens	0.018	0.968**	–0.213	0.267	–0.171**	–0.302*	–0.144**	0.198*	0.120
180 Comp	–0.001	0.759*	–0.551*	0.845*	0.002	–0.010	–0.013	0.023*	–0.020
1980: 303	–0.001	1.378*	–0.046	–0.272	0.074*	0.002	–0.008	–0.005	–0.169*
177 Cens	–0.001	0.890*	0.022	0.127*	–0.001	0.048*	–0.026*	–0.015	–0.014
177 Comp	–0.061	–0.537	0.546*	0.994	0.012	0.038*	–0.018**	–0.013	0.009
1981: 303	0.000	1.476*	–0.238	–0.242*	0.028*	0.020	–0.000	0.001	–0.041
161 Cens	0.002	0.653*	0.376*	0.069	–0.003	–0.010	–0.050	0.0012	–0.066*
161 Comp	–0.001	1.119*	–0.397*	0.294*	–0.005	0.019	–0.019*	–0.011	0.014
1982: 303	–0.019	2.382*	–2.379*	0.030*	–0.061*	0.225*	0.030	–0.084*	0.853*
158 Cens	–0.000	0.630*	0.108	0.265	–0.008	0.020	–0.024	–0.003	0.102
158 Comp	–0.001	1.088*	–0.573	0.469*	–0.016	0.097	–0.009	0.012	0.091*

*Significant at 5% level.
**Significant at 10% level.
Cens—Census R&D database used in analysis.
Comp—Compustat R&D database used in analysis.

TABLE 7.4 Two-Stage Least Squares Results. Dependent Variable: Investment (CE)

	Constant	CF	LIQ	Tax Rate	DIV	RD	EF
1978: 303	0.069*	0.336*	–0.194*	–0.008	–0.036	0.187**	0.457*
188 Cens	0.079*	0.338*	–0.181*	–0.012	–0.257	0.228*	0.208*
188 Comp	0.076*	0.320*	–0.182*	–0.010	–0.224	0.231*	0.218*
1979: 303	0.071*	0.345*	–0.200*	–0.001	–0.186**	0.422*	0.353*
180 Cens	0.073*	0.425*	–0.188*	–0.059*	–0.201	0.153*	0.423*
180 Comp	0.084*	0.365*	–0.213*	–0.054*	–0.126	0.464*	0.405*
1980: 303	0.075*	0.348*	–0.185*	0.000	0.093	0.312*	0.609*
177 Cens	0.073*	0.293*	–0.181*	–0.001	–0.131	0.508*	0.291*
177 Comp	0.077*	0.282*	–0.184*	–0.001	–0.151	0.461*	0.295*
1981: 303	0.070*	0.473*	–0.213*	–0.015	0.346*	0.398*	0.157*
161 Cens	0.080*	0.509*	–0.188*	–0.065**	–0.401	0.166	0.428*
161 Comp	0.081*	0.508*	–0.190*	–0.066**	–0.421	0.165	0.426*
1982: 303	0.070*	0.250*	–0.164*	0.028*	0.346*	0.398*	0.157*
158 Cens	0.061*	0.258*	–0.163*	0.030*	0.243	0.241*	0.151*
158 Comp	0.062*	0.257*	–0.165*	0.030*	0.200	0.274*	0.149*

*Significant at 5% level.
**Significant at 10% level.
Cens—Census R&D database used in analysis.
Comp—Compustat R&D database used in analysis.

TABLE 7.5 Two-Stage Least Squares Results. Dependent Variable: Dividend (DIV)

	Constant	LDIV	NI	ROE	LIQ	CE	RD	EF
1978: 303	0.002	0.965*	0.053*	–0.006	–0.005	0.008	–0.026*	–0.010
188 Cens	0.002	0.959*	0.080*	–0.002	–0.045*	–0.009	–0.027*	–0.006
188 Comp	0.001	0.958*	0.080*	–0.002	–0.005*	–0.009	–0.017**	–0.007
1979: 303	0.003	0.955*	0.067*	–0.017*	–0.002	–0.015*	0.005	–0.012**
180 Cens	0.001	0.982*	0.064*	–0.004	–0.004	–0.010	0.001	–0.008
180 Comp	0.001	0.981*	0.066*	–0.004	–0.003	–0.009	–0.005	–0.008
1980: 303	0.000	1.008*	0.055*	0.001*	0.007*	–0.003	–0.001	0.001
177 Cens	0.001	1.029*	0.065*	0.012*	–0.005*	–0.014**	–0.008	0.006
177 Comp	0.001	0.028*	0.065*	0.011*	–0.005*	–0.015*	–0.004	–0.006
1981: 303	0.001	1.073*	0.024*	–0.002	–0.004**	0.007**	–0.014**	–0.003
161 Cens	0.001	0.085*	0.077*	–0.015*	–0.029	0.012*	–0.021*	–0.612**
161 Comp	0.000	0.986*	0.079*	–0.015*	–0.003	0.012*	–0.017**	–0.012**
1982: 303	–0.008	0.429*	0.174*	0.000	–0.055*	0.034	0.651*	0.126*
158 Cens	–0.001*	0.995*	0.022*	0.003*	0.034*	0.010*	–0.005	–0.002
158 Comp	–0.014*	0.996*	0.022*	0.003*	0.034*	0.010*	–0.004	–0.014

*Significant at 5% level.
**Significant at 10% level.
Cens—Census R&D database used in analysis.
Comp—Compustat R&D database used in analysis.

TABLE 7.6 Two-Stage Least Squares Results. Dependent Variable: New Debt (EF)

	Constant	CF	KD	DE	CE	RD	DIV
1978: 303	0.002	–0.155*	–0.027*	0.019*	0.322*	0.514*	0.272*
188 Cens	0.023*	0.012	0.023	0.014**	0.082	0.185	–0.751*
188 Comp	0.026*	0.024	0.003	0.011	0.088	0.023	–0.801*
1979: 303	–0.008	–0.085**	–0.020**	0.013*	0.313*	0.329*	0.381*
180 Cens	0.013	0.024	0.005	0.014*	0.203*	–0.045	–0.725*
180 Comp	0.011	0.017	0.004	0.016*	0.188*	0.097	–0.709*
1980: 303	0.011	–0.029	–0.004	–0.007*	0.472*	0.042	–0.820*
177 Cens	0.034*	–0.033	0.017	–0.012*	0.226*	–0.053	–0.505*
177 Comp	0.034*	–0.031	0.002	–0.012*	0.225*	–0.061	–0.504*
1981: 303	0.023*	0.055	0.005	0.003	0.347*	–0.072	–1.291*
161 Cens	–0.005	–0.061	0.008	0.036*	0.278*	0.157	–0.251
161 Comp	–0.005	–0.064	0.009	0.036*	0.281*	0.183**	–0.276
1982: 303	0.009	–0.192	0.032*	–0.000	0.302*	0.117	0.533*
158 Cens	0.038*	–0.113	0.002*	–0.004	0.348*	–0.190	–0.514
158 Comp	0.037*	–0.114	–0.001	–0.004	0.348*	–0.171	0.488

*Significant at 5% level.
**Significant at 10% level.
Cens—Census R&D database used in analysis.
Comp—Compustat R&D database used in analysis.

Recall that the 303-firm Compustat sample supported the following model for the 1975–1982 period, as well as for the shorter period[8]:

$$\text{COMP303(75}-\text{82): R\&D} = f(\overset{+}{\text{R\&D}_{t-1}},\ \overset{+}{\text{NI}},\ \overset{-}{\text{DIV}})$$

One important factor may be that the 303-firm sample is highly diversified and includes firms that reported no R&D expenditures. The NSF/Census sample, which determines the reduced Compustat (RCOMP) sample, does not contain such (predominately nonmanufacturing) firms.[9]

On the positive side, all three models strongly support the importance of last year's R&D expenditures as a prediction of this year's R&D.

When the investment (CE) equation was reestimated, it was perfectly stable. As can be seen by inspecting Table 7.4, nothing changes. The tax rate variable is significant in three of the five years, but changes signs (as is the case with dividends).[10] The investment equation is:

$$\text{CE} = f(\overset{+}{\text{CF}},\ \overset{-}{\text{R\&D}},\ \overset{+}{\text{EF}},\ \overset{-}{\text{LIQ}})$$

The dividend (DIV) equation (Table 7.5) is also stable for the 1978–1982 period. However, it is noteworthy that the new debt variable (EF), which was significantly and negatively related to dividends in 1975–1977, did not hold up in the 1978–1982 period. Thus, the data support the following dividend equation in all cases:

$$\text{DIV} = f(\overset{+}{\text{DIV}},\ \overset{+}{\text{NI}}_{t-1})$$

The new debt (EF) equation (Table 7.6) must also be modified because of the time frame covered in this study. While both cash flow and dividends were significantly and negatively related to new debt over the 1975–1982 time frame, cash flow does not hold up between 1978 and 1982, and dividends waver somewhat. For the 1978–1982 period, the Compustat 303 data support the following model:

$$\text{COMP303(78 – 82): EF} = f(\overset{+}{\text{CE}},\ \overset{+}{\text{DIV}})$$

The longer Compustat period (1975–1982) model is:

$$\text{COMP303(78 – 82): EF} = f(\overset{+}{\text{CE}},\ \overset{+}{\text{DIV}},\ \overset{-}{\text{CF}})$$

Using the reduced Compustat sample, the equation for the 1978–1982 would become:

$$\text{RCOMP(78 – 82): EF} = f(\overset{+}{\text{CE}},\ \overset{-}{\text{DIV}})$$

Using the NSF/Census data in the reduced sample, the 1978–1982 equation is:

$$\text{CENS(78 – 82): EF} = f(\overset{+}{\text{CE}},\ \overset{+}{\text{DE}},\ \overset{-}{\text{DIV}})$$

These results provide a mixed picture of the new debt equation. Clearly, new debt is issued to finance capital expenditure in all cases. However, the direction of the dividend relationship seems sensitive to the time frame issue. It is significantly and negatively related to new debt except for the 1978–1982 time period using the Compustat 303-firm sample, when it is marginally positive. For the reduced Compustat sample, the dividend variable becomes negative and significant, while cash flow drops out. Finally, when the NSF/Census R&D data are substituted, the debt/equity ratio enters as a significant positive variable. This is counterintuitive, since the cost of debt should rise as the debt/equity ratio rises, thus discouraging new debt. This latter result was found by Guerard and McCabe (1992).

RELATION OF CURRENT RESULTS TO PRIOR RESEARCH

Three new models of statistically significant relationships between financial decisions and the stock market value of a firm have been estimated. They have then been compared with a fourth reference model developed in an earlier study.

1. The compression of the time frame from 1975–1982 to 1978–1982 did not change the structure of the R&D equation or the capital expenditure equation associated with the 303-firm Compustat sample. This means that the interdependence of the R&D, net income, dividends, and capital expenditures decisions were preserved, implying support for the imperfect markets hypothesis.[11]

2. The reduced Compustat data set includes only the firms that are present in both the Compustat (1978–1982) and the NSF/Census (1978–1982) samples (see Guerard, Bean, and Andrews 1987). An important result of this analysis is that the R&D decision is no longer dependent on the net income and dividend decisions, but is driven only by previous R&D. This finding tends to weaken support for the imperfect markets hypothesis. The capital expenditures equation continues to be stable, including a positive association between R&D and capital expenditures, which is consistent with expectations and prior results. The fact that the RCOMP (1978–1982) sample contains only R&D-performing firms, and thus includes a limited range of observed levels of R&D expenditures (lacking a zero point, for example), may explain why R&D expenditures are no longer interdependent with other financial decisions. The dividend equation is consistent with the COMP303 (1978–1982) version. New debt continues to be strongly affected by capital expenditures, but the relationship to dividends changes signs again, thus indicating instability based on sample composition as well as time frame (the preceding item 1).

3. The substitution of the NSF/Census R&D expenditure data for the Compustat R&D data in the reduced sample suggests only minor modifications for the aforementioned findings. R&D expenditures are dependent only on the prior year's R&D. The discussion in item 2 is relevant here. The capital expenditures and dividends equations are unchanged. The new debt equation once again shows some instability. Capital expenditures and dividends are related to new debt, as they were in the RCOMP (1978–1982) series. However, the debt/equity ratio has now entered the equation, but the sign is opposite to expectations. As the debt/equity ratio rises, new debt financing should fall, because the cost of new debt should be rising; thus, the finding is counterintuitive. Moreover, the beta variable, measuring the firm's systematic risk, is positively associated with new debt. A similar relationship was found by Switzer (1984).

The stock price was positively affected by dividends and investment in 1979 and 1980, research and development in 1982, and the book value of common stock, as shown in Table 7.7.[12] However, the financial decision variables, particularly the dividend variable, tend to be positively associated with the firm's stock price. One should notice that the significance levels for the capital expenditures variable tends to decline in the latter years of the study, 1981 and 1982. The book value of the equity variable domi-

TABLE 7.7 Stock Price Equation Estimates. Two-Stage Least Squares Regressions

Variables	1978	1979	1980	1981	1982
Constant (t)	–0.0170	–0.0461	–0.0780	0.0060	–0.0134
	(–2.52)	(–4.45)	(–6.00)	(0.40)	(–3.00)
Beta	0.0276	0.0057	0.0268	0.0113	0.0056
	(–1.32)	(0.78)	(3.80)	(1.95)	(1.99)
Dividends	0.3898	0.2612	0.4345	0.2508	0.2374
	(4.75)	(1.67)	(2.64)	(1.75)	(3.22)
Investment	0.0551	0.2434	0.3310	–0.1675	0.0194
	(1.25)	(3.62)	(4.46)	(–3.85)	(0.77)
R&D	0.0431	–0.0248	–0.1490	–0.0059	0.1027
	(0.68)	(–0.28)	(–1.30)	(–0.80)	(2.55)
Book Value	0.8360	1.4961	1.4833	0.0026	0.8582
	(18.18)	(19.78)	(17.74)	(0.95)	(21.66)
Patents	0.0547	0.2891	–0.3328	–0.375	0.1438
	(0.62)	(0.89)	(–1.10)	(–1.90)	(1.51)
LPatents	0.0344	–0.1055	0.4237	0.5218	–0.0207
	(0.34)	(–0.54)	(1.33)	(2.29)	(–0.28)
R^2	0.760	0.765	0.745	0.057	0.834

nates the stock price (PCS) equation, as is found in Ben-Zion (1984), for all years, with the noted exception of 1981.

EXTENSIONS OF THE SIMULTANEOUS EQUATIONS APPROACH

After developing the original simultaneous equations model of stock price valuation based on the 303-firm Compustat sample, Guerard and McCabe (1992) and Guerard, Bean, and Stone (1990) explored several extensions. This section reexamines two of those extensions based on the availability of the NSF/Census data. A multicriteria model was developed from the imperfect markets hypothesis (Guerard, Bean, and Andrews 1987). It was used to determine the research, dividend, and investment allocations, as well as the external financing levels, needed to maximize a firm's common stock price relative to its asset base. Regression coefficients from the three-stage least squares model were used as inputs to a multiple-goal linear programming model that minimizes the firm's underachievement or overachievement (relative to industry averages) of allocations among the financial variables that impact common stock prices. A firm that is interested in minimizing the underachievement of desired research, investment, and dividend expenditures and the overachievement of desired levels of debt in order to maximize its share price can use the goal programming model to determine the appropriate financial decisions. The objective function of the linear programming model may be written as:

$$\min Z = p_1\overset{-}{d_1} + p_2\overset{-}{d_2} + p_3\overset{-}{d_3} + p_4\overset{+}{d_4}$$

where d_1 = underachievement of desired research expenditures
d_2 = underachievement of desired investment expenditures
d_3 = underachievement of desired dividend payments
d_4 = overachievement of desired external financing
p = priority goal programming levels

Guerard, Bean, and Andrews (1987) estimated this model for a firm selected at random from the 303-firm Compustat database for 1982. The sample firm's R&D, capital, and dividend allocations were less than the industry average for firms with its asset base, and its new debt was greater than the industry average, as shown in Table 7.8.

A question that might be raised by this firm's management is whether a

TABLE 7.8 1982 Allocations and Commitments ($ millions)

	Sample Firm	Industry Average
R&D	$ 68	$148
Capital Expenditures	770	799
Dividends	42	117
New Debt	577	231

change in its financial decisions would improve stockholder wealth and, if so, how the changes should be made.[13] As shown in Table 7.9, these results suggest that the firm, given its asset base, was spending less than optimal levels on R&D, capital replacement/expansion, and dividends, and that it incurred excessive new debt. Under the assumption that its asset base would remain the same, these results imply that the firm could increase its stock price in 1983 by increasing its expenditures on worthy R&D and capital projects, increasing dividends, and reducing issuance of new debt. As pointed out in Guerard and Bean (1987), this approach to maximizing stockholder wealth (that of formulating optimal financial policies) was shown to be more effective than approaches that attempt to maximize return on equity or growth in earnings per share, as discussed by Rappaport (1983). In addition, the approach presented here offers econometric support for the financial modeling approach and extends the theoretical models of Carleton (1970), Hamilton and Moses (1973), and Burton, Damon, and Obel (1979, 1984).

Given these interesting results from the Compustat data, the analysis was replicated using the 1982 NSF/Census data; the results are shown in Table 7.10.

Clearly, the two data sets produce somewhat different results. The NSF/Census data call for smaller adjustments than the Compustat data. However, the adjustments are all in the same direction relative to the firm's actual allocations, and with respect to the industry averages. Thus, in both

TABLE 7.9 Sample Firm—Results of Optimization Procedure Using 1982 Compustat Data ($ millions)

	Sample Firm	Optimal Levels	Under/Over
R&D	$ 68	$199	$–131
Capital Expenditures	770	924	–155
Dividends	42	278	–236
New Debt	577	475	102

TABLE 7.10 Sample Firm—Results of Optimization Procedure Using 1982 NSF/Census Data ($ millions)

	Firm's Actual	Optimal Levels	Under/Over
R&D	68	189	$–121
Capital Expenditures	770	882	–112
Dividends	42	139	–97
New Debt	577	540	36

cases it appears that the firm's actual financial decisions resulted in depressed stock prices in 1982 relative to its asset base. Given its assets, it was underinvesting in R&D and capital projects, paying lower dividends, and issuing more new debt than the industry average. However, given its asset base, the new debt decision was closer to optimal than the other decisions. The most striking contrast between the two cases involves dividend policy. Clearly, in the case of the Compustat data, stock prices in this industry are much more dependent on dividend policy than in the NSF/Census case. The comparisons are summarized in Table 7.11.

SUMMARY AND CONCLUSIONS

An examination of R&D data for matched pairs of firms has shown that Compustat data and NSF/Census data are comparable for a diverse sample of firms. However, on a year-by-year basis, the NSF/Census data appear to be significantly different from the Compustat data in 1979 and, probably, in 1978. In general, it appears that firms overreported R&D expenditures in the Compustat studies relative to NSF/Census studies. This

TABLE 7.11 Sample Firm—Optimal 1983 Decisions Based on 1982 Actual and Industry Levels ($ millions)

Decision Variables	1982 Actual Levels	1982 Industry Levels	Optimal 1983 Compustat	Optimal 1983 NSF/Census
R&D	68	178	199	189
Capital Expenditures	769.5	798.5	924.1	881.5
Dividends	42	117	278	139
New Debt	577	231	475	540

is not surprising, given the exclusion of engineering and technical services, as well as research in the behavioral sciences, from NSF's definitions of R&D. In the analysis of six specific industries, the R&D expenditures data were significantly different in only one, petroleum, where the sample size was relatively small.

When the NSF/Census R&D data were substituted into a series of regression equations used to test for relationships associated with the perfect markets hypothesis, support for the interdependence of R&D and other financial management decisions became progressively weaker as:

- The time frame of the data series was compressed.
- The diversity of the firms in the sample was reduced.

