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ETHICAL DRUG INDUSTRY RETURN ON INVESTMENT

A Dissertation Presented

By

RODNEY FENTON SMITH

Submitted to the Graduate School of the
University of Massachusetts in
partial fulfillment of the requirements for the degree of

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January

1974

Major Subject Business Administration

ETHICAL DRUG INDUSTRY RETURN ON INVESTMENT

A Dissertation

By

RODNEY FENTON SMITH

Approved as to style and content by:

Chairman of Committee, Alexander Barges Director of Graduate Studies, Carl Dennler, Jr. Member, James B. Ludtke Member, H. Richard Hartzler

January 1974

PREFACE

The ethical drug industry has received considerable attention both from academic researchers and government investigators. A focal point for this interest is the industry's high rate of return relative to other manufacturing industries. In spite of this extensive coverage, studies of the industry's return on investment have ignored important economic and financial variables. Consequently, this study considers the effects of certain previously suggested variables on return on investment in general and on the ethical drug industry's rate in particular.

The goal of this study, then, is to add to our knowledge regarding rate of return and its determinants. It is not the intent here either to criticize or defend the drug industry regarding rate of return or any other matter. Whether an industry's return on investment is excessive can only be decided with reference to normative judgements by social and political decision-makers.

The writer's interest in the drug industry results from exposure to prior research conducted by Professor Alexander Barges. An acknowledgement of gratitude is due to Professor Barges and to Professors James B. Ludtke, H. Richard Hartzler, and Donald G. Frederick, all

of the University of Massachusetts, for their help in producing this study. Professors Willard T. Carleton and Thomas Warren of Dartmouth College were most helpful in the acquisition of data from the Compustat Tape. The use of the computer facilities at Nichols College is gratefully acknowledged. Two colleagues at Nichols College, Professors James L. Conrad, Jr., and Kenneth M. Parzych read the manuscript and offered many helpful comments. The responsibility for errors in the final result remains my own. My wife, Carolyn, provided encouragement and support throughout the project.

Ethical Drug Industry Return on
Investment. (January 1974)

Rodney F. Smith, B.A., University of New Hampshire

Directed by: Dr. Alexander Barges

The ethical drug industry has been under continuous study by governmental investigators and academic researchers for some time. The focal point of many of these studies is the industry's relatively high rate of return on investment (ROI). High rates are often cited as an indication, if not proof, of noncompetitive behavior. However, there is little agreement regarding the definition of ROI, the determinants of ROI, and the proper method for making inter-industry ROI comparisons. These issues are examined and a model is developed to study the ethical drug industry's return on investment.

Regression techniques are utilized to test the investment and structural characteristics as potential determinants of ROI. The hypothesized association with ROI is supported for the two risk measures and for growth in demand but rejected for the concentration ratio, average company size, and R&D intensity.

The three measures of investment characteristics are combined into a cross-sectional, multiple regression equation giving a model of ROI which is used to study the drug

industry's rate of return. Data for the industry are introduced into the model to obtain a forecast of rate of return with variance, skewness, and growth held constant. Comparing the forecast with the observed rate shows observed ethical drug industry average ROI to be below the rate that could result given the particular set of investment characteristics exhibited by the drug industry sample. Therefore, the hypothesis is accepted that ethical drug industry average ROI is the same as all-manufacturing industries average ROI after consideration of investment characteristics.

There are several possible explanations for why this model can explain statistically drug industry ROI: First, data are utilized only for firms primarily engaged in the manufacture of ethical drug products rather than data for both ethical and proprietary drug firms. Second, more recent data may reflect changed economic relationships, both within the drug industry and between the drug and other industries. Third, the model formulated includes more variables than prior models. Fourth, explicit consideration is made of possible statistical errors in both the regression equation and in the ROI forecast.