When the NSF/Census R&D data was substituted for the Compustat data in the more homogeneous sample in the compressed time frame, the regression results were not altered significantly. Thus, it appears that the NSF/Census data were equally useful in testing the perfect markets hypothesis within this sample.

SUGGESTIONS FOR FUTURE RESEARCH

A larger, more diversified sample of firms should be drawn from the NSF/Census data set to reexamine the perfect markets hypothesis. The hypothesis is important to national R&D policy concerns because it addresses the question of wealth creation and its underlying causes. The larger, more diversified sample drawn from the Compustat data provided relatively strong support for the concept of simultaneous determination of the financial decisions within a firm that influence wealth creation. Moreover, the level of R&D funding was an important determinant of wealth creation. A less diversified sample, covering fewer firms and a shorter time frame, provided weaker support for the interdependencies among these decisions, regardless of whether NSF/Census data or Compustat data were used. Since it is well known that technology flows through the economy by interindustry transfer processes (Scherer 1982), it is necessary to include technology-using firms that may not perform R&D, as well as technology-generating (R&D-performing) firms, in studies of the role of R&D in wealth creation. If the NSF/Census data set does not include non-R&D-performing firms, it becomes increasingly important to understand the pros and cons of linking this data set to others that are more representative of the economy as a whole.

This brief examination of the role of federal R&D expenditures in explaining wealth creation is merely an introduction to an important issue. The addition of federally funded R&D to a firm's own R&D lends support to the perfect markets hypothesis. This suggests that federal support for industrial R&D tends to reduce gaps between social and private returns to R&D (Mansfield 1981, 1984). Much more work is needed on this important issue.[14]

There seems to be little doubt that the firm-aggregate Compustat and NSF/Census data are not the only data necessary to examine the strategic value of industrial R&D. Industrial competitiveness depends on the specific product-market segments toward which industrial R&D is directed, not simply the aggregate level of R&D in firms that are nominally classified by an aggregate SIC code. The large firm's financial decisions, which are seen in the aggregate in Compustat and NSF/Census data, reflect a composite of operating-level decisions associated with specific lines of business. The inclusion of the Federal Trade Commission (FTC) Line-of-Business database (1974–1977) in the analysis would enable an examination of the impact of R&D strategic focus (and other financial decisions) on stock market values. This type of analysis will set the stage for the study of some of the more micro aspects of the NSF/Census database, such as the mix of R&D activities, its structure by field of science, and employment patterns of science and engineering personnel.

CHAPTER 8

The Use of Financial Information in the Risk and Return of Equity

Individual investors must be compensated for bearing risk. It seems intuitive to the reader that there should be a direct linkage between the risk of a security and its rate of return. We are interested in securing the maximum return for a given level of risk, or the minimum risk for a given level of return. The concept of such risk-return analysis is the efficient frontier of Harry Markowitz (1952, 1959). If an investor can invest in a government security, which is backed by the taxing power of the federal government, then that government security is relatively risk-free. We refer to the 90-day Treasury bill rate as our risk-free rate. A liquidity premium is paid for longer-term maturities, due to their increasing risk. Investors are paid interest payments, as determined by the bond's coupon rate, and may earn price appreciation. During the period from 1926 to 2003, Treasury bills returned 3.69 percent, longer-term government bonds earned 5.28 percent, corporate bonds yielded 5.99 percent, and corporate stocks, as measured by the S&P 500, earned 11.84 percent annually. Small stocks averaged a 16.22 percent return, annually, over the corresponding period. The annualized standard deviations are 1.00, 19.48, and 29.66 percent, respectively, for Treasury bills, stocks (S&P), and small stocks. The risk-return trade-off has been relevant for the 1926–2003 period. Why do corporate stocks offer investors such returns? Let us review some of the empirical relationships of risk and return of stocks.

First, as a stockholder, one owns a fraction, a very small fraction for many investors, of the firm. When one owns stocks, one is paid a dividend and earn stock price appreciation. That is, one buys a stock when one expects its stock price to raise and compensate one for bearing the risk of the stock's price movements. Investors have become aware in recent years that not all price movements are in positive directions. Let us examine three widely held R&D-intensive stocks: Johnson & Johnson

(JNJ), IBM, and DuPont (DD), during the 1998–2003 period. The monthly stock returns are taken from the Center for Research in Security Prices (CRSP) database. A very simple concept is the holding period return (HPR) calculation, in which one assumes that the stock was purchased at last period's price and the investor earns a dividend per share for the current period and a price appreciation (or depreciation) relative to last period's price.

$$HPR_t = \frac{D_t + P_t - P_{t-1}}{P_{t-1}}$$

where D_t = current period's dividend
P_t = current period's stock price
P_{t-1} = last period's stock price
HPR_t = current period's holding period return

Let us examine the monthly CRSP stock returns and their corresponding standard deviations of our three stocks for the January 1999–December 2003 period. (See Table 8.1.) The reader notes that Johnson & Johnson (JNJ) had an average monthly return of .0071 (.71 percent) during the January 1999–December 2003 period. One multiplies the average monthly return by 12 to annualize the JNJ monthly average. The annualized JNJ return was 8.52 percent during the 1999–2003 period, whereas the corresponding annualized standard deviation is 24.64 percent (the monthly standard deviation is multiplied by the square root of 12 to annualize the term).

Please note that the calculations of expected returns and standard deviations allow the investor to allocate scarce resources on the basis of his-

TABLE 8.1 Monthly CRSP Stock Returns and Corresponding Standard Deviations

	Monthly		Annualized	
Stock	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
DD	.0033	.0811	.0396	.2807
IBM	.0064	.1107	.0768	.3835
JNJ	.0071	.0710	.0852	.2464

Data source: Center for Research in Security Prices.

toric returns and risk. An investor should not allocate resources to only one security, as was the case with many Enron stockholders. Clearly the standard deviation of return may be minimized by investing in several assets, particularly if these assets are somewhat uncorrelated. An investor does not benefit from investing in two stocks, as opposed to only one security, if both stocks move in parallel. That is, if stock A rises 10 percent and stock B rises 10 percent, then it is not evident that the investor has any benefits to a second stock investment. If Johnson & Johnson has an expected return of 8.52 percent and DuPont has an expected return of 3.96 percent, indicating the stocks are not perfectly correlated with each other, an investor can purchase an equal dollar amount of each stock and reduce risk. The correlation coefficient, as we remember, is the covariance of two series, divided by the product of the respective standard deviations. The correlation coefficient allows an investor to understand the statistical nature of a covariance because the correlation coefficient is bounded between –1 and +1. The covariance between two series is calculated as the sum of the product of the differences between each series and its respective mean. If the covariance of Johnson & Johnson and DuPont is positive, then this implies that when Johnson & Johnson's return is above its mean or expected value, then DuPont's return is above its mean. The correlation coefficient of the two series is 0.165, which is relatively low and implies that the investor might want to have only Johnson & Johnson and DuPont in a two-asset portfolio. The correlation coefficient of Johnson & Johnson and IBM is only 0.018, which is the lowest set of correlations in the three assets (see Table 8.2), and thus one would want to build a two-asset portfolio using these two securities to minimize risk. The most important question is: What should be the respective weights in the portfolio of these two securities to minimize risk?

TABLE 8.2 Monthly Correlation Matrix

	Stock		
Stock	DD	IBM	JNJ
DD	1.0000	0.2988	0.1646
IBM	0.2988	1.0000	0.0184
JNJ	0.1646	0.0184	1.0000

Data source: Center for Research in Security Prices.

The portfolio variance is given by the weighted asset variances and covariances.

$$\sigma_p^2 = x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + 2x_1(1-x_1)\sigma_{12}$$
$$\sigma_{12} = \rho_{12}\sigma_1\sigma_2 \qquad (8.1)$$

where ρ_{12} = correlation coefficients of assets 1, 2
σ_{12} = covariance of assets 1, 2

let $x_2 = 1 - x_1$

To minimize the portfolio variance, one should take the first derivative of the variance with respect to the decision variable, x_1, and set the function equal to zero.

$$\sigma_p^2 = x_1^2\sigma_1^2 + (1-x_1)^2\sigma_2^2 + 2x_1(1-x_1)\sigma_{12}$$
$$= x_1^2\sigma_1^2 + (1-x_1)^2\sigma_2^2 + 2x_1(1-x_1)\rho_{12}\sigma_1\sigma_2$$
$$= x_1^2\sigma_1^2 + (1-x_1)(1-x_1)\sigma_2^2 + 2x_1\rho_{12}\sigma_1\sigma_2 - 2x_1^2\rho_{12}\sigma_1\sigma_2$$
$$\sigma_p^2 = x_1^2\sigma_1^2 + (1-2x_1+x_1^2)\sigma_2^2 + 2x_1\rho_{12}\sigma_1\sigma_2 - 2x_1^2\rho_{12}\sigma_1\sigma_2$$
$$\frac{\partial\sigma\rho^2}{\partial x_1} = 2x_1\sigma_1^2 - 2\sigma_2^2 + 2x_1\sigma_2^2 + 2\rho_{12}\sigma_1\sigma_2 - 4x_1\rho_{12}\sigma_1\sigma_2 = 0 \qquad (8.2)$$
$$2\sigma_2^2 - 2\rho_{12}\sigma_1\sigma_2 = 2x_1\sigma_1^2 + 2x_1\sigma_2^2 - 4x_1\rho_{12}\sigma_1\sigma_2$$
$$(\sigma_1^2 + \sigma_2^2 - 2\rho_{12}\sigma_1\sigma_2)x_1 = \sigma_2^2 - \rho_{12}\sigma_1\sigma_2$$
$$x_1 = \frac{\sigma_2(\sigma_2 - \rho_{12}\sigma_1)}{\sigma_1^2 + \sigma_2^2 - 2\rho_{12}\sigma_1\sigma_2}$$

Equation (8.2) is the risk-minimizing investment in security one in a two-asset portfolio. One can compare the portfolio variances of the optimally weighted portfolio with an equally weighted portfolio, in which $x_1 = x_2 = 0.50$.

let x_1 = weight of JNJ
x_2 = weight of IBM

The portfolio expected return is a weighted combination of asset expected returns.

$$E(R_p) = x_1E(R_1) + x_2E(R_2)$$
$$= .5(.0852) + .5(.0768) = .0810 \qquad (8.3)$$

$$\sigma_p^2 = (.5)^2(.0710)^2 + (.5)^2(.1107)^2 + 2(.5)(.5)(.0184)(.0710)(.1107)$$
$$= .0013 + .0031 + .0001$$
$$\sigma_p^2 = .0045$$
$$\sigma_p = .0671$$

The monthly standard deviation of the equally weighted JNJ and IBM portfolio is .0045 (.45 percent), as its corresponding monthly standard deviation is 6.71 percent. The annualized standard deviation of the equally weighted portfolio is 23.24 percent. The annualized expected return of the equally weighted Johnson & Johnson and IBM portfolio is 8.10 percent, and its standard deviation is 23.24 percent. The portfolio returns should fall within the –15.14 to 31.34 percent range approximately 68 percent of the time.

If we use equation (8.2) to calculate the optimal security investments to minimize risk:

$$x_1 = x_{JNJ} = \frac{.1107[.1107 - .0184(.0710)]}{(.0710)^2 + (.1107)^2 - 2(.0184)(.0710)(.1107)}$$
$$x_1 = \frac{.0123 - .0001}{.0050 + .0123 - .0003}$$
$$x_1 = \frac{.0122}{.0170} = .718$$
$$x_2 = x_{IBM} = .282$$
$$E(R_p) = .718(8.52) + .282(7.68) = 6.12 + 2.17 = 8.29$$

The optimally weighted JNJ and IBM portfolio return is 8.29 percent.

$$\sigma_p^2 = (.718)^2(.0710)^2 + (.282)^2(.1107)^2 + 2(.718)(.282)(.0184)(.071)(.1107)$$
$$= .0026 + .0010 + .0001 = .0037$$
$$\sigma_p = .0605$$

The optimally weighted JNJ and IBM portfolio, composed of 71.8 percent JNJ and 28.2 percent IBM, has a monthly standard deviation of 6.05 percent and an annualized standard deviation of 20.96 percent. Note that the optimally weighted portfolio has a slightly higher expected return (in this particular case), but a lower standard deviation. Markowitz's mean-variance analysis seeks to minimize risk, holding expected return constant.

Let us now examine a three-asset portfolio construction process using Johnson & Johnson, DuPont, and IBM securities.

Stock	Asset
JNJ	1
IBM	2
DD	3

$$E(R_p) = \sum_{i=1}^{N} x_i E(R_i) \tag{8.4}$$

$$\sigma p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} x_i x_j \sigma_{ij} \tag{8.5}$$

$$\begin{aligned} &E(R_p) = x_1 E(R_1) + x_2 E(R_2) + x_3 E(R_3) \\ &\text{let } x_3 = 1 - x_1 - x_2 \\ &E(R_p) = x_1 E(R_1) + x_2 E(R_2) + (1 - x_1 - x_2) E(R_3) \end{aligned}$$

$$\begin{aligned} \sigma_p^2 &= x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + \sigma_3^2 x_3^2 + 2x_1x_2\sigma_{12} + 2x_1x_3\sigma_{23} + 2x_2x_3\sigma_{23} \\ &= x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + (1 - x_1 - x_2)^2\sigma_3^2 + 2x_1x_2\sigma_{12} + 2x_1(1 - x_1 - x_2)\sigma_{13} \\ &\quad + 2x_2(1 - x_1 - x_2)\sigma_{23} \\ &= x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + (1 - x_1 - x_2)(1 - x_1 - x_2)\sigma_3^2 + 2x_1x_2\sigma_{12} + 2x_1\sigma_{13} \\ &\quad - 2x_1^2\sigma_{13} - 2x_1x_2\sigma_{13} + 2x_2\sigma_{23} - 2x_1x_2\sigma_{23} - 2x_2^2\sigma_{23} \\ &= x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + (1 - 2x_1 - 2x_2 + 2x_1x_2 + x_1^2 + x_2^2)\sigma_3^2 + 2x_1x_2\sigma_{12} + 2x_1\sigma_{13} \\ &\quad - 2x_1^2\sigma_{13} - 2x_1x_2\sigma_{13} + 2x_2\sigma_{23} - 2x_1x_2\sigma_{23} - 2x_2^2\sigma_{23} \end{aligned}$$

$$\frac{\partial \sigma p^2}{\partial x_1} = 2x_1(\sigma_1^2 + \sigma_3^2 - 2\sigma_{13}) + x_2(2\sigma_3^2 + 2\sigma_{12} - 2\sigma_{13} - 2\sigma_{23}) - 2\sigma_3^2 + 2\sigma_{13} = 0$$

$$\frac{\partial \sigma p^2}{\partial x_2} = 2x_2(\sigma_2^2 + \sigma_3^2 - 2\sigma_{23}) + x_1(2\sigma_3^2 + 2\sigma_{12} - 2\sigma_{13} - 2\sigma_{23}) - 2\sigma_3^2 + 2\sigma_{23} = 0$$

$$\frac{\partial\sigma_p^2}{\partial x_1} = 2x_1[(.0710)^2 + (.0811)^2 - 2(.1646)(.0710)(.0811)] + x_2[2(.0811)^2$$
$$+ 2(.0184)(.0710)(.1107) - 2(.1646)(.0710)(.0811)$$
$$- 2(.2988)(.1107)(.0811)] - 2(.0811)^2 + 2(.1646)(.0710)(.0811) = 0$$
$$= 2x_1(.0037 + .0066 = .0002) + x_2(.0132 + .0003 - .0019 - .0054)$$
$$- .0132 + .0019$$
$$= 2x_1(.0101) + x_2(.0062) - .0113$$

$$\frac{\partial\sigma_p^2}{\partial x_1} = .0202x_1 + .0062x_2 - .0113 = 0$$

$$\frac{\partial\sigma_p^2}{\partial x_2} = 2x_2[(.1107)^2 + (.0811)^2 - 2(.2988)(.1107)(.0811)] + x_1[2(.0811)^2$$
$$+ 2(.0184)(.0710)(.1107) - 2(.1646)(.0710)(.0811) - 2(.2988)(.1107)(.0811)]$$
$$- 2(.0811)^2 + 2(.0811)^2 + 2(.2988)(.1107)(.0811)$$
$$= 2x_2(.0123 + .0066 - .0054) + x_1(.0132 + .0003 - .0019 - .0054) - .0132 + .0054$$
$$= 2x_2(.0135) + x_1(.0062) - .0078 = 0$$

$$\frac{\partial\sigma_p^2}{\partial x_2} = .027x_2 + .0062x_1 - .0078 = 0$$

We have two equations and two unknowns, x_1 and x_2.

$$.0202x_1 + .0062x_2 - .0113 = 0$$
$$.0062x_1 + .0270x_2 - .0078 = 0$$
$$.0202x_1 = -.0062x_2 + .0113$$
$$x_1 = -.3069x_2 + .5594$$

Having solved for x_1, we can now substitute x_1 into the following x_2 equation:

$$.0062\,(-.3069x_2 + .5594) + .027x_2 = .0078$$
$$-.0019x_2 + .0035 + .027x_2 = .0078$$
$$.0251x_2 = .0043$$
$$x_2 = .1713$$
$$x_1 = (-.3069)(.1713) + .5594 = .5068$$
$$x_3 = 1 - .5068 - .1713 = .3219$$

The optimal portfolio to minimize risk is composed of

Stock	Asset	Weight
JNJ	1	.5068
IBM	2	.1713
DD	3	.3219

The expected return of the equally weighted three-asset portfolio is 6.720 percent:

$$E(R_p) = .333\ (.0852 + .0768 + .0396)$$
$$= .333\ (.2016) = .0672$$

The standard deviation of the equally weighted three-asset portfolio is:

$$\sigma_p^2 = (.333)^2(.0710)^2 + (.333)^2(.1107)^2 + (.333)^2(.0811)^2$$
$$+ 2(.333)(.333)(.0184)(.0710)(.1107)$$
$$+ 2(.333)(.333)(.1646)(.0710)(.0811)$$
$$+ 2(.333)(.333)(.2988)(.1107)(.0811)$$
$$\sigma_p^2 = .0006 + .0014 + .0007 + .0000 + .0002 + .0006 = .0035$$
$$\sigma_p = .0592$$

The equally weighted monthly three-asset standard deviation is 5.92 percent, which is a 20.51 percent annualized standard deviation. The optimally weighted, risk-minimizing three-asset portfolio expected return is 6.92 percent (annualized).

$$E(R_p) = (.5068)(.0852) + (.1713)(.0768) + (.3219)(.0396)$$
$$= .0432 + .0132 + .0128 = .0692$$

The standard deviation of the three-asset, risk-minimizing portfolio is:

$$\sigma_p^2 = (.5068)^2(.0710)^2 + (.1713)^2(.1107)^2 + (.3219)^2(.0811)^2$$
$$+ 2(.5068)(.1713)(.0184)(.0710)(.1107)$$
$$+ 2(.5068)(.3219)(.1646)(.0710)(.0811)$$
$$+ 2(.1713)(.3219)(.2988)(.1107)(.0811)$$
$$\sigma_p^2 = .0013 + .0004 + .0007 + .0000 + .0003 + .0003$$
$$\sigma_p^2 = .0030$$
$$\sigma_p = .0548$$

The monthly standard deviation of the three-asset, risk-minimizing portfolio is 5.48 percent, which represents an 18.98 percent annualized standard deviation. There is a reduction in risk for the same (approximate) level of return when one uses the risk-minimizing versus the equally weighted portfolio deviation.

Markowitz analysis sought to minimize risk for a given level of return. Thus, one could construct an infinite number of portfolios, by varying security weights, but the efficient frontier would contain securities with weights that would maximize return for a given level of risk.

The Capital Market Line (CML) was developed to describe the return-risk trade-off assuming that investors could borrow and lend at the risk-free rate (RF) and that investors must be compensated for bearing risk. Investors seek to hold mean-variance efficient portfolios, invest for a one-period horizon, pay no taxes or transactions costs (we wish), and have homogeneous beliefs. All investors have identical probabilities of the distribution of future returns of securities.

$$E(R_p) = R_F + \left[\frac{E(R_M) - R_F}{\sigma_M}\right]\sigma_\rho \qquad (8.6)$$

where $E(R_p)$ = expected return on the portfolio
$E(R_M)$ = expected return on the market portfolio, where all securities are held relative to their market value
σ_M = standard deviation of the market portfolio
σ_ρ = standard deviation of the portfolio

The reader notes that as the standard deviation of the portfolio rises, its expected return must rise.

INTRODUCTION TO MODERN PORTFOLIO THEORY

Markowitz created a portfolio construction theory in which investors should be compensated with higher returns for bearing higher risk. The Markowitz framework measured risk as the portfolio standard deviation, its measure of dispersion, or total risk. The Sharpe (1964), Lintner (1965b), and Mossin (1966) development of the capital asset pricing model (CAPM) held that investors are compensated for bearing not total risk, but rather market risk, or systematic risk, as measured by the stock beta. Sharpe wrote his dissertation at UCLA and worked under Markowitz. Sharpe, Markowitz, and M. Miller shared the 1991 Nobel

Prize in Economic Sciences for their work. An investor is not compensated for bearing risk that may be diversified away from the portfolio. The beta is the slope of the market model, in which the stock return is regressed as a function of the market return. The difficulty of measuring beta and its corresponding Security Market Line (SML) gave rise to extramarket measures of risk, found in the work of King (1966), Farrell (1974), Rosenberg (1974, 1976), Rosenberg and Marathe (1979), Stone (1974), and Stone, Guerard, Gultekin, and Adams (2002), Ross (1976), and Ross and Roll (1980). The BARRA risk model, developed in the series of studies by Rosenberg and completely discussed in Grinhold and Kahn (1999), is discussed later in this chapter.

The CAPM holds that the return to a security is a function of the security beta.

$$R_{jt} = R_F + \beta_j[E(R_{Mt}) - R_F] + e_j \tag{8.7}$$

where R_{jt} = expected security return at time t
$E(R_{Mt})$ = expected return on the market at time t
R_F = risk-free rate
β_j = security beta
e_j = randomly distributed error term

Let us examine the capital asset pricing model beta, its measure of systematic risk, from the Capital Market Line equilibrium condition.

$$\beta_j = \frac{\text{Cov}(R_j, R_M)}{\text{Var}(R_M)} \tag{8.8}$$

$$E(R_j) = R_F + \left[\frac{E(R_M) - R_F}{\sigma_M^2}\right]\text{Cov}(R_j, R_M)$$

$$= R_F + [E(R_M) - R_F]\frac{\text{Cov}(R_j, R_M)}{\text{Var}(R_M)}$$

$$E(R_j) = R_F + [E(R_M) - R_F]\beta_j \tag{8.9}$$

The Security Market Line (SML), shown in equation (8.9), is the linear relationship between return and systematic risk, as measured by beta.

Let us estimate beta coefficients to be used in the capital asset pricing model (CAPM), to determine the rate of return on equity. One can regress monthly value-weighted security prices in the CRSP index, an index of all publicly traded securities. Most security betas are estimated using five years of monthly data, some 60 observations, although one can use almost any number of observations. One generally needs 30 observations for normality of residuals to occur. One can use the Standard & Poor's 500 index, the Dow Jones Industrial Average (DJIA), or many other stock indexes. The JNJ beta is 0.11 when estimated using the value-weighted Standard & Poor's 500 index, the traditional index for estimating betas. The t-value of the JNJ beta is 1.36, which is not statistically significant (at the 10 percent level, the critical t-value being 1.645). One must be careful, because the t-value allows one to reject a null hypothesis that the beta is zero. The JNJ beta versus the CRSP index, composed of some 8,000 securities having stock returns in 2003, is 0.11, and its t-value is 0.80. Betas should be estimated using value-weighted indexes. JNJ is a defensive security, having a beta less than unity. An aggressive security has a beta exceeding 1. If the market is expected to rise 10 percent in the coming year, we should expect JNJ stock to rise about 1.1 percent.

The corresponding betas for IBM and DD are:

Security	Value-Weight CRSP	Value-Weight S&P 500
IBM	1.32	1.45
(t)	(6.00)	(6.47)
DD	0.80	0.93
(t)	(4.55)	(5.24)

If a security's expected return exceeds the required rate of return from the CAPM and its beta, then the security should be purchased. Purchasing such a security drives up its price, and drives down its expected return.

The total excess return for a multiple-factor model (MFM) in the Rosenberg methodology for security *j*, at time *t*, dropping the subscript *t* for time, may be written:

$$E(R_j) = \sum_{k=1}^{K} \beta_{jk}\tilde{f}_k + \tilde{e}_j \tag{8.10}$$

The nonfactor, or asset-specific, return on security *j* is the residual risk of the security, after removing the estimated impacts of the *K* factors. The term *f* is the rate of return on factor *k*. A single-factor model, in which the market return is the only estimated factor, is obviously the basis of the capital asset pricing model.

DETERMINANTS OF STOCK SELECTION MODELS

The expected returns on assets are not often given by only the historic means of the securities. In this chapter we estimate models of expected return using expectation data and reported financial data. There are several approaches to security valuation and the creation of expected returns. Graham and Dodd (1934) recommended that stocks be purchased on the basis of the price-earnings (P/E) ratio. Graham and Dodd suggested that no stock should be purchased if its price-earnings ratio exceeded 1.5 times the price-earnings multiple of the market. Thus the "low price-earnings" criterion was established. It is interesting that the low P/E model was put forth at the height of the Great Depression. Graham and Dodd advocated the calculation of a security's net current asset value (NCAV), defined as its current assets less all liabilities. A security should be purchased if its net current value exceeded its current stock price. The price-to-book (PB) ratio should be calculated, but not used as a measure for stock selection, according to Graham, Dodd, and Cottle (1962). Fundamental variables such as cash flow and sales have been used in composite valuation models for security selection (Ziemba 1990, 1992; Guerard 1990). Livnant and Hackel (1995) advocated the calculation of free cash flow, which subtracts capital expenditures from the operating cash flow. In addition to the income statement indicators of value, such as earnings, cash flow, and sales, many value-focused analysts also consider balance sheet variables, especially the book-to-market ratio. The income statement measures are dividends, earnings, cash flow, and sales, and the key balance sheet measure is common equity per share outstanding, or book value. Expected returns modeling has been analyzed with a regression model in which security returns are functions of fundamental stock data, such as earnings, book value, cash flow, and sales, relative to stock prices, as well as forecasted earnings per share (EPS). The reader is referred to the works of Fama and French (1992, 1995), Bloch, Guerard, Markowitz, Todd, and Xu (1993), Guerard, Takano, and Yamane (1993), Ziemba (1992), and Guerard, Gultekin, and Stone (1997).

In 1975, a database of earnings per share forecasts was created by Lynch, Jones, and Ryan, a New York brokerage firm, by collecting and publishing the consensus statistics of one-year-ahead and two-year-ahead EPS forecasts (Brown 1999). The database has evolved to be known as the Institutional Brokerage Estimation Service (I/B/E/S) database. There is an extensive literature regarding the effectiveness of analysts' earnings forecasts, earnings revisions, earnings forecast variability, and breadth of earnings forecast revisions, summarized in Bruce and Epstein (1994) and Brown (1999). The vast majority of the earnings forecasting literature in the Bruce and Brown references finds that the use of earnings forecasts does not increase stockholder wealth, as specifically tested in Elton, Gruber, and Gultekin (1981). Reported earnings follow a random walk with drift process, and analysts are rarely more accurate than a no-change model in forecasting earnings per share (Cragg and Malkiel 1968; Guerard and Stone 1992). Analysts become more accurate as time passes during the year and quarterly data is reported. Analyst revisions are statistically correlated with stockholder returns during the year (Hawkins, Chamberlain, and Daniel 1984; Arnott 1985; Guerard 1997c). Wheeler (1995) developed and tested a strategy in which analyst forecast revision breadth, defined as the number of upward forecast revisions less the number of downward forecast revisions, divided by the total number of estimates, was the criterion for stock selection. Wheeler found statistically significant excess returns from the breadth strategy. A composite earnings variable, CTEF, is calculated using equally weighted revisions, forecasts, and breadth of current fiscal year (FY1) and next fiscal year (FY2) forecasts.

Ziemba (1990, 1992) and Guerard, Gultekin, and Stone (1997) employed annual fundamental Compustat variables, such as earnings, book value, cash flow, and sales, in addition to the composite earnings forecasting model in a regression model to identify the determinants of quarterly equity returns.

FURTHER ESTIMATIONS OF A COMPOSITE EQUITY VALUATION MODEL

In this section, we address the issues of databases and the inclusion of variables in composite models to identify undervalued securities. The database for this analysis is created by the use of all securities listed on the Compustat database, the I/B/E/S database, and the Center for Research in Security Prices (CRSP) database during the 1987–2003 period. The annual Compustat file contains some 399 data items from the company income statement, balance sheet, and cash flow statement during the 1950–2003 period. The I/B/E/S database contains all earnings forecasts made during the 1976–2003 period. The CRSP file contains monthly stock prices, shares outstanding, trading volumes, and returns for all traded securities from 1926–2003. We use the 1990–2003 period in this study. Our results will be consistent with many of the studies of the 1970s and 1980s.

There are a seemingly infinite number of financial variables that may be tested for statistical association with monthly security returns. Bloch, Guerard, Markowitz, Todd, and Xu (1993) tested a set of fundamental variables in the United States during the 1975–1990 period. Guerard

(1997a) tested a set of I/B/E/S variables for the 1982–1994 period. In this chapter, we test the variables of these two studies using both fundamental and expectation data. We initially test the effectiveness of the individual variables using the information coefficients (ICs) rather than the upper-quintile excess returns or the excess returns of individual variable portfolio optimizations. The information coefficient is the slope of the regression estimation in which ranked subsequent security returns are a function of the ranked financial strategy. The advantage of the IC approach is that the slope has a corresponding t-statistic that allows one to test the null hypothesis that the strategy is uncorrelated with subsequent returns. In developing a composite model, one seeks to combine variables that are statistically associated with subsequent returns. Let us define the variables tested in this study.

EP	Earnings per share/price per share
BP	Book value per share/price per share
CP	Cash flow per share/price per share
SP	Sales per share/price per share
DY	Dividend yield—dividends per share/price per share
NCAV	Net current asset value—net current assets per share/price per share
FEP1	One-year-ahead forecast earnings per share/price per share
FEP2	Two-year-ahead forecast earnings per share/price per share
RV1	One-year-ahead forecast earnings per share monthly revision/price per share
RV2	Two-year-ahead forecast earnings per share monthly revision/price per share
BR1	One-year-ahead forecast earnings per share monthly breadth/price per share
BR2	Two-year-ahead forecast earnings per share monthly breadth/price per share

The monthly ICs for all traded securities during the January 1990–December 2003 period for these variables are shown in Table 8.3. The majority of the variables are statistically associated with stockholder returns, a result consistent with the Bloch et al. and Guerard studies. We also use an equally weighted composite analysts' forecasting variable, CTEF, composed of FY1 and FY2 forecasts, forecast revisions, and forecast breadth.

The results of Table 8.3 support the estimation of the composite security valuation model reported in Guerard, Gultekin, and Stone (1997). The

TABLE 8.3 Monthly Information Coefficients, 1990–2003

Variable	IC (t)
EP	.047 (41.71)
BP	.011 (10.04)
CP	.039 (34.52)
SP	.009 (7.52)
DY	.052 (40.57)
NCAV	–.006 (–4.52)
FEP1	.042 (34.60)
FEP2	.030 (24.68)
RV1	.038 (13.16)
RV2	.026 (8.56)
BR1	.043 (25.06)
BR2	.037 (25.06)
CTEF	.049 (40.57)

model incorporates reported earnings, book value, cash flow, and sales, the corresponding relative variables, and an equally weighted composite model of earnings forecasts and their forecast derivative variables. The significance of the CTEF variable is quite similar to the one-year-ahead EPS breadth.

We estimate a similar monthly model for the January 1990–December 2003 period.

$$\begin{aligned} TR_{t+1} &= a_0 + a_1 EP_t + a_2 BP_t + a_3 CP_t + a_4 SP_t \\ &+ a_5 REP_t + a_6 RBP_t + a_7 RCP_t + a_8 RSP_t + a_9 CTEF_t + e_t \end{aligned} \tag{8.11}$$

where EP = (earnings per share)/(price per share)
= earnings-price ratio
BP = (book value per share)/(price per share)
= book-price ratio
CP = (cash flow per share)/(price per share)
= cash flow-price ratio
SP = (net sales per share)/(price per share)
= sales-price ratio
REP = (current EP ratio)/(average EP ratio over the past five years)

RBP = (current BP ratio)/(average BP ratio over the past five years)
RCP = (current CP ratio)/(average CP ratio over the past five years)
RSP = (current SP ratio)/(average SP ratio over the past five years)
CTEF = consensus earnings per share I/B/E/S forecast, revisions and breadth
e = randomly distributed error term

The monthly ordinary least squares (OLS) regressions are plagued with approximately twice the number of observations outside the 95 percent confidence interval as one might expect given a normal distribution of residuals. These aberrant observations, or outliers, lead us to reestimate the monthly regression lines using a Beaton-Tukey biweight (or robust, ROB) regression technique, in which each observation is weighted as the inverse function of its OLS residual. The application of the Beaton-Tukey ROB procedure addresses the issue of outliers. The weighted data is plagued with multicollinearity, the correlation among the independent variables, which may lead to statistically inefficient estimates of the regression coefficients. Bloch et al. (1993) and Guerard, Takano, and Yamane (1993) applied latent root regression (LRR) to the ROB-weighted data, referred to as weighted latent root regression (WLRR), and produced models with higher in-sample F-statistics and higher out-of-sample geometric means using WLRR than ROB and OLS techniques. The reader is referred to Guerard, Takano, and Yamane for a discussion of the regression procedures.

We create a composite model weight using the average weight of the positive coefficients of the preceding 12 monthly regressions, a monthly equivalent to the four-quarter averaging techniques used in Guerard, Gultekin, and Stone (1997). (See Table 8.4.) In terms of information coefficients (ICs), the use of the WLRR procedure produces the highest IC for the models during the 1990–2003 period for the Frank Russell 3000 universe and PACAP Japan-only securities. The PACAP database is very similar to the Japanese database used in Bloch et al. (1993). We show ICs of the EP and BP univariate variables, the equally weighted eight-variable value composite, EVL, and the equally weighted value and CTEF composite score, EQ9.

The WLRR technique produces the largest and most statistically significant IC, a result consistent with the previously noted studies and the Global Portfolio Research Department example. The t-statistics of the

TABLE 8.4 Information Coefficients of the Composite Security Valuation Model

Technique	Universe	IC (t)
EP	Russell 3000	0.036 (24.33)
BP	Russell 3000	0.025 (16.75)
CTEF	Russell 3000	0.035 (23.78)
EVL	Russell 3000	0.022 (15.00)
EQ9	Russell 3000	0.031 (20.88)
WLRR	Russell 3000	0.045 (30.21)
EP	Japan-Only PACAP	0.046 (21.87)
BP	Japan-Only PACAP	0.042 (19.94)
CTEF	Japan-Only PACAP	0.020 (8.64)
EVL	Japan-Only PACAP	0.042 (19.95)
EQ9	Japan-Only PACAP	0.043 (20.49)
WLRR	Japan-Only PACAP	0.053 (24.98)

composite model exceed the t-statistics of its components. The purpose of a composite security valuation model is to identify the determinants of security returns and produce a statistically significant out-of-sample ranking metric of total returns.

An indication of the relative importance of the eight fundamental variables and the composite earnings forecasting variables is given by the time average value of the regression coefficients estimated for each year in our 1990–2003 study period. They support the low P/E (high earnings yield) approach to value investing advocated by Graham and Dodd (1934) and Graham, Dodd, and Cottle (1962) and validated as a cross-sectional return anomaly by Basu (1977). They also support the Fama and French (1992, 1995) finding that the book-to-market ratio is an important variable for explaining the cross section of security returns. However, while both these variables are significant in explaining returns, the majority of the forecast performance is attributable to other model variables, namely the relative earnings-to-price, relative cash-to-price, relative sales-to-price, and earnings forecast variables. The most statistically significant variable in identifying security returns is the composite earnings forecast variable. One should use regression modeling of monthly holding period returns (HPRs) to identify factors influencing returns at particular points in time.

APPENDIX 8.A
Multifactor Risk Models

Earlier in Chapter 8, we introduced the reader to mean-variance analysis and the capital asset pricing model. Accurate characterization of portfolio risk requires an accurate estimate of the covariance matrix of security returns. A relatively simple way to estimate this covariance matrix is to use the history of security returns to compute each variance and covariance. This approach, however, suffers from two major drawbacks:

1. Estimating a covariance matrix for the stocks of the Russell 3000 index requires a great deal of data; with monthly estimation horizons, such a long history may simply not exist.
2. It is subject to estimation error. In Chapter 8 we estimated the correlation between two stocks and found that Johnson & Johnson and IBM have a lower correlation than Johnson & Johnson and DuPont. One might expect a still higher correlation between Johnson & Johnson and Pfizer than between Johnson & Johnson and DuPont because Johnson & Johnson and Pfizer are in the same industry, health care.

Taking this further, we can argue that firms with similar characteristics, such as their line of business, should have returns that behave similarly. For example, Johnson & Johnson, IBM, and DuPont all have a common component in their returns in that they would all be affected by news that affects the stock market, measured by their respective betas as we discussed and estimated earlier in the chapter. The degree to which each of the three stocks responds to this stock market component depends on the sensitivity of each stock to the stock market component, as measured by their respective betas.

Additionally, we would expect Johnson & Johnson and Pfizer to respond to news affecting the health care industry, whereas we would expect DuPont to respond to news affecting the chemical industry and IBM to respond to news affecting the computer industry. The effects of such news may be captured by the average returns of stocks in the health care, computer, and chemical industries. One can account for industry effects in the following representation for returns:

$$\begin{aligned}\tilde{r}_{JNJ} &= E(\tilde{r}_{JNJ}) + \beta_{JNJ} \cdot [\tilde{r}_M - E(\tilde{r}_M)] \\ &\quad + 1 \cdot [\tilde{r}_H - E(\tilde{r}_H)] + 0 \cdot [\tilde{r}_{JNJ} - E(\tilde{r}_{JNJ})] + \mu_{JNJ}\end{aligned} \tag{8.12}$$

where $\tilde{r}_{JNJ}$ = JNJ's realized return
$\tilde{r}_M$ = realized average stock market return
$\tilde{r}_H$ = realized average return to health care stocks
$\tilde{r}_{JNJ}$ = realized average return to health care stocks
$E[\cdot]$ = expectations
β_{JNJ} = JNJ's sensitivity to stock market returns
μ_{JNJ} = effect of JNJ-specific news on JNJ returns

This equation simply states that JNJ's realized return consists of an expected component and an unexpected component. The unexpected component depends on any unexpected events that affect stock returns in general $[\tilde{r}_M - E(\tilde{r}_M)]$, any unexpected events that affect the health care industry $[\tilde{r}_H - E(\tilde{r}_H)]$, and any unexpected events that affect JNJ alone (μ_{JNJ}). Similar equations may be written for IBM and DuPont.

By beginning with our intuition about the sources of co-movement in security returns, Rosenberg (1974) made substantial progress in estimating the covariance matrix of security returns by presenting the covariance matrix of common sources in security returns, the variances of security specific returns, and estimates of the sensitivity of security returns to the common sources of variation in their returns, creating the BARRA risk model. Because the common sources of risk are likely to be much fewer than the number of securities, we need to estimate a much smaller covariance matrix and hence a smaller history of returns is required. Moreover, because similar stocks are going to have larger sensitivities to similar common sources of risk, similar stocks will be more highly correlated than dissimilar stocks.