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CHAPTER I

THE ETHICAL DRUG INDUSTRY

The ethical drug industry is composed of firms whose main source of revenue is the sale of prescription drugs. Unfortunately, it is difficult to designate a company as belonging strictly to the ethical drug industry because most drug companies manufacture nonprescription, proprietary drugs as well as ethical drug products. This problem is met by selecting firms from the ethical drug classification on Standard and Poor's Compustat Tape. To be included in this classification, a firm must have prescription drugs as its primary source of revenue.¹

For some time considerable attention has been focused on the ethical drug industry's high rate of return relative to that of other manufacturing industries.² The results of earlier analyses by federal agencies and nongovernmental

¹For a list of the firms included in the ethical drug sample, see Appendix II. No data are available regarding what percentage of ethical drug companies' revenues come from ethical drugs and what percentage is derived from other products. It is unlikely that ethical drugs account for less than 60 to 65 percent of the revenues of the firms sampled.

²See Chapter VI and Appendix II for graphical and statistical comparisons of ROI for the ethical drug industry and for the all-manufacturing industries samples.

sources confirm this relatively high return, but there remain varying opinions regarding the contributing factors involved. This study seeks to identify and test statistically measurable variables that on logical grounds could conceivably explain industry rate of return.

Industry Characteristics

Much of the attention received by the ethical drug industry results from its unique characteristics. Attention has been focused in particular on relatively high return on investment, intensive promotional and research activity, and inelastic demand.

Considerable potential for monopolistic behavior, which can result in high rates of return, is created by the importance of health to the individual and by the nature of the channels of drug distribution. The ethical pharmaceutical industry is not subject to the usual consumer control, for once a drug is prescribed, the individual automatically purchases it.³ As health is involved, price is generally of little importance in the purchase of prescription drugs, and therefore, the industry faces a condition of relative price inelasticity.

³Demand elasticity for drugs is discussed in Mickey C. Smith, Principles of Pharmaceutical Marketing (Philadelphia: Lea and Febiger, 1971).

Similarly, the industry is characterized by income inelasticity evidenced by the fact that drug purchases are about equal for low- and high-income groups. As shown in Table 1, mean gross drug expenditures range from \$30 for families with incomes below \$2000 to \$52 for those having over \$7500 incomes. This small range is in contrast to the range of \$165 to \$411 in gross health expenditures per family.

Attempts to control the ethical drug industry are helped by the relative inelasticity of demand for pharmaceutical products. Competition based on price is supplanted by product differentiation and high promotional expenditures, both of which are characteristics of noncompetitive industries.

Intensive promotional efforts aimed at physicians contribute to the industry's control over product promotion and distribution.⁴ As the consumer is not directly involved in the selection of a drug, the manufacturer must convince only the prescribing physician that its brand-name product is the best for a particular disease or condition. Since physicians are readily identified, they are easily contacted by pharmaceutical firms through salesmen, direct mail, and

⁴For a detailed description of the way pharmaceutical products are marketed, see Bernard G. Keller and Mickey C. Smith, eds., Pharmaceutical Marketing (Baltimore: Williams and Wilkins, 1969).

TABLE 1

DISTRIBUTION OF FAMILY DRUG EXPENDITURES, 1958-1963

Mean Family Income	Mean Gross Personal Health Expenditures Per Family	Mean Gross Expenditures for Drugs Per Family	Estimated Income Elasticity of Demand for Drugs	Drug Expenditures as Percent of Family Income
All Groups	\$294	\$40		0.75%
Under \$2000	\$165	\$30	.077	2.37%
\$2000-\$3499	\$226	\$35	.067	1.30%
\$3500-\$4999	\$287	\$40	.012	0.89%
\$5000-\$7499	\$336	\$41	.118	0.66%
\$7500 and Over	\$411	\$52		0.50%

Source: Hugh D. Walker, Market Power and Price Levels in the Ethical Drug Industry (Bloomington, In.: Indiana University Press, 1971), p. 11.

advertising in medical journals. The intensity of these promotional efforts is indicated by the drug industry's high rank in inter-industry comparisons of advertising and promotional intensity.⁵

Another unique characteristic of the ethical drug industry is its relatively high outlays for research and development (R&D) activity. Table 2 shows that the industry allocates R&D expense at the rate of 4.5 to 5.6 percent of sales in contrast to an all-manufacturing average of 1.9 to 2.0 percent. Such intense research activity in conjunction with the patent privilege can give existing pharmaceutical manufacturers a significant advantage over potential entrants into the drug industry. As research can be a barrier to competitive entry, high R&D intensity may provide a non-competitive advantage that can be exploited to gain a high rate of return.⁶

While various structural characteristics are often cited as indications that the ethical drug industry is not competitive, relatively high rate of return on investment is commonly used as a summary measure for monopolistic

⁵For example, see Jules Backman, Advertising and Competition (New York: NYU Press, 1967). There is additional discussion of advertising and promotion in Chapter IV.