BARRA Model Mathematics

The BARRA risk model is a multiple-factor model (MFM). MFMs build on single-factor models by including and describing the interrelationships among factors. For single-factor models, the equation that describes the excess rate of return is:

$$\tilde{r}_j = X_j \tilde{f}_j + \tilde{u}_j \tag{8.13}$$

where $\tilde{r}_j$ = total excess return over the risk-free rate
X_j = sensitivity of security j to the factor
$\tilde{f}_j$ = rate of return on the factor
$\tilde{u}_j$ = nonfactor (specific) return on security j

We can expand this model to include K factors. The total excess return equation for a multiple-factor model becomes:

$$\tilde{r}_j = \sum_{k=1}^{K} X_{jk}\tilde{f}_k + \tilde{u}_j \tag{8.14}$$

where X_{jk} = risk exposure of security j to factor k
$\tilde{f}_k$ = rate of return on factor k

Note that when $K = 1$, the MFM equation reduces to the earlier single-factor version—the CAPM addressed in the previous chapter.

When a portfolio consists of only one security, equation (8.13) describes its excess return. But most portfolios comprise many securities, each representing a proportion, or weight, of the total portfolio. When weights $h_{p1}, h_{p2}, \ldots, h_{pN}$ reflect the proportions of N securities in portfolio P, we express the excess return in the following equation:

$$\tilde{r}_p = \sum_{k=1}^{K} X_{Pk}\tilde{f}_k + \sum_{j=1}^{N} h_{Pj}\tilde{u}_j \tag{8.15}$$

where $X_{Pk} = \sum_{j=1}^{N} h_{Pj}X_{jk}$

This equation includes the risk from all sources and lays the groundwork for further MFM analysis.

Risk Prediction with Multiple-Factor Models

Investors look at the variance of their total portfolios to provide a comprehensive assessment of risk. To calculate the variance of a portfolio, you need to calculate the covariances of all the constituent components. Without the framework of a multiple-factor model, estimating the covariance of each asset with every other asset is computationally burdensome and subject to significant estimation errors. Let us examine the risk structure of the BARRA MFM (see Figure 8.1).

An MFM simplifies these calculations dramatically. This results from replacing individual company profiles with categories defined by common characteristics (factors). Since the specific risk is assumed to be uncorre-

$$V(i,j) = \text{Cov}\,[r(\tilde{i}), r(\tilde{j})]$$

where $V(i,j)$ = asset covariance matrix

i,j = individual stocks

$$V = \begin{bmatrix} V(1,1) & V(1,2) & \dots & V(1,N) \\ V(2,1) & V(2,2) & \dots & V(2,N) \\ V(3,1) & V(3,2) & \dots & V(3,N) \\ \vdots & \vdots & & \vdots \\ V(N,1) & V(N,2) & \dots & V(N,N) \end{bmatrix}$$

FIGURE 8.1 The Covariance Structure of Security Returns

lated among the assets, only the factor variances and covariances need to be calculated during model estimation (see Figure 8.2).

By using a multiple-factor model, we significantly reduce the number of calculations. For example, in the U.S. Equity Model (US-E3), 65 factors capture the risk characteristics of equities. Moreover, since there are fewer parameters to determine, they can be estimated with greater precision.

We can easily derive the matrix algebra calculations that support and link the above diagrams by using an MFM. From Figure 8.2, we start with the MFM equation:

$$\tilde{r}_i = X\tilde{f} + \tilde{u} \tag{8.16}$$

where $\tilde{r}_i$ = excess return on asset i
X = exposure coefficient on the factor
$\tilde{f}$ = factor return
$\tilde{u}$ = specific return

$$\tilde{r} = X\tilde{f} + \tilde{u}$$

where $\tilde{r}$ = vector of excess returns

X = exposure matrix

$\tilde{f}$ = vector of factor returns

$\tilde{u}$ = vector of specific returns

$$\begin{bmatrix} \tilde{r}(1) \\ \tilde{r}(2) \\ \vdots \\ \tilde{r}(N) \end{bmatrix} = \begin{bmatrix} X(1,1) & X(1,2) & \dots & X(1,K) \\ X(2,1) & X(2,2) & \dots & X(2,K) \\ \vdots & \vdots & & \vdots \\ X(N,1) & X(N,2) & \dots & X(N,K) \end{bmatrix} \begin{bmatrix} \tilde{f}(1) \\ \tilde{f}(2) \\ \vdots \\ \tilde{f}(K) \end{bmatrix} + \begin{bmatrix} \tilde{u}(1) \\ \tilde{u}(2) \\ \vdots \\ \tilde{u}(N) \end{bmatrix}$$

FIGURE 8.2 The BARRA Multiple-Factor Structure

Substituting this relation in the basic equation, we find that:

$$\text{Risk} = \text{Var}(\tilde{r}_j) \tag{8.17}$$

$$= \text{Var}(X\tilde{f} + \tilde{u}) \tag{8.18}$$

Using the matrix algebra formula for variance, the risk equation becomes:

$$\text{Risk} = XFX^T + \Delta \tag{8.19}$$

where X = exposure matrix of companies upon factors
F = covariance matrix of factors
X^T = transpose of X matrix
Δ = diagonal matrix of specific risk variances

This is the basic equation that defines the matrix calculations used in risk analysis in the BARRA equity models.

Let us address some of the estimated earnings forecasting components of the CTEF model discussed earlier in the chapter for the Russell 3000 universe during the 1990–2001 period. The CTEF model produced not only higher ICs than its components, but also higher and more statistically significant asset selection than its components in the Russell 3000 universe. See Table 8.5 for Russell 3000 earnings component results in which portfolios of approximately 100 stocks are produced by tilting on the individual and component CTEF factors. The forecast earnings per share for the one-year-ahead and two-year-ahead periods, FEP1 and FEP2, offer negative, but statistically insignificant asset selection. The total active returns are positive, and not statistically significant. The asset selection is negative because the FEP variables have positive and statistically significant loadings on the risk indexes, particularly the earnings yield index. The factor loading of the FEP variables on the earnings yield risk index is not unexpected, given that the earnings yield factor index in the US-E3 includes the forecast earnings-to-price variable. Thus, there is no multiple factor model benefit to the FEP variables. The breadth variables (BR) produce statistically significant total active returns and asset selection, despite a statistically significant risk index loading. The breadth variable loads on the earnings yield and growth risk indexes. Let us take a closer look at the BR1 factor risk index loading. The BR1 variable leads a portfolio manager to have a positive average active exposure to the earnings yield index, which incorporates the analyst-predicted earnings-to-price and historic earnings-to-price measures. The BR1 tilt has a negative and statistically significant average exposure to size, nonlinearity, the cube of normalized market capitalization. This result is consistent with analyst revisions being more effective in smaller-capitalized securities. The BR1 variable tilt leads the portfolio manager to have a positive and statistically significant exposure to the growth factor index, composed of the growth in the dividend payout ratio, the growth rates in total assets and earnings per share during the past five years, recent one-year earnings growth, and the variability in capital structure. Furthermore, the one-year-ahead BR is slightly better

TABLE 8.5 Components of the Composite Earnings Forecasting Variable, 1990–2001, Russell 3000 Universe

R3000 Earnings Analysis	Total Active	T-Stat	Asset Selection	T-Stat	Risk Index	T-Stat	Sectors	T-Stat
FEP1	2.14	1.61	–1.18	–1.17	**4.20**	**4.42**	–0.86	–1.34
FEP2	1.21	0.91	–1.43	–1.35	**3.33**	**3.35**	–0.78	–1.15
BR1	**2.59**	**2.83**	**1.85**	**2.43**	**1.08**	**2.15**	–0.20	–0.51
BR2	**2.43**	**2.36**	**1.51**	**1.75**	**1.09**	**2.04**	–0.01	–0.02
CTEF	**2.87**	**2.81**	**2.07**	**2.66**	**1.19**	**1.70**	–0.26	–0.66

Note: Bold figures denote statistically significant at 10% level.

than the two-year-ahead BR, a result consistent with Stone, Guerard, Gultekin, and Adams (2002). The CTEF variable produces statistically significant total active returns and asset selection. The CTEF variable loading on the risk index is statistically significant at the 10 percent level because of its loading on the earnings yield and nonlinear size indexes, as was the case with its breadth components. There are no statistically significant sector exposures in the CTEF variable. The CTEF model offers statistically significant asset selection in a multiple-factor model framework.

We test the Frank Russell large market capitalization (the Russell 1000), middle market capitalization (mid-cap), small capitalization (the Russell 2000), and small and middle market capitalization (the Russell 2500) universes. We test the equally weighted composite model, CTEF, of I/B/E/S earnings forecasts, revisions, and breadth, described in the previous section.

The portfolio optimization algorithm seeks to maximize the ranking of the CTEF variable while minimizing risk. The underlying CTEF variable is statistically significant, having a monthly information coefficient of 0.049 over the 491,119 observations. The CTEF variable is used as the portfolio tilt variable in the ITG optimization system using the BARRA risk model, and statistically significant total excess returns are found in the Frank Russell universes (see Table 8.6). We create 100-stock portfolios monthly during the 1990–2001 period. A lambda tilt value of one is initially used in producing efficient portfolios. Active returns rise as the average stock size diminishes, a result consistent with the inefficient markets literature summarized in Dimson (1988) and Ziemba (1992). The highest total active returns are found in the Russell 2000 stocks, the smallest stocks in the largest 3000 stocks in the Frank Russell universes, each year (see Table 8.6).

The CTEF tilt variable does not produce statistically significant sector exposures, as reported in Table 8.7, as we previously noted in the Russell 3000 universe. The factor exposures of the CTEF variable in the Russell

TABLE 8.6 Risk and Return of Mean-Variance Efficient Portfolios, 1990–2001

Universe	Total Active	T-Value	Asset Selection	T-Value	Risk Index	T-Value	Sectors	T-Value
RMC	1.98	1.37	0.99	0.86	0.97	1.45	–0.88	–0.97
R1000	2.47	2.52	1.85	2.12	0.82	2.13	–0.11	–0.23
R2500	7.76	4.37	6.48	3.96	1.61	2.85	–0.33	–0.62
R2000	9.68	5.83	8.81	5.57	0.90	2.36	–0.02	–0.07

RMC—Frank Russell mid-cap universe.
R1000—Frank Russell largest 1,000 stock universe.
R2000—Frank Russell small-cap universe.
R2500—Frank Russell small and mid-cap universe.

TABLE 8.7 CTEF Variable, Russell 1000 Universe. Attribution Report: Annualized Contributions to Total Return

Source of Return	Contribution (% Return)	Risk (% Std Dev)	Info Ratio	T-Stat
Risk Free	4.93	N/A	N/A	N/A
Total Benchmark	13.58	14.52		
Market Timing	–0.02	0.25	–0.18	–0.61
Risk Indexes	0.83	1.16	0.62	2.13
Sectors	–0.11	1.01	–0.07	–0.23
Asset Selection	1.85	2.76	0.61	2.12
Total Exceptional Active	2.54	3.07	0.75	2.59
Total Active	2.47	3.07	0.73	2.52
Total Managed	16.04	14.96		

1000 universe are shown in Table 8.8. The CTEF variable has statistically significant factor loadings on earnings yield and growth, as was the case in the Russell 3000 universe. The total active return of CTEF variable for the Russell 2000 universe is shown in Table 8.9.

The CTEF variable produces statistically significant asset selection, and significant factor exposures, primarily due to the earnings yield exposure. The earnings forecasting variable produces over 600 basis points annually of greater asset selection in the Russell 2000 universe than it does in the Russell

TABLE 8.8 CTEF Variable Factor Exposures, Russell 1000 Universe. Attribution Analysis: Annualized Contributions to Risk Index Return

Source of Return	Average Active Exposure	Contribution (% Return) Average [1]	Contribution (% Return) Variation [2]	Contribution (% Return) Total [1+2]	Total Risk (% Std Dev)	Total Info Ratio	Total T-Stat
Volatility	–0.01	0.01	–0.07	–0.06	0.17	–0.32	–1.12
Momentum	0.12	–0.07	0.08	0.01	0.60	0.03	0.11
Size	–0.20	0.36	–0.09	0.27	0.93	0.24	0.83
Size Nonlinearity	–0.02	0.02	0.03	0.05	0.10	0.44	1.52
Trading Activity	0.00	0.00	0.01	0.01	0.11	0.11	0.37
Growth	–0.05	0.05	0.03	0.08	0.14	0.48	1.65
Earnings Yield	0.13	0.66	–0.12	0.55	0.40	1.20	4.13
Value	0.06	0.03	0.02	0.06	0.17	0.30	1.03
Earnings Variation	0.02	–0.02	0.00	–0.03	0.10	–0.21	–0.73
Leverage	0.06	–0.01	–0.04	–0.04	0.17	–0.23	–0.80
Currency Sensitivity	–0.02	0.01	–0.05	–0.04	0.11	–0.32	–1.11
Yield	0.04	0.01	–0.04	–0.04	0.14	–0.24	–0.81
Non-Est Universe	0.00	0.00	0.01	0.01	0.04	0.20	0.68
Total				0.82	1.16	0.62	2.13

TABLE 8.9 CTEF Variable, Russell 2000 Universe. Attribution Analysis: Annualized Contributions to Total Return

Source of Return	Contribution (% Return)	Risk (% Std Dev)	Info Ratio	T-Stat
Risk Free	4.93	N/A	N/A	N/A
Total Benchmark	11.73	18.42		
Expected Active	–0.11	N/A	N/A	N/A
Market Timing	0.09	0.45	0.05	0.17
Risk Indexes	0.90	1.11	0.68	2.36
Sectors	–0.02	0.95	0.02	0.07
Asset Selection	8.81	4.67	1.61	5.57
Total Exceptional Active	9.79	4.88	1.71	5.90
Total Active	9.68	4.88	1.69	5.83
Total Managed	21.41	17.67		

1000 universe. Earnings forecasts and breadth generate greater asset selection in small stock universes than in larger stock universes. Moreover, as the firm size decreases, the CTEF variable is more statistically associated with risk index returns, such as earnings yield. The factor exposures increase as the size of firms decrease. The earnings yield variable loading is statistically significant in the Russell 2000 universe. The reader is referred to Table 8.10.

TABLE 8.10 CTEF Variable Factor Exposures, Russell 2000 Universe. Attribution Report: Annualized Contributions to Risk Index Return

		Contribution (% Return)			Total		
Source of Return	Average Active Exposure	Average [1]	Variation [2]	Total [1+2]	Risk (% Std Dev)	Info Ratio	T-Stat
Volatility	–0.12	0.04	–0.17	–0.13	0.57	–0.22	–0.76
Momentum	0.10	–0.07	0.06	0.00	0.57	0.04	0.15
Size	0.03	–0.03	–0.09	–0.12	0.26	–0.39	–1.33
Size Nonlinearity	0.05	–0.03	0.13	0.11	0.36	0.21	0.73
Trading Activity	–0.04	–0.03	0.00	–0.03	0.19	–0.15	–0.51
Growth	–0.07	0.07	–0.01	0.06	0.18	0.28	0.97
Earnings Yield	0.24	1.24	–0.14	1.10	0.74	1.25	4.31
Value	0.04	0.02	–0.01	0.01	0.16	0.04	0.13
Earnings Variation	–0.06	0.08	0.00	0.08	0.18	0.37	1.29
Leverage	–0.05	0.00	0.02	0.02	0.16	0.15	0.53
Currency Sensitivity	–0.01	0.00	-0.04	–0.03	0.12	–0.25	–0.88
Yield	–0.02	0.00	–0.06	–0.06	0.20	–0.23	–0.79
Non-Est Universe	–0.01	0.01	–0.11	–0.10	0.21	–0.39	–1.35
Total				0.90	1.11	0.68	2.36

APPENDIX 8.B
US-E3 Descriptor Definitions

This appendix gives the detailed definitions of the descriptors that underlie the risk indexes in US-E3. The method of combining these descriptors into risk indexes is proprietary to BARRA.

Volatility

1. *BTSG: Beta times sigma*. This is computed as $\sqrt{\beta\sigma_\varepsilon}$, where β is the historical beta and σ_ε is the historical residual standard deviation. If β is negative, then the descriptor is set equal to zero.

2. *DASTD: Daily standard deviation*. This is computed as:

$$\sqrt{N_{days}\left[\sum_{t=1}^{T} w_t r_t^2\right]}$$

where r_t is the return over day t, w_t is the weight for day t, T is the number of days of historical returns data used to compute this descriptor (we set this to 65 days), and N_{days} is the number of trading days in a month (we set this to 23).

3. *HILO: Ratio of high price to low price over the last month*. This is calculated as:

$$\log\left(\frac{P_H}{P_L}\right)$$

where P_H and P_L are the maximum price and minimum price attained over the last one month.

4. *LPRI: Log of stock price*. This is the log of the stock price at the end of last month.

5. *CMRA: Cumulative range*. Let Z_t be defined as:

$$Z_t = \sum_{s=1}^{t} \log(1 + r_{i,s}) - \sum_{s=1}^{t} \log(1 + r_{f,s})$$

where r_i,s is the return on stock I in month s, and $r_{f,s}$ is the risk-free rate for month s. In other words, Z_t is the cumulative return of the stock over the risk-free rate at the end of month t. Define Z_{max} and Z_{min} as the maximum and minimum values of Z_t over the past 12 months. CMRA is computed as:

$$\log\left(\frac{1+Z_{\max}}{a+Z_{\min}}\right)$$

6. *VOLBT: Sensitivity of changes in trading volume to changes in aggregate trading volume*. This may be estimated by the following regression:

$$\frac{\Delta V_{i,t}}{N_{i,t}} = a + b\frac{\Delta V_{M,t}}{N_{M,t}} + \xi_{i,t}$$

where $\Delta V_{i,t}$ is the change in share volume of stock I from week $t-1$ to week t, $N_{i,t}$ is the average number of shares outstanding for stock I at the beginning of week $t-1$ and week t, $\Delta V_{M,t}$ is the change in volume on the aggregate market from week $t-1$ to week t, and $N_{M,t}$ is the average number of shares outstanding for the aggregate market at the beginning of week $t-1$ and week t.

7. *SERDP: Serial dependence*. This measure is designed to capture serial dependence in residuals from the market model regressions. It is computed as follows:

$$\text{SERDP} = \frac{\frac{1}{T-2}\sum_{t=3}^{T}(e_t + e_{t-1} + e_{t-2})^2}{\frac{1}{T-2}\sum_{t=3}^{T}(e_t^2 + e_{t-1}^2 + e_{t-2}^2)}$$

where e_t is the residual from the market model regression in month t, and T is the number of months over which this regression is run (typically, T = 60 months).

8. *OPSTD: Option-implied standard deviation*. This descriptor is computed as the implied standard deviation from the Black-Scholes option pricing formula using the price on the closest to at-the-money call option that trades on the underlying stock.

Momentum

1. *RSTR: Relative strength*. This is computed as the cumulative excess return (using continuously compounded monthly returns) over the past 12 months—that is,

$$\text{RSTR} = \sum_{t=1}^{T} \log(1 + r_{i,t}) - \sum_{t=1}^{T} \log(1 + r_{f,t})$$

where $r_{i,t}$ is the arithmetic return of the stock in month i, and $r_{f,t}$ is the arithmetic risk-free rate for month i. This measure is usually computed over the past one year—that is, T is set equal to 12 months.

2. *HALPHA: Historical alpha*. This descriptor is equal to the alpha term (i.e., the intercept term) from a 60-month regression of the stock's excess returns on the S&P 500 excess returns.

Size

1. *LNCAP: Log of market capitalization*. This descriptor is computed as the log of the market capitalization of equity (price times number of shares outstanding) for the company.

Size Nonlinearity

1. *LCAPCB: Cube of the log of market capitalization*. This risk index is computed as the cube of the normalized log of market capitalization.

Trading Activity

1. *STOA: Share turnover over the past year*. STOA is the annualized share turnover rate using data from the past 12 months—that is, it is equal to $V_{ann}/\bar{N}_{out}$, where V_{ann} is the total trading volume (in number of shares) over the past 12 months and $\bar{N}_{out}$ is the average number of shares outstanding over the previous 12 months (i.e., it is equal to the average value of the number of shares outstanding at the beginning of each month over the previous 12 months).

2. *STOQ: Share turnover over the past quarter*. This is computed as the annualized share turnover rate using data from the most recent quarter. Let V_q be the total trading volume (in number of shares) over the most recent quarter and let $\bar{N}_{out}$ be the average number of shares outstanding over

the period (i.e., $\bar{N}_{out}$ is equal to the average value of the number of shares outstanding at the beginning of each month over the previous three months). Then, STOQ is computed as $4V_q/\bar{N}_{out}$.

3. *STOM: Share turnover over the past month.* This is computed as the share turnover rate using data from the most recent month (i.e., it is equal to the number of shares traded last month divided by the number of shares outstanding at the beginning of the month).

4. *STO5: Share turnover over the past five years.* This is equal to the annualized share turnover rate using data from the past 60 months. In symbols, STO5 is given by:

$$\text{STO5} = \frac{12\left[\frac{1}{T}\sum_{s=1}^{T} V_s\right]}{\sigma_\varepsilon}$$

where V_s is equal to the total trading volume in month s and $\bar{N}_{out}$ is the average number of shares outstanding over the past 60 months.

5. *FSPLIT: Indicator for forward split.* This descriptor is a 0 – 1 indicator variable to capture the occurrence of forward splits in the company's stock over the past two years.

6. *VLVR: Volume to variance.* This measure is calculated as follows:

$$\text{VLVR} = \log \frac{\frac{12}{T}\left[\sum_{s=1}^{T} V_s P_s\right]}{\sigma_\varepsilon}$$

where V_s equals the number of shares traded in month s, P_s is the closing price of the stock at the end of month s, and σ_ε is the estimated residual standard deviation. The sum in the numerator is computed over the past 12 months.

Growth

1. *PAYO: Payout ratio over five years.* This measure is computed as follows:

$$\text{PAYO} = \frac{\frac{1}{T}\sum_{t=1}^{T} D_t}{\frac{1}{T}\sum_{t=1}^{T} E_t}$$

where D_t is the aggregate dividend paid out in year t and E_t is the total earnings available for common shareholders in year t. This descriptor is computed using the past five years of data on dividends and earnings.

2. *VCAP: Variability in capital structure*. This descriptor is measured as follows:

$$\text{VCAP} = \frac{\frac{1}{T-1}\sum_{t=2}^{T}\left(|N_{t-1} - N_t|P_{t-1} + |LD_{t-1} - LD_t| + |PE_t - PE_{t-1}|\right)}{CE_T + LD_T + PE_T}$$

where N_{t-1} is the number of shares outstanding at the end of time $t - 1$; P_{t-1} is the price per share at the end of time $t - 1$; LD_{t-1} is the book value of long-term debt at the end of time period $t - 1$; PE_{t-1} is the book value of preferred equity at the end of time period $t - 1$; and CE_T, LD_T, and PE_T are the book values of common equity, long-term debt, and preferred equity as of the most recent fiscal year.

3. *AGRO: Growth rate in total assets*. To compute this descriptor, the following regression is run:

$$TA_{it} = a + bt + \xi_{it}$$

where TA_{it} is the total assets of the company as of the end of year t, and the regression is run for the period $t = 1,\ldots,5$. AGRO is computed as follows:

$$\text{AGRO} = \frac{b}{\frac{1}{T}\sum_{t=1}^{T} TA_{it}}$$

where the denominator average is computed over all the data used in the regression.

4. *EGRO: Earnings growth rate over past five years*. First, the following regression is run:

$$\text{EPS}_t = a + bt + \xi_t$$

where EPS_t is the earnings per share for year t. This regression is run for the period $t = 1,\ldots,5$. EGRO is computed as follows:

$$\text{EGRO} = \frac{b}{\frac{1}{T}\sum_{t=1}^{T} \text{EPS}_t}$$

5. *EGIBS: Analyst-predicted earnings growth*. This is computed as follows:

$$\text{EGIBS} = \frac{(\text{EARN} - \text{EPS})}{(\text{EARN} + \text{EPS})/2}$$

where EARN is a weighted average of the median earnings predictions by analysts for the current year and next year, and EPS is the sum of the four most recent quarterly earnings per share.

6. *DELE: Recent earnings change*. This is a measure of recent earnings growth and is measured as follows:

$$\text{DELE} = \frac{(\text{EPS}_t - \text{EPS}_{t-1})}{(\text{EPS}_t + \text{EPS}_{t-1})/2}$$

where EPS_t is the earnings per share for the most recent year, and EPS_{t-1} is the earnings per share for the previous year. We set this to missing if the denominator is nonpositive.

Earnings Yield

1. *EPIBS: Analyst-predicted earnings-to-price*. This is computed as the weighted average of analysts' median predicted earnings for the current fiscal year and next fiscal year divided by the most recent price.

2. *ETOP: Trailing annual earnings-to-price*. This is computed as the sum of the four most recent quarterly earnings per share divided by the most recent price.

3. *ETP5: Historical earnings-to-price*. This is computed as follows:

$$\text{ETP5} = \frac{\frac{1}{T}\sum_{t=1}^{T} \text{EPS}_t}{\frac{1}{T}\sum_{t=1}^{T} P_t}$$

where EPS_t is equal to the earnings per share over year t, and P_t is equal to the closing price per share at the end of year t.

Value

1. *BTOP: Book-to-price ratio*. This is the book value of common equity as of the most recent fiscal year-end divided by the most recent value of the market capitalization of the equity.

Earnings Variability

1. *VERN: Variability in earnings*. This measure is computed as follows:

$$\text{VERN} = \frac{\left(\dfrac{1}{T-1} \sum_{t=1}^{T} (E_t - \overline{E})^2 \right)^{1/2}}{\dfrac{1}{T} \sum_{t=1}^{T} E_t}$$

where E_t is the earnings at time t ($t = 1,\ldots,5$) and $\overline{E}$ is the average earnings over the past five years. VERN is the coefficient of variation of earnings.

2. *VFLO: Variability in cash flows*. This measure is computed as the coefficient of variation of cash flow using data over the past five years—that is, it is computed in an identical manner to VERN, with cash flow being used in place of earnings. Cash flow is computed as earnings plus depreciation plus deferred taxes.

3. *EXTE: Extraordinary items in earnings*. This is computed as follows:

$$\text{EXTE} = \frac{\dfrac{1}{T} \sum_{t=1}^{T} | EX_t + NRI_t |}{\dfrac{1}{T} \sum_{t=1}^{T} E_t}$$

where EX_t is the value of extraordinary items and discontinued operations, NRI_t is the value of nonoperating income, and E_t is the earnings available to common before extraordinary items. The descriptor uses data over the past five years.

4. *SPIBS: Standard deviation of analysts' prediction to price*. This is computed as the weighted average of the standard deviation of I/B/E/S analysts' forecasts of the firm's earnings per share for the current fiscal year and next fiscal year divided by the most recent price.

Leverage

1. *MLEV: Market leverage*. This measure is computed as follows:

$$\text{MLEV} = \frac{ME_t + PE_t + LD_t}{ME_t}$$

where ME_t is the market value of common equity, PE_t is the book value of preferred equity, and LD_t is the book value of long-term debt. The value of preferred equity and long-tem debt are as of the end of the most recent fiscal year. The market value of equity is computed using the most recent month's closing price of the stock.

2. *BLEV: Book leverage*. This measure is computed as follows:

$$\text{BLEV} = \frac{CEQ_t + PE_t + LD_t}{CEQ_t}$$

where CEQ_t is the book value of common equity, PE_t is the book value of preferred equity, and LD_t is the book value of the long-term debt. All values are as of the end of the most recent fiscal year.

3. *DTOA: Debt-to-assets ratio*. This ratio is computed as follows:

$$\text{DTOA} = \frac{LD_t + DCL_t}{CEQ_t}$$

where LD_t is the book value of long-term debt, DCL_t is the value of debt in current liabilities, and TA_t is the book value of total assets. All values are as of the end of the most recent fiscal year.

4. *SNRRT: Senior debt rating*. This descriptor is constructed as a multilevel indicator variable of the debt rating of a company.

Currency Sensitivity

1. *CURSENS: Exposure to foreign currencies*. To construct this descriptor, the following regression is run:

$$r_{it} = \alpha_I + \beta_i r_{mt} + \varepsilon_{it}$$

where r_{it} is the excess return on the stock and r_{mt} is the excess return on the S&P 500 index. Let ε_{it} denote the residual returns from this regression. These residual returns are in turn regressed against the contemporaneous and lagged returns on a basket of foreign currencies, as follows:

$$\varepsilon_{it} = c_i + \gamma_{i1}(FX)_t + \gamma_{i2}(FX)_{t-1} + \gamma_{13}(FX)_{t-2} + \mu_{it}$$

where ε_{it} is the residual return on stock I, $(FX)_t$ is the return on an index of foreign currencies over month t, $(FX)_{t-1}$ is the return on the same index of foreign currencies over month $t - 1$, and $(FX)_{t-2}$ is the return on the same index over month $t - 2$. The risk index is computed as the sum of the slope coefficients γ_{i1}, γ_{i2}, and γ_{i3} (i.e., CURSENS = $\gamma_{i1} + \gamma_{i2} + \gamma_{i3}$).

Dividend Yield

1. *P_DYLD: Predicted dividend yield.* This descriptor uses the past four quarterly dividends paid out by the company along with the returns on the company's stock and future dividend announcements made by the company to come up with a BARRA-predicted dividend yield.

Non-Estimation Universe Indicator

1. *NONESTU: Indicator for firms outside US-E3 estimation universe.* This is a 0–1 indicator variable: It is equal to 0 if the company is in the US-E3 estimation universe and equal to 1 if the company is outside the US-E3 estimation universe.

CHAPTER 9

The Optimization of Efficient Portfolios: How the R&D Quadratic Term Enhances Stockholder Wealth

In this chapter, we produce mean-variance efficient portfolios for various universes in the U.S. equity market, and show that the use of a composite of analyst earnings forecasts and breadth variables, introduced in Chapter 8, as a portfolio tilt variable and an R&D quadratic term enhances stockholder wealth. The use of the R&D screen creates portfolios in which total active returns generally rise relative to the use of the analyst variable. Stock selection may not necessarily rise as risk index and sector index returns are affected by the use of the R&D quadratic term. R&D expenditures of corporations may be integrated into a mean-variance efficient portfolio creation system to enhance stockholder returns and wealth. The use of an R&D variable enhances stockholder wealth relative to the use of capital expenditures or dividends as the quadratic term. The stockholder return implications of the R&D quadratic variable are particularly interesting given that most corporations allocate more of their resources to capital expenditures than to R&D.

Portfolio optimization is a tool that maximizes return for a given level of risk, or minimizes the risk for a given level of return (Markowitz 1952, 1959). The purpose of this study is to test the effectiveness of a security valuation composite earnings forecast model composed of consensus analysts' earnings per share forecasts, revisions, and breadth over various equity universes. We find that the composite earnings forecast model (CTEF) is statistically significant in identifying undervalued stocks in the United States, particularly in equity universes composed of smaller-capitalized securities. We combine the composite earnings forecast variable with fundamental variables, such as reported earnings, book value, cash flow, and sales. The composite earnings valuation model is statistically significant, but not as effective in asset selection as the composite earnings forecasting variable by itself during the 1990–2001 period. Corporations seek to enhance stockholder wealth by paying dividends and engaging in capital expenditures and research and development. We find that stockholder wealth is increased by including research and development expenditures with the composite earnings forecasting variable. Risk models have been constructed to analyze the covariance matrix of U.S. security returns in terms of market risk, the security beta, and extramarket covariance.

The factor loading of the variable is estimated and analyzed in the universes. The use of an R&D quadratic variable enhances stockholder returns and wealth relative to the use of a stock valuation model, and we address the issue of the factor loading of the R&D variable.

EFFICIENT PORTFOLIO OPTIMIZATION RESULTS

The universes for this study are the monthly Frank Russell stock universes for the January 1990–December 2001 period. The information coefficient (IC) analysis introduced in Chapter 8 supported the construction of a composite earnings forecast model in that the IC of the composite model exceeded the ICs of its components. We address in this section the estimated asset selection properties of the earnings components and the composite models. Let us address the estimated earnings forecasting components of the CTEF model for the Russell 3000 universe during the 1990–2001 period. The CTEF model produced not only higher ICs than its components, but also higher and more statistically significant asset selection than its components in the Russell 3000 universe, as we saw in Chapter 8. The CTEF variable produces statistically significant total active returns and asset selection (see Table 9.1). We test the Frank Russell large market capitalization universe (the Russell 1000), middle market capitalization (mid-cap), small capitalization (Russell 2000), and small and middle market capitalization (Russell 2500) universes. The CTEF produces statistically significant active returns in all Frank Russell universes, although the returns rise substantially as the size of the firms decrease, and we move into the Russell 2000 securities. We test the equally weighted composite model, CTEF, of I/B/E/S earnings forecasts, revisions, and breadth, described in the previous section. The portfolio optimization algorithm seeks to maximize the ranking of the CTEF variable while minimizing risk.

The underlying CTEF variable is statistically significant, having a monthly information coefficient of 0.049 over the 491,119 observations.

TABLE 9.1 Risk and Return of Mean-Variance Efficient Portfolios, 1990–2001

Universe	Total Active	T-Value	Asset Selection	T-Value	Risk Index	T-Value	Sectors	T-Value
RMC	1.98	1.37	0.99	0.86	0.97	1.45	–0.88	–0.97
RMCRD	7.07	2.80	2.97	2.06	0.60	0.93	1.33	0.85
R1000	2.47	2.52	1.85	2.12	0.82	2.13	–0.11	–0.23
R1000RD	4.71	2.88	1.35	2.12	2.20	3.93	0.65	0.70
R2500	7.76	4.37	6.48	3.96	1.61	2.85	–0.33	–0.62
R2500RD	9.77	2.91	4.46	1.79	0.52	0.54	2.73	1.65
R2000	9.68	5.83	8.81	5.57	0.90	2.36	–0.02	–0.07
R2000RD	9.17	5.18	7.01	4.98	1.06	2.84	0.86	1.00

RMC—Frank Russell mid-cap universe.
R1000—Frank Russell largest 1000 stock universe.
R2000—Frank Russell small-cap universe.
R2500—Frank Russell small and mid-cap universe.
RD—Imposition of the R&D quadratic variable.

The CTEF variable is used as the portfolio tilt variable in the ITG optimization system using the BARRA risk model, and statistically significant total excess returns are found in the Frank Russell universes (see Table 9.1). We create 100 stock portfolios monthly during the 1990–2001 period. The R&D quadratic variable is created by dividing the annual Compustat R&D expenditures by the corresponding monthly market capitalization. The monthly information coefficient of the R&D variable is statistically significant, having a mean of 0.005, with a t-value of 2.70, over 245,411 observations. The imposition of the R&D quadratic term enhances total active return in most Frank Russell universes. Total active returns rise by more than 230 basis points in the larger Russell 1000 stock universe, with continued statistically significant asset selection, and an increased risk index, due principally to earnings yield, size, and trading activity index exposures. Asset selection drops by 50 basis points in the Russell 1000 universe with the imposition of the R&D tilt, although its variability also falls, such that its t-statistic on asset selection is constant. A similar result is found in the Russell 2000 universe.

The CTEF variable tilt with the R&D quadratic term produces 100 stock portfolios that have statistically significant loadings on the risk index (see Table 9.2). The t-statistic of the risk index variables in the CTEF model is 3.93, statistically significantly different from zero, as it exceeds the critical 5 percent level of 1.96. The CTEF variable tilt and the R&D quadratic variable produce statistically significant loadings on the earnings yield index (t = 4.32) and the size index (t = 2.72), as was the case with the

TABLE 9.2 CTEF Variable Active Returns with R&D Tilt, Russell 1000 Universe. Attribution Analysis: Annualized Contributions to Total Return

Source of Return	Contribution (% Return)	Risk (% Std Dev)	Info Ratio	T-Stat
Risk Free	4.93	N/A	N/A	N/A
Total Benchmark	13.58	14.52		
Expected Active	0.03	N/A	N/A	N/A
Market Timing	0.46	0.72	0.53	1.84
Risk Indexes	2.20	1.68	1.14	3.93
Sectors	0.65	2.95	0.20	0.70
Asset Selection	1.35	3.60	0.36	1.24
Total Exceptionally Active	4.67	5.05	0.83	2.86
Total Active	4.71	5.05	0.84	2.88
Total Managed	18.29	15.24		

CTEF variable and its breadth components reported in Chapter 8 (see Table 9.3). The only statistically significant sector exposure in the CTEF variable and the R&D quadratic variable portfolio construction process is the health care sector exposure.

A lambda tilt value of 1 is initially used in producing efficient portfolios. Active returns rise as the average stock size diminishes, a result consistent with the inefficient markets literature summarized in Dimson (1988)

TABLE 9.3 CTEF Variable Factor Exposures with R&D Tilt, Russell 1000 Universe. Attribution Report: Annualized Contributions to Risk Index Return

		Contribution (% Return)			Total		
Source of Return	Average Active Exposure	Average [1]	Variation [2]	Total [1+2]	Risk (% Std Dev)	Info Ratio	T-Stat
Volatility	–0.01	0.01	0.16	0.18	0.22	0.69	2.39
Momentum	–0.01	0.01	0.02	0.03	0.49	0.05	0.19
Size	–0.32	0.57	0.86	1.43	1.55	0.79	2.72
Size Nonlinearity	–0.04	0.03	-0.10	–0.07	0.20	–0.30	–1.02
Trading Activity	0.09	0.04	0.10	0.14	0.28	0.49	1.68
Growth	–0.18	0.17	–0.02	0.15	0.36	0.37	1.28
Earnings Yield	0.11	0.55	–0.12	0.44	0.30	1.25	4.32
Value	0.07	0.04	–0.01	0.03	0.18	0.12	0.43
Earnings Variation	0.05	–0.06	–0.03	–0.09	0.17	–0.43	–1.48
Leverage	–0.02	0.00	–0.04	–0.03	0.16	–0.18	–0.63
Currency Sensitivity	0.01	–0.01	–0.07	–0.07	0.15	–0.42	–1.45
Yield	–0.02	0.00	0.08	0.08	0.22	0.31	1.07
Non-Est Universe	0.00	0.01	–0.01	0.00	0.03	–0.04	–0.13
Total				2.20	1.68	1.14	3.93

and Ziemba (1992). The CTEF variable has statistically significant factor loadings on earnings yield and growth, as was the case in the Russell 3000 universe. The CTEF variable produces statistically significant asset selection and significant factor exposures, primarily due to the earnings yield exposure. Earnings forecasts and breadth generate greater asset selection in small stock universes than in larger stock universes, as we reported in Chapter 8. Moreover, as the firm size decreases, the CTEF variable is more statistically associated with risk index returns, such as earnings yield. The factor exposures increase as the sizes of firms decrease.

The additional R&D tilt increases the CTEF variable portfolio exposures to size, trading activity, and earnings yield exposures. Larger firms with greater trading activity are firms that engage in greater R&D expenditures. Sector exposures, particularly in the technology and health care industries, result from the R&D variable (see Table 9.4). The R&D quadratic term leads the portfolio manager to underinvest in financial companies.