⁶Research and development intensity is discussed in detail in Chapter IV.

TABLE 2
INDUSTRY RESEARCH AND DEVELOPMENT INTENSITY^a

Industry	Percent		
	1963	1964	1965
Food and Kindred Products	b	b	0.4
Textiles and Apparel	0.4	0.4	0.4
Paper and Allied Products	0.8	0.7	0.7
Industrial Chemicals	4.1	4.2	3.9
Petroleum--Refining and Extracting	1.2	1.0	0.9
Rubber Products	1.6	1.0	1.7
Stone, Clay, and Glass Products	1.6	1.6	1.6
Primary Metals	0.7	0.7	0.7
Fabricated Metal Products	1.4	1.3	1.2
Machinery	3.1	3.2	3.1
Electrical Equipment	3.6	3.6	3.6
Transportation Equipment	2.5	2.6	2.3
Aircraft and Missiles	2.6	2.5	3.4
Professional & Scientific Instruments	<u>4.2</u>	<u>4.3</u>	<u>4.2</u>
All-Manufacturing Industries--Mean	1.9	2.0	2.0
Ethical and Proprietary Drugs	4.5	5.6	5.4

^aR&D expense as a percent of net sales. Company outlays only; government outlays not included.

^bNot available.

Source: U.S., National Science Foundation, Basic Research, Applied Research and Development in Industry, 1969 (Washington, D.C.: Government Printing Office, 1970), p. 81.

behavior.⁷ It is the industry's high return on investment along with high research outlays, intensive promotional activity, inelastic demand, and other indications of a noncompetitive situation that has led to the many investigations and studies.

Studies of the Industry

The first extensive review of the ethical drug industry was initiated in 1959 when the Senate Subcommittee on Antitrust and Monopoly, with Estes Kefauver as Chairman, investigated the monopolistic aspects of the industry.⁸ These hearings were wide-ranging and covered such topics as differential prices of brand-name and generic-name drugs, the role of patents, the comparison of foreign and U.S.

⁷For example, see U.S., Congress, Senate, Subcommittee on Monopoly, Competitive Problems in the Drug Industry, statement submitted by Willard F. Mueller (Washington, D.C.: Government Printing Office, 1968), pp. 1807-1861; and Estes Kefauver, In a Few Hands--Monopoly Power in America (Baltimore: Penguin, 1965).

⁸U.S., Congress, Senate, Subcommittee on Antitrust and Monopoly, Administered Prices in the Drug Industry (Washington, D.C.: Government Printing Office, 1960). The following are discussions of the hearings: Richard Harris, The Real Voice (New York: Macmillan, 1964); Kefauver, In a Few Hands; and William S. Comanor, "The Drug Industry and Medical Research: The Economics of the Kefauver Committee Investigations," Journal of Business (January, 1966), pp. 12-18.

prices, and extensive promotional activity.⁹ Concluding that the anti-competitive aspects of the industry required attention, the Kefauver Committee recommended corrective legislation designed to force the lowering of drug prices and industry rate of return.¹⁰ The resulting Kefauver-Harris Act, passed in 1962, basically followed the Committee's proposals, although a key provision requiring compulsory patent licensing was omitted. However, the legislation failed to bring about any appreciable decline in the drug industry's rate of return.¹¹

This failure to reduce return on investment resulted in another major set of hearings by Senator Gaylord Nelson's Subcommittee on Monopoly.¹² The main recommendations by

⁹As different brand-name drugs may closely resemble one another as regards chemical composition, they are grouped together under a common or generic name. This generic name, of course, is not the possession of any company and is not patentable.

¹⁰The following were identified by the Committee as being indicative of lack of competition: monopoly pricing under patents, lower foreign prices for identical products, identical prices for different companies' products, and high ROI. The Committee's recommendations were that use of generic-name drugs be encouraged, that the existence of side effects be included in advertising, that there be compulsory patent licensing after three years, and that the Food and Drug Administration be given increased regulatory powers.