The imposition of the CTEF tilt and R&D quadratic variable increases total active returns in the Russell 1000 universe. One must ask if total active portfolio returns and asset selection increase as the value of lambda is increased. We find that as the lambda value is increased, total active returns rise, the t-statistic on stock selection is increased, and the impact on risk indexes and sector sensitivities is reduced. Total active returns increase from

TABLE 9.4 CTEF Variable Sector Exposures with R&D Tilt, Russell 1000 Universe. Attribution Report: Annualized Contributions to Sector Return

		Contribution (% Return)			Total		
Source of Return	Average Active Weight (%)	Average [1]	Variation [2]	Total [1+2]	Risk (% Std Dev)	Info Ratio	T-Stat
Basic Materials	6.76	–0.28	–0.02	–0.30	0.65	–0.36	–1.23
Energy	–4.98	–0.09	0.23	0.14	0.94	0.13	0.44
Consumer (Noncyclical)	–2.96	0.05	0.13	0.18	0.30	0.50	1.72
Consumer (Cyclical)	2.13	–0.54	–0.24	–0.79	0.82	–0.78	–2.69
Consumer Services	–2.19	–0.10	0.02	–0.08	0.38	–0.18	–0.64
Industrials	3.77	–0.25	–0.09	–0.34	0.49	–0.57	–1.97
Utilities	–5.19	0.12	0.02	0.14	0.57	0.21	0.73
Transportation	–1.48	0.08	–0.01	0.07	0.14	0.37	1.27
Health Care	11.94	1.33	0.00	1.33	1.12	0.98	3.40
Technology	9.87	0.25	0.19	0.43	1.17	0.32	1.12
Telecommunications	–4.96	–0.03	–0.02	–0.05	0.56	–0.07	–0.24
Commercial Services	–0.67	0.01	0.04	0.05	0.09	0.44	1.52
Financial	–12.03	–0.14	0.02	–0.12	0.98	–0.12	–0.40
Total				0.65	2.95	0.20	0.70

25.17 percent with a lambda of 1, to 25.54 percent with a lambda of 10, and to 25.81 percent with a lambda of 100. The corresponding t-statistics on asset selection are 3.46, 3.75, and 3.87, respectively. One finds that asset selection is enhanced with the use of R&D, and the use of higher lambda values produces better asset selection and a reduction of risk indexes and sector exposures. We report the total active return findings of the analysis of lambda equaling 100 in Table 9.5, and the corresponding sector and risk index analysis in Tables 9.6 and 9.7, respectively. The technology and health care industries have the highest R&D to market capitalization ratios among the sectors, and the portfolio optimization results are consistent with the sector data. R&D enhances portfolio returns and stockholder wealth, a result consistent with Guerard, Bean, and Stone (1990), but produces within a more rigorous risk model.

We used the R&D variable as a quadratic term to enhance stockholder returns in many Frank Russell universes during the 1990–2001 period. One could have used dividend payments or capital expenditures as the quadratic term. The use of dividend or capital expenditure quadratic variables lowers total active returns and asset selection in the Russell 1000 universe relative to the R&D quadratic term. (See Table 9.8.) Capital expenditures generate higher asset selection in the Russell 2000 universe than R&D, but larger factor exposures, primarily due to earnings yield and growth indexes. R&D is a better use of funds to enhance stockholder wealth than capital expenditures and dividends in the Russell 1000. This is a particularly interesting result given that companies historically spend on capital expenditures twice what

TABLE 9.5 Total Active Return of the CTEF Variable with R&D Quadratic Variable, Lambda = 100. Attribution Report: Annualized Contributions to Total Return

Source of Return	Contribution (% Return)	Risk (% Std Dev)	Info Ratio	T-Stat
Risk Free	4.93			
Total Benchmark	11.73	18.42		
Expected Active	1.25			
Market Timing	0.39	4.32	0.24	0.81
Risk Indexes	0.82	3.45	0.28	0.98
Sectors	2.00	6.08	0.33	1.15
Asset Selection	9.63	7.54	1.12	3.87
Total Exceptionally Active	12.84	11.44	1.09	3.76
Total Active	14.08	11.44	1.18	4.07
Total Managed	25.81	25.01		

TABLE 9.6 Sector Exposures to CTEF Variable with R&D Quadratic Variable, Lambda = 100. Attribution Report: Annualized Contributions to Sector Return

Source of Return	Average Active Weight (%)	Contribution (% Return) Average [1]	Variation [2]	Total [1+2]	Total Risk (% Std Dev)	Info Ratio	T-Stat
Basic Materials	3.25	–0.01	–0.10	–0.11	0.87	–0.12	–0.43
Energy	–3.35	–0.21	0.33	0.12	0.84	0.16	0.56
Consumer (Noncyclical)	–2.41	–0.08	0.00	–0.09	0.36	–0.17	–0.58
Consumer (Cyclical)	–6.84	0.09	–0.20	–0.11	1.13	–0.03	–0.11
Consumer Services	–3.81	–0.09	0.01	–0.07	0.55	–0.07	–0.24
Industrials	6.02	–0.11	0.35	0.24	1.01	0.17	0.60
Utilities	–4.65	–0.13	0.01	–0.12	0.72	–0.10	–0.33
Transportation	–1.63	0.00	0.05	0.05	0.31	0.14	0.47
Health Care	0.20	0.01	–0.13	–0.11	0.90	–0.07	–0.23
Technology	34.53	3.54	0.07	3.61	4.94	0.62	2.13
Telecommunications	–1.21	–0.11	0.01	–0.10	0.26	–0.28	–0.97
Commercial Services	–2.64	–0.06	–0.04	–0.09	0.50	–0.09	–0.32
Financial	–17.45	–1.21	–0.01	–1.22	2.60	–0.34	–1.17
Total				2.00	6.08	0.33	1.15

TABLE 9.7 Risk Index Exposures to CTEF Variable with R&D Quadratic Variable, Lambda = 100. Attribution Report: Annualized Contributions to Risk Index Return

Source of Return	Average Active Exposure	Contribution (% Return) Average [1]	Variation [2]	Total [1+2]	Total Risk (% Std Dev)	Info Ratio	T-Stat
Volatility	0.51	–0.33	–0.24	–0.56	2.28	–0.10	–0.36
Momentum	–0.18	0.09	1.88	1.96	1.90	0.89	3.08
Size	–0.28	0.31	0.20	0.51	1.32	0.30	1.04
Size Nonlinearity	–0.56	0.27	–0.14	0.12	2.21	0.05	0.19
Trading Activity	0.22	0.13	–0.11	0.03	0.87	0.06	0.20
Growth	–0.02	0.02	0.05	0.07	0.31	0.17	0.59
Earnings Yield	0.07	0.39	–0.65	–0.26	0.97	–0.23	–0.78
Value	0.03	0.01	0.15	0.17	0.48	0.27	0.94
Earnings Variation	0.19	–0.29	–0.05	–0.33	0.56	–0.47	–1.63
Leverage	–0.04	0.00	–0.07	–0.06	0.22	–0.21	–0.72
Currency Sensitivity	0.16	–0.06	–0.28	–0.34	0.51	–0.53	–1.82
Yield	–0.43	0.01	–0.08	–0.07	0.96	–0.09	–0.33
Non-Est Universe	0.16	–0.41	0.00	–0.41	1.09	–0.31	–1.07
Total				0.82	3.45	0.28	0.98

TABLE 9.8 CTEF Variable with Various Quadratic Variables

	Total Active	T-Stat	Asset Selection	T-Stat	Risk Index	T-Stat	Sectors	T-Stat
R1000 CTEF Analysis								
CTEF	**2.47**	**2.52**	**1.85**	**2.12**	**0.82**	**2.13**	–0.11	–0.23
CTEF with R&D	**4.71**	**2.88**	**1.35**	**2.12**	**2.20**	**3.93**	0.65	0.70
CTEF with DIV	**1.73**	**1.60**	1.13	1.24	**1.12**	**2.87**	–0.37	–0.91
CTEF with CE	1.40	1.00	0.99	0.90	**1.75**	**2.73**	**–1.17**	**–2.01**
R2000 CTEF Analysis								
CTEF	**9.68**	**5.83**	**8.81**	**5.57**	**0.90**	**2.36**	–0.02	–0.07
CTEF with R&D	**9.17**	**5.18**	**7.01**	**4.98**	**1.06**	**2.84**	0.86	1.00
CTEF with DIV	**4.41**	**2.56**	**3.46**	**2.21**	**1.75**	**4.01**	**–0.77**	**–1.91**
CTEF with CE	**8.98**	**4.86**	**7.89**	**4.57**	**1.39**	**3.11**	–0.34	–0.70

Note: Bold figures denote statistically significant at 10% level.

they spend on R&D. See Table 9.9 for capital expenditures, dividends, and R&D for all traded U.S. companies in 2000. Asset selection was not enhanced with these long-held variables of security valuation relative to the use of expectation data. These trading evaluation measures, coupled with traditional and alternative means of trading, allow an investment firm to manage client portfolios while tightly controlling trading costs.[1] (See Figures 9.1, 9.2, and 9.3.)

TABLE 9.9 Average Companies Expenditures for Year 2000 ($ millions)

	Average Expenditures	Number of Companies
R&D Expenditures	$ 68.46	4,671
Capital Expenditures	151.78	8,461
Dividends	36.41	9,622
Average Expenditures, by I/B/E/S Sectors		
Financials		
R&D Expenditures	$ 1.41	173
Capital Expenditures	65.01	429
Dividends	65.35	932

TABLE 9.9 *(Continued)*

	Average Expenditures	Number of Companies
Health Care		
R&D Expenditures	91.69	516
Capital Expenditures	109.28	583
Dividends	79.50	594
Consumer Nondurables		
R&D Expenditures	75.24	10
Capital Expenditures	109.28	257
Dividends	79.50	266
Consumer Services		
R&D Expenditures	9.29	449
Capital Expenditures	140.35	864
Dividends	11.77	878
Consumer Durables		
R&D Expenditures	387.27	108
Capital Expenditures	519.83	197
Dividends	43.11	138
Energy		
R&D Expenditures	80.34	57
Capital Expenditures	391.78	219
Dividends	110.58	236
Transportation		
R&D Expenditures	0	0
Capital Expenditures	335.10	101
Dividends	18.10	101
Technology		
R&D Expenditures	88.66	896
Capital Expenditures	85.42	1,021
Dividends	4.91	1,036
Basic Industries		
R&D Expenditures	87.74	148
Capital Expenditures	186.77	278
Dividends	52.35	254
Capital Goods		
R&D Expenditures	80.74	265
Capital Expenditures	119.48	384
Dividends	38.31	386
Utilities		
R&D Expenditures	545.67	23
Capital Expenditures	1,151.55	202
Dividends	191.82	208

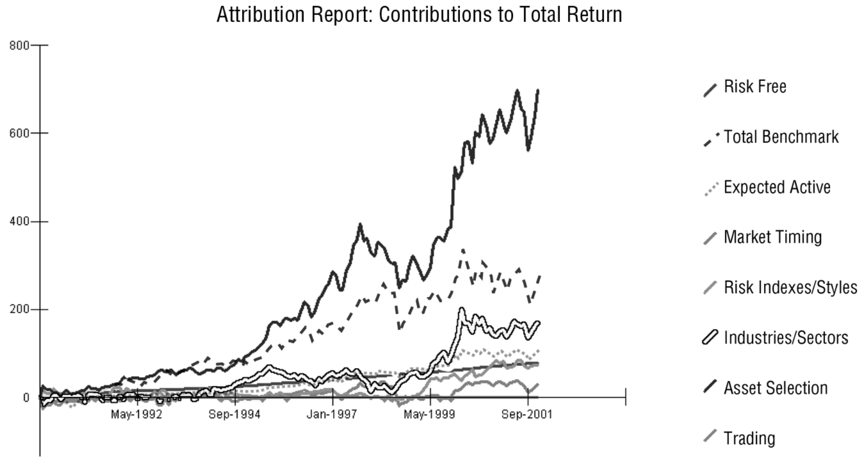

FIGURE 9.1 Cumulative Attribution Exposures to CTEF Variable

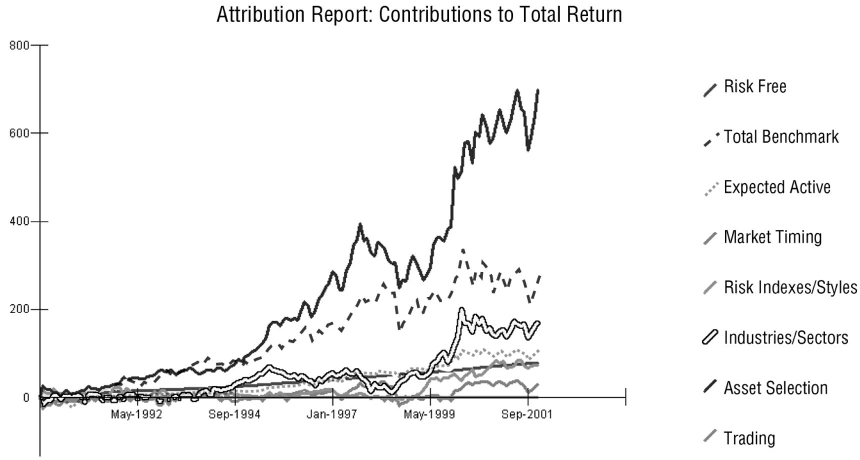

FIGURE 9.2 Cumulative Attribution Exposures to CTEF Variable with R&D Quadratic Variable

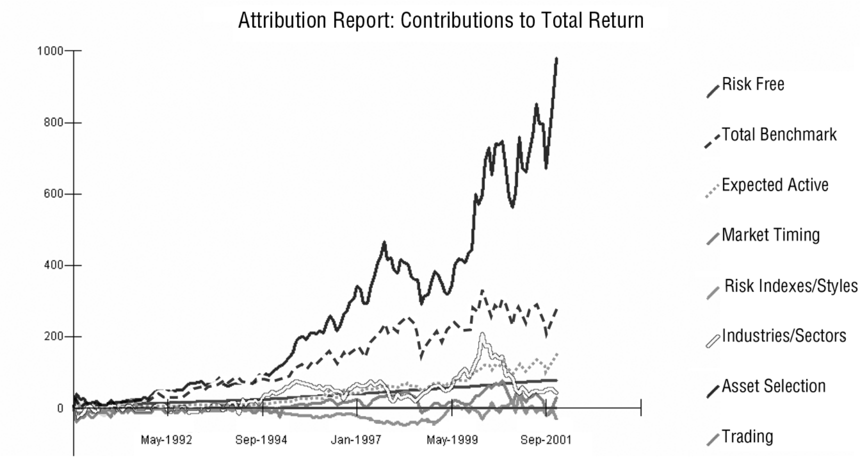

FIGURE 9.3 Cumulative Attribution Exposures to CTEF Variable with R&D Quadratic Variable, Lambda = 100

CHAPTER 10

The (Not So Special) Case of Social Investing

In this chapter we address two questions concerning socially responsible investing. First, is the average return of a socially screened equity universe statistically different from the average return of an unscreened universe? Second, can one use an expected return model incorporating both value and growth components to select stocks and create portfolios in the socially screened and unscreened equity universes such that one can outperform both universe benchmarks? Guerard (1997a) found no statistically significant differences in the mean returns of unscreened and screened equity universes for the 1987–1994 period. Subsequent analysis by Stone, Guerard, Gultekin, and Adams (2002) found no statistically significant differences in the respective universes during the 1983–1998 period. We find little difference in the predictive power of the composite model to select stocks in both unscreened and screened equity universes.

The estimated composite model offers the potential for substantial outperformance of socially screened and unscreened equity universes. There is a growing literature in academic and professional investment journals that suggests that socially responsible investing may produce higher risk-adjusted portfolio returns than those achieved by merely using all available stocks in the equity universe.[1] Whereas a financial screen is applied to an investment universe to reduce potential investments, a social screen is a nonfinancial criterion applied in the investment process that is an expression of a social, ethical, or religious concern. The application of a social screen allows the manager to apply these concerns in the investment process (Kinder 1997). An investor might expect lower returns from companies that damage the natural environment; sell liquor and other alcoholic products; produce, design, or use nuclear power; engage in gambling; or are large defense contractors, when one considers the possible corporate expenses of fines and litigation. Is socially screened investing a dumb idea, as has been put forth in some recent popular media?[2] It is the case that 24 socially screened mutual funds have substantially underperformed the S&P 500 during the past five and 10 years.[3] However, the difference between the average return on socially screened equity mutual funds and 2,034 unscreened equity mutual funds drops from –417 basis points over the past five years to –105 basis points over the past 10 years, a less meaningful differential, particularly given the very small number of socially screened equity mutual funds with long-term track records. There are only six socially screened equity mutual funds with five-year track records in the Morningstar universe, and only Dreyfus Third Century and Parnassus have 10-year records. The College Retirement Equities Fund (CREF) Social Choice Account, a balanced account containing 62 percent socially screened equities and 38 percent debt, has matched its annualized benchmark for the past five years.[4] The equity performance of the CREF Social Choice Account provides substantial evidence that social screening need not lead to the underperformance that one finds in the recent Morningstar socially responsible fund universe.

We will show that a socially screened universe return is not significantly different from an unscreened universe return for the 1987–1994 period. We also show that a composite model integrating value and growth components, such as that developed and estimated in Chapter 8, can consistently produce positive and statistically significant correlations between a stock's expected return ranking and its subsequent performance. Significant outperformance is generated in a socially screened investment universe. It is not dumb to be a socially conscious investor; rather, one must look at how a manager implements the investment process. We will examine a special case of the models estimated in Chapter 8 and show how one can construct a socially responsible portfolio with financial characteristics that are virtually identical to those of an unscreened portfolio.

Guerard (1997a) examined the returns of an unscreened equity universe composed of 1,300 equity stocks and a socially screened universe of approximately 900 stocks, tested as to whether there are statistically significant differences in the average returns of the two equity universes, and determined whether a composite model using both value and growth components is as effective in a screened universe as in an unscreened universe in identifying undervalued securities, and whether these can be combined into portfolios that may outperform the screened universe benchmark. Guerard (1997a) showed that there is no significant difference between the average monthly returns of the screened and unscreened universes during the 1987–1994 period. Indeed, from January 1987 to December 1994, there is less than a 15-basis-point differential in equally weighted annualized stock returns. We also show that a composite model using both value and growth (I/B/E/S) components produces statistically significant information coefficients (ICs) in the unscreened and screened stock universes. There are no significant differences in stock selection modeling between screened and unscreened universes, and significant excess returns may be realized using quantitative models in the screened universe. The screens used in this analysis, provided by Kinder, Lydenberg, Domini & Co. (KLD), are:

Military

Nuclear Power

Product (Alcohol, Tobacco, and Gambling)

Environment

The Vantage Global Advisors (VGA) unscreened 1,200-stock universe generated returns such that a $1.00 investment grew to $3.84 during the December 1987–December 1996 period. A corresponding investment in the socially screened universe would have grown to $3.57. There is no statistically significant difference in the respective return series, and more important, there is no economically meaningful difference between the return differentials. The variability of the two return series is almost equal during the 1987–1996 period. One can test for statistically significant differences in the two return series using the F-test, which examines the differences in series mean (returns) relative to the standard deviations of the series. When one applies the F-test, one finds that series are not statistically different from one another.

As an example, let us examine the financial characteristics of the stocks in the unscreened and socially screened VGA universes as of December 1994. The unscreened VGA universe of 1,300 stocks had BARRA growth and book-to-price sensitivities of 0.185 and 0.306, whereas the socially screened VGA universe had corresponding BARRA growth and book-to-price sensitivities of 0.269 and 0.279, respectively. The unscreened universe had an average market capitalization of $3.433 billion in December 1994, whereas the socially screened universe had a mean capitalization of $2.796 billion. The average BARRA growth and book-to-price sensitivities of the excluded securities were –0.164 and 0.414, respectively, and the average market capitalization of the excluded stocks exceeded $6.1 billion. Thus, socially screened-out stocks had higher market capitalizations and were more value-oriented than the unscreened universe, a condition noted by Lloyd Kurtz (Kurtz and DiBartolomeo 1996). There was a statistically significant difference between the unscreened VGA universe lower price-to-book ratio and the higher price-to-book ratio of the VGA screened universe. Professors Fama and French at the University of Chicago found that smaller stocks with lower price-to-book ratios tended to outperform larger stocks with higher price-to-book ratios in the very long run.[5] The higher price-to-book ratio of the screened universe represents a risk exposure to a socially responsible investor. The screened universe is more sensitive to the BARRA growth factor return than the VGA unscreened universe, and this exposure should help relative performance for socially responsible investors when the BARRA growth factor return outperforms the BARRA value factor return.[6]

The higher growth sensitivity helped Luck and Pilotte (1993) find that the Domini Social Index outperformed the S&P 500 index during the May 1990–September 1992 period. Luck and Pilotte used the BARRA Performance Analysis (PAN) package and found that the 400 securities in the DSI produced an annualized active return of 233 basis points relative to the S&P 500, and specific asset selection accounted for 199 basis points of the active return. Luck and Pilotte noted that the May 1990–September 1992 period was characterized by positive growth factor and size returns (smaller stocks outperformed larger-capitalized stocks as a rule during this period). Superior asset selection may have been achieved as Kinder, Lydenberg, Domini & Co. (KLD) created the DSI in May 1990 by including non-S&P 500 stocks with good records on corporate citizenship, product quality, and broad representation of women and minorities. KLD developed criteria to establish the records of socially responsible firms (see Kinder, Lydenberg, and Domini 1993). For example, in March 1992, KLD produced a screen of 24 publicly traded firms that dealt in or used recycled materials. A second screen of 20 companies known for quality products was developed by KLD, although one-third of these firms failed other screens. In August 1992, 12 firms were recognized by a KLD diversity screen that identified firms with four or more (or at least one-third of the members if the firm had fewer than 12 members) board seats held by women or minorities. Additional KLD screens in August 1992 identified 10 firms with women or minority CEOs and 20 firms that possessed notable records on promoting women and minorities. KLD screens established criteria to substantiate good corporate citizenship. It is important to note that these criteria did not cost the investor any meaningful average return during the 1987–1994 period and may have produced positive active (relative to the S&P 500) returns during some subperiods.

STOCK SELECTION IN UNSCREENED AND SCREENED UNIVERSES

In the previous section we examined the financial characteristics of unscreened and socially screened stocks, finding, as did Kurtz and DiBartolomeo (1996), that larger, more value-oriented stocks are excluded by social screening. Can a composite stock selection model, using value and growth factors, be effective in selecting securities that outperform the market in a socially screened universe? Let us propose to use a quantitative model for all securities publicly traded on any exchange during the 1987–1996 period. The model has seven variables: six value factors and the composite, proprietary growth variable developed in Chapter 8. The six value factors are earnings-to-price, book value-to-price, cash flow-to-price, sales-to-price, dividend yield, and net current asset value. The earnings, book value, cash flow, and sales variables are traditional fundamental variables examined in the investment literature, as discussed in Chapter 8. The traditional theory of value investing holds that securities with higher earnings, book value, cash flow, and sales are preferred to those securities with lower ratios, respectively. The net current asset value is the current assets of a firm less its total liabilities. A firm is hypothesized to be undervalued when its net current asset value is less than its stock price (Graham, Dodd, and Cottle 1962; Vu 1990).

Stone, Guerard, Gultekin, and Adams (2002) applied a four-factor risk model using a response surface methodology and found no differences between portfolios constructed using a composite stock selection model in socially screened and unscreened universes.

Financial economists have studied the effectiveness of consensus (mean values of forecasts) for more than 30 years in the United States, producing a huge literature exceeding 400 articles, summarized in Keon (1996). A consensus has yet to develop as to whether analysts' forecasts add value, that is, create excess returns. It has been shown that analysts' forecasts are generally more accurate than time series models, but it has not been consistently shown that the more accurate forecasts produce statistically significant excess returns; see Brown (1993) for an excellent survey of the literature on earnings forecasting. In this study we analyze three possible sources of excess returns from analysts' forecasts: (1) the forecasts themselves, (2) the changes in the mean values of earnings forecasts relative to the stock price, and (3) the breadth of the forecasts, where breadth is defined to be the monthly net number of analysts raising the forecast divided by the total number of forecasts. It is possible that the forecasts themselves may not produce excess returns; that is, simply buying securities forecasted to have the highest growth in earnings for the current fiscal year (FY1) or next fiscal year (FY2) may not add value.

Cragg and Malkiel (1968) and Niederhoffer and Regan (1972) found that analysts could not effectively forecast annual earnings relative to naive time series models, and Elton, Gruber, and Gultekin (1981) found little excess returns associated with purchasing securities solely on the basis of predicted earnings forecasts (EP). Niederhoffer and Regan (1972) and Elton, Gruber, and Gultekin (1981) found that the securities achieving the highest earnings growth produced significant excess returns. Thus, there is a significant reward to correctly forecasting earnings, but analysts' forecasts may be not sufficient.

Guerard, Blin, and Bender (1996a) found that analysts' forecasts were not sufficient in Japan to outperform the market during the 1987–1994 period. The lack of excess returns associated with consensus forecasts should not be the end of the analysis, because changes in the mean values of the forecasts divided by the stock price have been shown to add value in the United States (Hawkins, Chamberlain, and Daniel 1984; Wheeler 1995) and Japan (Guerard, Blin, and Bender 1996a). The changes in mean forecasts are referred to as "earnings revisions" (EREV), and one purchases stocks when analysts are raising their forecasts (Keon 1996). Wheeler (1995) found substantial value to using the breadth of earnings (defined as the number of forecasts raised less the number of forecasts lowered, the result divided by the total number of forecasts) to rank stock, where one purchases stocks when a (net) increasing number of analysts are raising their forecasts (EB). The breadth measure may well be less susceptible to the undue influence of a single analyst.

A composite growth variable (CTEF) is created from consensus I/B/E/S forecasts, forecast revisions, and breadth of forecasts and is of the general form described in Wheeler (1990) and discussed in Chapters 8 and 9. The composite I/B/E/S variable, PRGR, greatly enhances return even after transactions costs have been included.

In this study we test several forms of an earnings forecasting (EF) variable:

1. EQ(FY1, FY2EP)
2. EQ(FY1, FY2 EREV)
3. EQ(FY1, FY2 EB)
4. EQ(FY1 EP, EREV, EB)
5. EQ(FY2 EP, EREV, EB)
6. CTEF

The model may be summarized in equation (10.1):

$$\begin{aligned} \mathrm{TR}t = a0 + a1\mathrm{EP}t + a2\mathrm{BP}t + a3\mathrm{CP}t + a4\mathrm{SP}t + a5\mathrm{DY}t \\ + a6\mathrm{NCAV}t + a7\mathrm{EF}t + et \end{aligned} \tag{10.1}$$

where TR = total returns for the subsequent holding period (quarter)
EP = (net income per share) earnings-to-price ratio
BP = book value per share-to-price ratio
CP = cash flow per share-to-price ratio
SP = sales-to-price ratio
DY = dividend yield
NCAV = net current asset value per share
EF = a particular form of the growth variable
e = randomly distributed error term

The expected returns are created as described in Guerard (1990), Guerard and Takano (1992), and Guerard, Takano, and Yamane (1993). That is, quarterly cross-sectional regressions are run for each quarter during the 1982–1994 period every March, June, September, and December, as seen in Chapter 8. The dependent variable is the coming return for the subsequent three months; the independent variables are constructed from the Compustat database in which the annual data are the fundamentals assumed to be known in June of each year and monthly prices are used to construct the valuation ratios. The quarterly weights are again calculated by (1) finding the independent variables that are positive (the hypothesized sign of the coefficients) and statistically significant at the 10 percent level, (2) normalizing the regression coefficients to be weights that sum to one, and (3) averaging the coefficients over the past four quarters.[7] The cross-sectional regressions employ the Beaton-Tukey (1974) biweight technique in which the regressions weigh observations inversely with their ordinary least squares errors; that is, the larger the residual, the lower the observation weight in the regression.[8] The Beaton-Tukey outlier-adjustment procedure, also referred to as robust regression (ROB), has been shown to produce more efficient composite models for creating a statistically based expected return ranking model than the use of ordinary least squares (OLS) (Guerard 1990; Guerard and Stone 1992).

We tested the effectiveness of the various forms of the earnings forecasting variable by creating portfolios using an equally weighted seven-factor model for all securities with annual sales and monthly stock prices on Compustat during the 1987–1996 period, using the several forms of equation (10.1), and quarterly stock rankings were created.[9] The advantage to using equally weighted portfolios is that one can examine the excess returns (ExR) and portfolio turnover (Turn) of the various forms of earnings forecasting relative to the use of an equally weighted value-only model. If one runs a simulation in which one purchases securities with the highest expected return ranking, one finds that the breadth of earnings dominates earnings forecasts and revisions in the current forecast year analysis (FY1).

The use of two-year-ahead forecasts, revisions, and breadth does not outperform the one-year-ahead forecasts, a result consistent with Guerard, Gultekin, and Stone (1996).

Earnings forecasts themselves do not add value, a result consistent with Elton, Gruber, and Gultekin (1981) and Blin, Bender, and Guerard (1997). Earnings breadth produces higher turnover than analysts' forecasts or revisions, but generally enhances excess returns relative to the other forms of earnings forecast variable—a conclusion supported in the regression results of Guerard, Gultekin, and Stone (1996) and in Chapter 8. The proprietary, composite earnings forecast variable produces somewhat higher turnover than the individual forecast variable, but much higher excess returns. In the simulations, we assume that a portfolio manager tightly constrains portfolio security weighting and industry weights to be very similar to the S&P 500 index. A composite earnings forecasting framework similar to that in Wheeler (1995) substantially dominates the use of individual forecast variables. The equally weighted proprietary growth model produces 362 basis points of excess returns.

The results of this study are more consistent with those of Wheeler (1994), Guerard and Stone (1992), and Chapter 8, in that analysts added significant value, than with the results of the earlier studies of Cragg and Malkiel (1968) and Elton, Gruber, and Gultekin (1981). Perhaps the value of analysts was significant because we used a broader definition of earnings forecasting and because earnings rose substantially during the 1982–1994 period. An annual regression of ranked achieved earnings growth on ranked total returns produced positive and statistically significant coefficients on the achieved earnings variable in 12 of the 13 years. Earnings are certainly a major determinant of stock prices—a result consistent with Graham, Dodd, and Cottle (1962), Niederhoffer and Regan (1972), and Elton, Gruber, and Gultekin (1981).

We have shown that earnings forecasts, breadth, and revisions enhance returns relative to using only historical, value-oriented data. Now we address the question of using equally weighted or regression-weighted composite models. The application of the Beaton-Tukey outlier-adjustment procedure to equation (10.1) during the 1987–1996 period in estimating equation (10.1), using the proprietary growth variable, produced the scaled regression coefficients, where the value variable weights average approximately 65 percent during the period. The proprietary growth variable weight approaches 0.50 during the 1990–1994 period and averages 0.35, quite consistent with the Guerard (1990) and Guerard, Takano, and Yamane (1993) estimations. The excess returns of the robust-weighted composite model are 635 basis points, exceeding the equally weighted model despite turnover of more than 170 percent. The regression-weighted composite model has an average F-statistic of 28 and is statistically significant at the 5 percent level. The composite model expected return ranking procedure described earlier produces an average information coefficient of 0.093 for the 1982–1996 period (t = value of 6.5) and an average t-value of 4.14 for the 1987–1996 period. The lower quintile (least preferred) securities consistently underperform the average stock return, and the upper quintile (most preferred) securities produce positive excess returns such that the quintile spread is positive and statistically significant. The information coefficient, measuring the association between the ranked composite model score and subsequent ranked total returns, indicates that the quantitative model is statistically significant in its ranking of securities. The IC is a standard tool used in accessing the predictive power of financial information (Farrell 1983). In a more recent study, Guerard, Blin, and Bender (1996b) found that the estimated model from equation (10.1) outperformed the S&P 500 index by 420 basis points annually during the 1987–1994 period, assuming a 3 percent upper bound on security weights, transactions costs of 80 basis points each way, and quarterly reoptimization. Guerard, Gultekin, and Stone (1996) found excess returns of approximately 412 basis points annually during the 1982–1994 period using a variation on equation (1) that was discussed in Chapter 8.[10] The Guerard, Blin, and Bender (1996a,b) and Guerard, Gultekin, and Stone (1996) studies used unscreened investment universes.

The estimated expected return ranking model is used to create portfolios during the 1987–1995 period using a socially screened universe. The socially screened universe is created by subtracting the current KLD exclusions from a universe of 1,200 large stocks, resulting in a screened universe of approximately 950 stocks. A simulation is run for the January 1987–December 1995 period on the socially screened universe in which one tightly constrains industry and capitalization weighting and a 100-basis-point transactions cost (round-trip) is assessed in the simulation. We find that the estimate composite model produces an average excess return of 743 basis points. Socially screened portfolios can outperform unscreened portfolios during the 1987–1995 period. One can invest in a socially screened portfolio and still outperform the S&P 500 socially screened benchmark.[11] It is interesting to see how the use of a socially screened universe creates a higher average weight of the proprietary growth variable in equation (10.1). The ICs of the composite model may be enhanced as one shifts from a more value-oriented weighting to a more growth-oriented weighting as one forecasts relative factor returns.[12]

STOCK SELECTION AND THE DOMINI SOCIAL INDEX SECURITIES

In this section of the study we specifically address the issue of stock with the 400 stocks of the Domini Social Index (DSI) during the June 1990–December 1994 period. If one applied the seven-factor robust regression-weighted composite model ranking to the 1,200-stock universe for the June 1990–December 1994 period and used the simulation conditions discussed in the preceding section, one would have outperformed the S&P 500 by 297 basis points instead of the 400 points of outperformance previously found. The portfolios turned over approximately 228 percent annually during the June 1990–December 1994 period. If one used an equally weighted portfolio rule in which one sold securities when the expected return ranking fell into the bottom half of the distribution, one could substantially slow down turnover and enhance performance. If one used a selling criterion of selling when the alpha fell below –.7, the seven-factor model would earn an excess return of 439 basis points with turnover of only 107 percent. If one used the same –.7 selling criterion and employed the seven-factor model including only the 400 stocks of the DSI for the June 1990–December 1994 period, the excess returns would be 299 basis points and annualized portfolio turnover would be 79.3 percent. One can effectively pick stocks within the socially responsible DSI universe, and the excess returns of the 1,300-stock universe and DSI 400 would be virtually identical. Furthermore, if one wanted to be even more socially responsible and not invest in DSI stocks in which KLD has noted minor environmental and product concerns, one could create a portfolio strategy using the –.7 alpha sell rule and outperform the S&P 500 by 323 basis points. The difference between the 323 basis points of outperformance of the environmental and products concerns portfolio and the 299-basis-point outperformance of the DSI portfolios using our seven-factor model represents the additional excess returns occurring with the implementation of two KLD screens. Clearly, more research needs to be undertaken with respect to the effective use of social screens in a socially responsible universe.

RECENT SOCIALLY RESPONSIBLE RESEARCH

Drhymes (1997) and Guerard (1997b) showed that the use of all KLD concerns and strengths should not significantly alter unscreened universe returns during the 1992–1997 period. Guerard found that only the military screen cost the investor returns during the period. The military screen is the only social screen producing a statistically significant cost during the

1992–2002 period.[13] A benefit to the investor is the product strength variable, which is positively associated with returns and reflects R&D leadership of the firm. Firms that engage in R&D can be recognized as being good socially responsible firms.[14] If one eliminates securities of companies that spend less than the median firm on R&D during the 1982–1996 period, the IC of the composite model rises from 0.093 to 0.117. Moreover, if one uses R&D as a quadratic term, as we did in Chapter 9, one adds more than 240 basis points of excess returns to mean-variance efficient portfolios. R&D adds value to stockholders in socially screened and unscreened universes.

SUMMARY AND CONCLUSIONS

The purpose of this study has been to show that there has been no statistically significant difference between the average returns of a socially screened and an unscreened universe during the 1987–1996 period and the 1983–1998 period. Socially conscious investing need not be a dumb idea, but one should be attentive when selecting a socially screened mutual fund, as manager performance can vary dramatically.

CHAPTER 11

R&D Management and Corporate Financial Policy: Conclusions

The purpose of this book has been to analyze the determinants of corporate research and development (R&D) expenditures in the United States during the 1970–2003 period and the impact that these expenditures have had on stockholder wealth. Our research began with a review of the corporate financial statements and ratios. We illustrated calculations to assess the financial health of firms, using the Altman (1968, 2000) bankruptcy prediction models. The statistical theory of simultaneous equations was reviewed such that we could empirically estimate and evaluate the interactions among the R&D, capital investment, dividend, and new debt financing decisions of major industrial corporations. We found significant interdependencies, such that one must use a simultaneous equations model to adequately analyze a firm's financial decision-making process. Even the presence of federal financing of R&D was insufficient to completely eliminate the potentially binding budget constraints on firms. A corporate planning model was developed and estimated by the authors. We found significant correlations between stock prices and our targeted variables. Among our goals was to develop an econometric model to analyze the interdependencies of decisions in regard to research and development, investment, dividends, and new debt financing decisions.

The strategic decision makers of a firm seek to allocate resources in accordance with a set of seemingly incompatible objectives. Management attempts to manage dividends, capital expenditures, and R&D activities while minimizing reliance on external funding to generate future profits. Each firm has a pool of resources, composed of net income, depreciation, and new debt issues, and this pool is reduced by dividend payments, investment in capital projects, and expenditures for R&D activities. Miller and Modigliani (1961) put forth the perfect markets hypothesis in regard to financial decisions, which holds that dividends are not influenced (limited) by investment decisions. There are no interdependencies between financial decisions in a perfect markets environment, except that new debt is issued to finance R&D,

dividends, and investment. The imperfect markets hypothesis concerning financial decisions holds that financial decisions are interdependent and that simultaneous equations must be used to efficiently estimate the equations. The interdependence hypothesis reflects the simultaneous-equation financial-decision modeling work of Dhrymes and Kurz (1967), Mueller (1967), Damon and Schramm (1972), McCabe (1979), Peterson and Benesh (1983), Jalilvand and Harris (1984), Switzer (1984), and Guerard and McCabe (1992). Higgins (1972), Fama (1974), and McDonald, Jacquillat, and Nussenbaum (1975) found little evidence of significant interdependencies among financial decisions. We reported econometric evidence to reject the perfect markets hypothesis and found the estimation of a simultaneous equation system necessary for strategic planning.

The estimation of simultaneous equations for financial decision making is the primary modeling effort of Chapters 5 and 6. We find statistically significant association among investment, new debt, and R&D decisions. In Chapter 6, we estimate a set of simultaneous equations for the largest corporations in the United States during the 1971–2003 period. We review the federal financing impact on financial decisions during the 1975–1982 period. Recent restructuring has greatly changed the way many corporate officers think of new debt issuance.

Security valuation and portfolio construction is a major issue and is developed in Chapters 8, 9, and 10. Chapter 8 presents our valuation analysis, using historical fundamental data from Compustat and earnings forecast data from I/B/E/S. We find statistically significant stock selection models in the United States, Europe, and Japan, using both historical and earnings forecasting data that violate the efficient markets hypothesis. Chapter 9 extends the basic portfolio strategies discussed in Chapter 8 to include market-variance efficient portfolios, and we find a much greater use of earnings forecasts in the United States. We find that R&D enhances stockholder wealth in mean-variance efficient portfolios, increasing stockholder wealth more than 230 basis points during the 1990–2001 period. Socially responsible investing is examined in Chapter 10, and we find no difference between socially screened and socially unscreened portfolios. One can be socially responsible and produce efficient portfolios. It may be possible for management to increase its R&D activities, be recognized as a better firm in the socially responsible investment community, and see its stock price rise.