¹¹See Chapter VI and Appendix II for graphical and statistical evidence of the trend of drug industry ROI from 1963 to 1971.

¹²The hearings which were conducted from 1967 through 1972 were compiled in U.S., Congress, Senate, Subcommittee on Monopoly, Competitive Problems in the Drug Industry (Washington, D.C.: Government Printing Office, 1967-1972).

witnesses critical of the industry were to encourage the use of generic-name drugs and to restrict the patent privilege. As the hearings were only recently concluded, no corrective legislation has been passed as yet.

Unfortunately, investigation of the drug industry has been complicated by political overtones, which is understandable given the importance of health to individuals and to society. An academic researcher who is generally critical of the drug industry observed:

The hearings constitute an interesting and often fascinating contribution to the literature of politics, but are here and there notably incomplete as an exercise in applied economic analysis. In part this is due to the periodic interference of moral indignation when giving and taking testimony, for the issues investigated were highly controversial. . . .¹³

Additional studies have resulted from the publicity generated by the Senate hearings. In general, the focus has been on the structural and investment characteristics of the industry and on how these characteristics are associated with the industry's high return on investment.¹⁴ For example, Professor Seymour Harris of Harvard asks,

¹³Henry B. Steele, "Patent Restriction and Price Competition in the Ethical Drugs Industry," Journal of Industrial Economics (July, 1964), p. 198.

¹⁴Structural characteristics refer to the way the industry is organized, particularly in regard to concentration and barriers to competitive entry. Investment characteristics are the distinctive features of an investment, such as risk and growth in demand, that capital suppliers assess when evaluating a project's expected rate of return.

Is it appropriate that a public-utility industry should be subject to such large areas of monopoly, . . . unusually high profits . . . , and yet be free of any substantial regulation of monopoly practices?¹⁵

Harris, like Kefauver, favors modification of the patent laws and the dampening of demand for brand-name ethical drugs with the hope of reducing prices and rates of return.

The effects of patents and promotional activity on drug industry return on investment have been extensively studied by Professor Henry Steele of the University of Houston. He recommends uncompromising legislation to correct ". . . misallocation of resources in excessive selling efforts, duplicative research and product development programs, and exceptionally high profit levels. . . ." ¹⁶

In an empirical study, the probable effects of several commonly suggested policy changes are assessed by Hugh Walker.¹⁷ His conclusion is that the net social benefits

¹⁵Seymour E. Harris, The Economics of American Medicine (New York: Macmillan, 1964), p. 99.

¹⁶U.S., Congress, Senate, Subcommittee on Monopoly, Competitive Problems in the Drug Industry, statement submitted by Henry B. Steele, p. 1970. Professor Steele, who has a Ph.D. in Industrial Economics from MIT has done much research in the areas of medical economics and drug industry regulation.

¹⁷Hugh D. Walker, Market Power and Price Levels in the Ethical Drug Industry (Bloomington, In.: Indiana University Press, 1971). Walker is currently Visiting Professor of Economics at the University of Toronto. The empirical work was the basis for a Ph.D. dissertation completed by the author at Vanderbilt University in 1967.

would be small from 1) removal of drug brand-names;
2) removal of drug patents; or 3) removal of both.

Investment characteristics such as risk and growth in demand have been emphasized in other studies of the drug industry. An example is the attempt by Gordon Conrad and Irving Plotkin of the A. D. Little Company to measure the risk premium in rate of return.¹⁸ Using regression techniques to hold risk constant, they compare drug industry and average all-manufacturing rates of return. Although the drug industry is found to be relatively risky, the risk variable does not explain the excess of the industry's rate of return over that of the all-manufacturing sample.

Growth in demand is considered as a determinant of drug industry return on investment by Alexander Barges and Brian Hickey.¹⁹ In attempting to explain statistically the industry's relatively high rate of return, the authors find growth in demand to be a significant determinant. However, using a growth variable, they are able to explain only about one-third of the difference between drug industry and

¹⁸Gordon R. Conrad and Irving H. Plotkin, "Risk/Return: U.S. Industry Pattern," Harvard Business Review (March-April, 1968), pp. 90-99. This article is discussed in more detail in Chapter III.