Corporate financial decisions necessarily integrate the R&D decision within a strategic framework, including the dividend, capital investment, and new debt decisions. Stockholder wealth is enhanced, particularly in large-capitalization (stock) portfolios, by tilting the portfolios to include stocks engaging in R&D activities.

Exercises

CHAPTER 2 An Introduction to Financial Statements

1. Given the database in JNJBS.Txt, what is the average CATA, CLTA, and TDTA for JNJ? How do the ratios for JNJ compare to the respective CATA, CLTA, and TDTA ratios for all WRDS companies in the year 2003, found in BSIS2003.txt? Explain with respect to external capital markets needs.

   The file format is:

```
Data JNJBS;
infile "D:JNJBS.txt" lrecl=50;
input smbl 1-6 yeara 8-11 @13 CATA f9.3 @23 CLTA f9.3 @33
    TDTA f9.3;

Data BSIS2003;
infile "D:BSIS2003.txt" lrecl=75;
input smbl 1-6 yeara 8-11 @13 CATA f9.3 @23 CLTA f9.3 @33
    TDTA f9.3 @43 ROE f9.3 @53 ROA f9.3 @63 ROS f9.3;
```

2. Given the database in JNJIS.Txt, what is the average ROA, ROS, and ROE for JNJ? How do the ratios for JNJ compare to the respective ROA, ROS, and ROE ratios for all WRDS companies in the year 2003, found in BSIS2003.txt? Explain with respect to profitability, leverage, and product.

   The file format is:

```
Data JNJIS;
infile "D:JNJIS.txt" lrecl=50;
input smbl 1-6 yeara 8-11 @13 ROE f9.3 @23 ROA f9.3 @33 ROS
    f9.3;
```

CHAPTER 3 Ratio Analysis

1. Given the database in JNJRatios.Txt, what is the average CR, SA, TDA, ROE, DuPontA, and NewZ for JNJ? How do the ratios for JNJ compare to the respective ratios for all WRDS companies in the year

2003, found in Rat2003.txt? Explain with respect to potential bankruptcy concerns.

The file format is:

```
Data JNJRatios;
infile "D:JNJRatios.txt" lrecl=75;
input smbl 1-6 yeara 8-11 @13 CR f9.3 @23 SA f9.3 @33 TDA
    f9.3 @43 ROE f9.3 @53 DuPontA f9.3 @63 NewZ f9.3;

Data Rat2003;
infile "D:Rat2003.txt" lrecl=75;
input smbl 1-6 yeara 8-11 @13 CR f9.3 @23 SA f9.3 @33 TDA
    f9.3 @43 ROE f9.3 @53 DuPontA f9.3 @63 NewZ f9.3;
```

CHAPTER 8 The Use of Financial Information in the Risk and Return of Equity

1. Given the following data for stocks X, Y, and Z, find the means and standard deviations of equally weighted, and risk-minimizing portfolios:

Stock	Expected Returns	Standard Deviation
X	0.075	0.125
Y	0.098	0.178
Z	0.147	0.251

2. Given the following file structure for December 1999, estimate the determinants of returns (ret):

```
data FR1D&yymm;
infile "d:FR1D&yymm..txt" lrecl= 159;
input cusip $ 1-8 ticker $ 10-15 permno 17-22 @25 Ret&yymm
    f7.4 @33 ep&yymm f6.3 @40 bp&yymm f6.3 @47
    cp&yymm f6.3 @54 sp&yymm f6.3 @61 rep&yymm f6.3
    @68 rbp&yymm f6.3 @75 rcp&yymm f6.3 @82 rsp&yymm
    f6.3 @89 fep1&yymm f6.3 @96 fep2&yymm f6.3 @103
    br1&yymm f6.3 @110 br2&yymm f6.3 @117 rv1&yymm
    f6.3 @124 rv2&yymm f6.3 @131 ctef&yymm f6.3 @138
    rd&yymm f6.3 @145 pm&yymm f6.3;
run;
```

Notes

CHAPTER 2 An Introduction to Financial Statements

1. The items may be called the proprietorship account in a single proprietorship or the partners' equity in a partnership.
2. Operating statements for internal control can be made up for any feasible time period. Most large firms present quarterly statements for their investors, although the annual results carry the most weight and go into the record books of the financial services, such as Standard & Poor's or Mergent's.

CHAPTER 3 Ratio Analysis

1. As additional ratios are used, one soon discovers that the same information is being presented in a different form.
2. This means that these companies, in effect, carry no net working capital.
3. The larger the percentage of ownership capital in the financial structure the smaller will be any difference between the rate of net profit on equity and the rate of net profit on total assets.
4. See Chapter 9 for a detailed analysis of this ratio and its variants.
5. For example, a company with many firm contracts might borrow on current terms and safely carry a lower current ratio than would be desirable for another company of the same type.

CHAPTER 4 Debt, Equity, Financial Structure, and the Investment Decision

1. Called "gearing" in England.
2. Financial risk was divided into borrower's risk and lender's risk by John Maynard Keynes in *The General Theory of Employment, Interest and Money* (Harcourt, Brace, 1936), pp. 144–145.

CHAPTER 7 Comparing Census/National Science Foundation R&D Data with Compustat R&D Data

1. Reprinted from *Research Policy*, Vol. 18, No. 4, Bean and Guerard, "A Comparison of Census/NSF R&D Data vs. Compustat R&D Data in a Financial Decision-Making Model," pp. 193–208, 1989 with kind permission

from Elsevier Science-NL, Sara Burgerhartstraat 25, 1055 kV Amsterdam, The Netherlands.

2. In view of this difference, the data used for the 1981 regression were reexamined, and no irregularities were found. The decline in significance was particularly noteworthy for the R&D variable.
3. Thus, the procedure involved matching firms present in the original 303-firm Compustat database with identical firms in the NSF/Census database on a year-by-year basis: (1) pairwise elimination of cases with missing data; (2) reestimating the original models using the Compustat data; (3) substituting the NSF/Census R&D data for the Compustat R&D data in the relevant firms; and (4) reestimating the original models, once again using the hybrid NSF/Census–Compustat database.
4. This implies that the richer content of the NSF/Census data set regarding the R&D activities of a firm can be brought to bear on questions impossible to answer with the Compustat data alone.
5. Closer examination of the firm-level data might help to explain the reasons for these differences.
6. The fact that the variances were significantly different in 1978 and 1979 and the means differed in the opposite direction in 1979 raises questions about the way R&D expenditures were reported in these years.
7. It is noteworthy that the differences in variances of the two series become insignificant in 1980–1982 when the sample size drops from 12 to 11, thus suggesting that a single firm could have accounted for the 1975–1979 differences.
8. This result is noted in Guerard, Bean, and Andrews (1987).
9. Thus, the COMP303 data set covers firms with a wider range of R&D expenditures and has a true zero point. Inasmuch as the constant term is not significantly different from zero for any of the samples across the five years, the COMP303 model seems the most plausible. To put it another way, it seems implausible that a firm that did no prior R&D would never spend money on R&D. Clearly, some firms must launch R&D programs even though they previously had none. The COMP303 model can accommodate this event while the others cannot.
10. The change in sign between 1981 and 1982 may reflect the effects of the R&D tax incentives associated with the 1981 tax reforms. This should be examined as a separate issue.
11. The dividends and new debt equations were changed by the reduced time frame. In the dividends equation, new debt was no longer significant, a finding that is consistent with the work of Dhrymes and Kurz (1967) for the 1947–1960 period. New debt, in turn, is influenced by capital expenditures, but not by cash flow. The relationship between dividends and new debt changes from negative to positive, although the relationship is not well-behaved. It was positive in three years and negative in two, all five being statistically significant. Thus, it appears that the new debt equation is highly sensitive to the change in time frame. While a positive relationship between new debt

and dividends is consistent with the notion that sources and uses of funds should rise and fall together, the relationship is weak for this sample.

12. The results are in reasonable agreement with Ben-Zion (1984), who used ordinary least squares analysis to investigate the relationship between research and development and the firm's market value for 157 firms during the 1969–1977 period. However, patents, stock betas, and lagged patents rarely influence the stock price, counter to Ben-Zion's results. The stock price maximization framework for R&D analysis proposed in Guerard and Bean (1986) is not found to be as significant as reported in the larger sample.
13. Additional assumptions that were needed to estimate the model, such as depreciation schedules, can be found in balance sheets and income statements in Guerard and Bean (1987).
14. We believe that a causal modeling technique (such as LISREL) should be employed to examine the linkages between public and private R&D expenditures and the financial decisions that affect stock market prices.

CHAPTER 9 The Optimization of Efficient Portfolios

1. The GlobeFlex Capital Management proprietary modeling and trading systems have outperformed the respective benchmarks for small capitalization, small-cap growth, and mid-cap portfolios during their real-time trading periods. The past one-year and three-year returns, ended December 31, 2002, are:

Portfolio	Portfolio Return	Index Return	Period
Small Capitalization	–14.71	–20.48	One-Year
	–7.58	–7.54	Three-Year
	12.94	10.17	Inception
Small-Cap Growth	–22.87	–30.26	One-Year
	–13.98	–21.11	Three-Year
	–9.09	–16.31	Inception
Mid-Cap	–17.09	–16.18	One-Year
	1.13	–5.04	Three-Year
	14.67	10.79	Inception

The GlobeFlex portfolio index returns lead to higher Sharpe ratios, because the GlobeFlex portfolios normally produce (significantly) smaller standard deviations than the index returns.

CHAPTER 10 The (Not So Special) Case of Social Investing

1. The initial academic study finding that 17 socially responsible mutual funds established prior to 1985 outperformed—that is, underperformed less than—traditional mutual funds of similar risk for the 1986–1990 period was that of

Hamilton, Jo, and Statman (1993). The relative monthly outperformance of 7 basis points was not statistically different from zero. It is not obvious what criteria were used to determine the socially responsible universe in the Hamilton, Jo, and Statman study. Recent studies by Diltz (1995a,b) found no statistically significant difference in returns for 28 stock portfolios generated from a universe of 159 securities during the 1989–1991 period. Diltz found that only the environmental and military business screens were statistically significant at the 5 percent level during the 1989–1991 period.

2. J. Rothchild, "Why I Invest with Sinners," *Fortune* (May 1996).
3. Morningstar, *Principia for Mutual Funds*, March 31, 1996.
4. The CREF Social Choice Account was a \$1.174 billion account as of December 31, 1995, consisting of 61.49 percent socially screened equities, 37.67 percent bonds, and 1.72 percent short-term commercial paper. The CREF Social Choice Account uses screens for environmental, weapons, nuclear power, alcohol, tobacco, and gambling products, as well as MacBride Principles (a code of fair employment by U.S. firms in Northern Ireland to prevent religious discrimination). The CREF Social Choice Account has matched its performance benchmark for the past one- and five-year periods ending March 31, 1996, producing total returns of 23.56 percent and 12.70 percent versus its benchmarks of 24.00 percent and 12.32 percent, respectively. The recent CREF Social Choice equity component is important because CREF underperformed in its unscreened equity fund during the past one year. The CREF Bond Market account has been a market performer in its bond investment for the one- and five-year periods ending March 31, 1996, producing bond returns of 10.52 percent and 8.51 percent versus the Lehman Aggregate Bond Yield index of 10.79 percent and 8.49 percent, respectively. The CREF Stock Account earned one- and five-year returns of 28.81 percent and 13.55 percent versus the S&P returns of 32.10 percent and 14.66 percent, respectively. The CREF Social Choice Account has produced total returns consistent with its balanced performance benchmark and has not substantially underperformed on its equity component. The reader is referred to the College Retirement Equities Fund prospectus, "Individual, Group, and Tax-Deferred Variable Annuities," April 1, 1995, for a description of the CREF Social Choice Account.
5. Fama and French (1995) actually tested whether higher book-to-price stocks outperformed the lower book-to-price stocks. It can be confusing when one thinks of the low P/E approach of Graham, Dodd, and Cottle (1962) in which an investor purchases low price-to-earnings stocks (i.e., one should not purchase a stock that has a price-earnings multiple exceeding 1.5 times the average price-earnings multiple of the market) and the higher earnings yield, or earnings-to-price (EP), approach tested in the academic literature. The two earnings formulations yield roughly the same result when applied to low-P/E or high-EP decisions; see Guerard and Takano (1992). Wall Street persons traditionally think of the low-P/E and low-PB models, whereas academicians prefer the conventional EP and BP models because the conventional formulations are not plagued by small negative and positive denominators, such as with very

small positive and negative earnings that can create very large positive and negative (often meaningless) P/Es. See Graham, Dodd, and Cottle (1962) for long-run evidence supporting the low P/E approach and their mixed thoughts on the price-to-book multiple.

6. The BARRA growth factor is a predictor of future growth of a company and is based on the five-year earnings-to-price ratio, historical earnings growth, recent earnings change, recent I/B/E/S change, the current earnings-to-price ratio, the I/B/E/S earnings-to-price ratio, and asset growth (BARRA, *U.S. Equity Beta Book*, January 1996).
7. The composite model-weighting scheme was advanced in Guerard (1990) and continues to produce statistically significant rankings. It is obvious that an infinite number of weighting schemes can be created; the four-period weighted regression pattern produced significant real-time outperformance in the United States and Japan during the 1988–1994 period. See Miller, Guerard, and Takano (1992) and Guerard, Takano, and Yamane (1993).
8. The Beaton-Tukey biweight procedure was put forth in Beaton and Tukey (1974). The reader is referred to D. C. Montgomery and E. A. Peck, *Introduction to Linear Regression Analysis* (New York: John Wiley & Sons, 1982) for a very complete description of the outlier-adjustment process.
9. Guerard has experimented with several variations on equation (10.1) in his joint research with Blin, Bender, Gultekin, Stone, Takano, and Yamane. Let us briefly examine the average F-statistics and ICs of the various forms of equation (10.1) using the top 3,000 securities for the 1982–1994 period. In summary: (1) the BP variable has an average IC of 0.012 (t-value of 0.71), whereas the EP variable has an average IC of 0.039 (t-value of 2.10), which indicates that the low P/E, or high EP, strategy worked well in identifying undervalued securities during the 1982–1994 period; (2) the use of relative variables—that is, the relative EP (REP, the current EP divided by its five-year average of monthly ratios)—increased the ICs of the four-fundamental-variable model (EP, BP, CP, SP) from 0.039 (t-value of 2.17) to 0.042 (t-value of 2.28); (3) the addition of the I/B/E/S FY1 forecast and breadth components further increased the IC in (2) to 0.072 (t-value of 3.82); (4) the use of equation (10.1) in this study produces an equally weighted IC of .058 (t-value of 3.15); and (5) the Beaton-Tukey robust regression estimation procedure increased the ICs to approximately 0.085, with little difference in the composite model ICs. Guerard initially used composite I/B/E/S revisions (CIR) and breadth (cm) in lieu of the CTEF variable.
10. It is interesting to note that if one uses only the 1,300-stock universe less the socially screened stocks as the entire universe, reran the regression, and recalculated the expected returns, one finds an average F-statistic of 9.64 in the OLS analysis and 12.4 in the ROB estimations. The average IC of 0.078 is statistically significant, having an average t-value of 3.63. The use of a value-oriented model with the elimination of many smaller stocks does not diminish the IC; however, the weighting of the composite growth variable is approximately 0.40. If one equally weights the seven-factor model, the average IC is 0.027

with a t-value of 0.90; the ranking procedure is not statistically significant in the smaller, socially screened universe. One finds positive and statistically significant ICs even using only a larger-capitalized, socially screened universe when one applies the Beaton-Tukey estimation procedure.

11. Vantage Global Advisors has been the adviser to a socially responsible fund, the Lincoln Life Social Awareness Fund in its Multi Fund Variable Annuity Family, which has produced a net return of 16.40 percent for the seven years ending March 13, 1996, whereas its socially responsible benchmark, the S&P 500 less its restrictions, has generated a corresponding return of 14.62 percent, respectively. Vantage has used a quantitative proprietary model emphasizing growth at a reasonable price (GARP) and will not invest in securities of firms that (1) engage in activities that damage the natural environment; (2) produce, design, or manufacture nuclear power or equipment for the production of nuclear power; or (3) manufacture or contract for military weapons; or (4) are in liquor, tobacco, and gambling industries. It is indeed possible to be a socially responsible manager and outperform the market. The seven-year returns are annualized. The performance figures include the reinvestment of dividends and other income. Past performance is not indicative of future results.
12. If one believes that BARRA value and growth factor returns can be forecast for the coming quarter using a Box-Jenkins (1976) time series model, then a random walk with drift formulation with a seasonal moving average operator can increase the CIBF (Consensus IBES Forecasted) weight when the BARRA growth factor return is expected to rise relative to the BARRA value factor return and can increase the predictive power of the model from a monthly IC of 0.052 (t-value of 1.66) to 0.063 (t-value of 1.99) during the 1987–1994 period.
13. If one regresses 12-month total returns for the 1992–2002 period for all Russell 3000 stocks, one finds the following "social screening costs" (i.e., positive returns):

Social Screen	*Cost*	*T-Stat*
Alcohol	–.017	(–.40)
Military	.036	(2.67)
Nuclear Power	–.054	(–2.86)
Gaming, Tobacco	.028	(0.77)

14. If one uses net KLD social strength, the strengths less the concerns, and regresses 12-month returns for the Russell 3000 stocks with the KLD criteria for the 1992–2002 period, one finds that the net product strength variable, a surrogate for R&D activity, is positively associated with total returns. Diversity and employment net social strength measures create stockholder wealth losses.

Net Social Strength	*Coeff*	*T-Stat*
Community	.021	(3.28)
Diversity	–.008	(–2.12)
Employment	–.021	(–4.40)
Environment	.011	(2.31)
Product	.020	(3.35)

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About the CD-ROM

INTRODUCTION

This appendix provides you with information on the contents of the CD that accompanies this book. For the latest and greatest information, please refer to the ReadMe file located at the root of the CD.

SYSTEM REQUIREMENTS

- A computer with a processor running at 120 Mhz or faster.
- At least 32 MB of total RAM installed on your computer; for best performance, we recommend at least 64 MB.
- A CD-ROM drive.

USING THE CD WITH WINDOWS

To install the items from the CD to your hard drive, follow these steps:

1. Insert the CD into your computer's CD-ROM drive.
2. The CD-ROM interface will appear. The interface provides a simple point-and-click way to explore the contents of the CD.

If the opening screen of the CD-ROM does not appear automatically, follow these steps to access the CD:

1. Click the Start button on the left end of the taskbar and then choose Run from the menu that pops up.
2. In the dialog box that appears, type ***d:*\setup.exe**. (If your CD-ROM drive is not drive *d*, fill in the appropriate letter in place of *d*.) This brings up the CD interface described in the preceding set of steps.

WHAT'S ON THE CD

This section provides a summary of the software and other materials you'll find on the CD.

Content

Any material from the book, including forms, slides, and lesson plans if available, are in the folder named "Content."

The CD contents are to provide students with the data with which they can (1) calculate financial ratios to assess the financial health of firms; (2) compare firms with objective performance criteria; (3) estimate simultaneous equation systems to illustrate the statistical interdependencies of financial decisions; and (4) estimate and analyze the determinants of total returns.

The reader is provided with data and can calculate the firm performance variables described in Chapters 2 and 3. The estimation of the two simultaneous equation systems in Chapter 6 allows the reader to note the differences in two distinct statistical procedures. The reader notes the importance of different regression estimations techniques in modeling total returns of securities in Chapter 8. The CD data allows the reader to employ the financial and statistical modeling techniques used in the monograph.

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