¹⁹Alexander Barges and Brian R. Hickey, "Drug Industry Profits," Financial Analysts Journal (May-June, 1968), pp. 75-83. When the article was written, the authors were, respectively, Associate Professor of Finance and Faculty Research Assistant at the University of Massachusetts. See Chapter III for additional discussion of this study.

average all-manufacturing rates of return.

Prior studies have not satisfactorily explained ethical drug industry rate of return, because either determinants of return on investment were ignored or no more than one or two determinants were considered simultaneously.²⁰ In particular, investment and structural characteristics have not been considered jointly in any single significant research.

The purpose of this study is to develop a model that can be used to study the ethical drug industry's rate of return on investment. To do this requires: 1) the evaluation and empirical testing of variables associated with rate of return including risk, growth, concentration, company size, R&D intensity, and promotional intensity; 2) the assembly of these determinants into a model of return; 3) the use of the model in an attempt to explain statistically the drug industry's rate of return. No attempt will be made to determine whether or not drug industry returns are excessive, since this can only be normatively established with reference to social and economic values.

By providing additional understanding of return on investment and its determinants, this study will aid social and political decision-makers in making judgements regarding whether a particular industry should be more closely

²⁰These determinants are defined as those measurable investment and structural characteristics that are contributing factors to explaining rate of return.

regulated. This increased understanding should be particularly useful in reference to the drug industry, which is characterized by ongoing controversy regarding its relatively high rate of return.

CHAPTER II

RETURN ON INVESTMENT

Return on investment is a widely used measure of how well capital suppliers are rewarded for the use of their resources.¹ To calculate return on investment (ROI), a profit figure is divided by the amount of capital invested:

$$\text{ROI} = \text{PROFIT} / \text{INVESTMENT}$$

The resulting figure can be ambiguous since different commonly used definitions for both profit and investment produce varying measurements for rate of return.²

One interpretive ambiguity is the profit variable which appears in the numerator of the ROI fraction. Using income before taxes eliminates the effects of taxes. Income before financial costs reflects return without the influence of leverage (financial risk). Income after taxes

¹For example, ROI is used as a means of inter-industry comparisons in Aerospace Research Center, Aerospace Profits Vs. Risks (Washington, D.C.: Aerospace Industries Association of America, 1971); and in George J. Stigler, Capital and Rates of Return in Manufacturing Industries (Princeton: Princeton University Press, 1963).

²It is not proper to combine just any profit or income figure with just any investment figure. The logic of accounting conventions produces relationships between particular income and investment accounts. Examples of such logical pairings are net operating income with total operating assets and net income after taxes with stockholders' equity.

is affected by both tax law and leverage. Other definitions of profit similarly have unique interpretations.

The definition of the capital base is also a source of ambiguity for ROI since different figures have different interpretations as to the efficiency of an investment. To contribute further to the interpretive complexity, the investment figures are balance sheet items and can be measured at the beginning-of-the-year, end-of-the-year, or the two can be averaged.³

Differences in depreciation practice also affect return on investment. Assuming the use of net fixed assets, depreciation expense is a current deduction from income which is offset by an equal reduction in capital invested. As the depreciation schedule is not necessarily the same as the rate of wearing out or obsolescence of assets, depreciation deductions can distort the relation between accounting income and economic rate of return. A study by Thomas Stauffer concludes that accounting rate of return (after depreciation) is a poor measure for economic rate of return.⁴ Another

³For a discussion of the possible effects of using beginning- or end-of-the-year figures along with a numerical example, see Alexander Barges and Brian R. Hickey, "Drug Industry Profits," Financial Analysts Journal (May-June, 1968), p. 80.

⁴Thomas R. Stauffer, "The Measurement of Corporate Rates of Return: A Generalized Formulation," The Bell Journal of Economics and Management Science (Autumn, 1971), pp. 434-469. The profit figure used to calculate economic rate of return would reflect a depreciation deduction just sufficient to replace the capital used up in generating revenue during the profit period.

study presents evidence that,

. . . in long-run equilibrium the forces of competition tend to equalize "cash returns" rather than "accounting returns." The rate-of-return calculation which excludes depreciation deductions approximates the "cash rate of return on gross assets."⁵

The question of which ROI measure is most appropriate for use in comparisons of return on investment is unresolved with different researchers arriving at conflicting conclusions. Marshall Hall and Leonard Weiss argue for the use of return after taxes divided by stockholders' equity because they believe that capital structure is an integral part of the mix of inputs.⁶ They conclude that different capital structures produce different rates of return on assets even in competitive equilibrium, and therefore, rates of return on equity, not return on total assets, would be expected to be equalized.⁷

Return on equity is rejected in another study because the measure does not consider the debt-to-equity ratio.⁸

⁵Barges and Hickey, "Drug Industry Profits," p. 82.

⁶Marshall Hall and Leonard Weiss, "Firm Size and Profitability," Review of Economics and Statistics (August, 1967), pp. 319-331.

⁷Return after taxes to stockholders' equity is used also in I. N. Fisher and G. R. Hall, "Risk and Corporate Rates of Return," Quarterly Journal of Economics (February, 1969), pp. 79-92. However, no explicit rationale is given.

⁸Aerospace Research Center, Aerospace Profits Vs. Risks.

Return on total assets is used instead to eliminate financial risk as a variable and to focus on business risk.⁹ As outlined above, similar reasoning regarding leverage by Hall and Weiss leads them to prefer the return on equity measure.

In an extensive study of rates of return in manufacturing industries, George Stigler used income after taxes plus interest divided by total assets, arguing that rate of return on equity ignores debt capital suppliers' attitudes about risk and return.¹⁰ Stigler conceded that the decision to use return on total assets is made in the face of many unanswered questions regarding the influence of capital structure on ROI.

With no apparent agreement on what constitutes the best definition of return on investment for inter-industry comparisons, the choice of a measure is up to each individual researcher's judgement and rationale for his particular study. The definition used in this research is net income after taxes divided by net worth.¹¹

⁹Business risk is the uncertainty or variability of return inherent in an economic undertaking.

¹⁰Stigler, Capital and Rates of Return.

¹¹The rationale for the choice of net income after taxes divided by net worth is presented in Chapter V. In Chapter VI, the possible effects of different capital structures are considered by including the debt ratio as an independent variable and by introducing return on total assets into the regression model.

Relation to Capital Supply

There are well established concepts regarding the rewards that go to those who supply resources for the productive process. The total reward flow from an economic undertaking is divided into wages, rent, interest, and profit, with profit as a balancing item. Profit, therefore, is a residual and can range from a negative amount to a positive figure well above normal.¹²

The flow of money capital from surplus spenders (who spend less than their incomes) to deficit spenders (who spend more than their incomes) varies considerably over time in response to political, social, and economic variables, with expected rate of return being particularly important. To induce investment in a given project, capital suppliers require a minimum rate of return which is determined by pure interest plus a premium associated with any undesirable investment characteristics inherent in the project.¹³ This

¹²To the accountant, profit is the revenue remaining after subtracting out costs. To the economist, a normal profit is the reward to the supplier of equity capital and is, therefore, a cost. Return above the normal level is called pure or excess profit.

¹³For a discussion of required rate of return, see William F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk," Journal of Finance (September, 1964), pp. 425-442; Lawrence Fisher, "Determinants of Risk Premiums on Corporate Bonds," Journal of Political Economy (June, 1959), pp. 217-237; and Donald S. Watson, Price Theory and Its Uses (New York: Houghton Mifflin, 1963), Chapter 5.

required rate of return has at least three identifiable levels: The first level is a minimum rate established by administrative costs, time preference, or liquidity preference below which investors will not supply any capital. The second level is determined by opportunity costs as rational investors will not commit capital to a project that offers a lower ROI than an alternative project with the same investment characteristics. The third level is the maximum rate obtainable from any project with a given set of investment characteristics.

The first level of required rate of return is established by investors' attitudes regarding capital investment, but the second and third levels are based on individual companies' financial results. Although capital suppliers receive their return as interest, dividends, or capital gains with their preferences determined by the tax structure and brokerage costs, the fact remains that the reward for contributing capital ultimately comes from the profitability of the firm.

Normal Rate of Return

The theory of pure competition includes the proposition that rate of return regulates investment to produce the most efficient allocation of capital. If there is insufficient investment to meet consumer demand, prices are expected to be bid up which increases ROI and attracts additional capital.

Eventually, according to the theory, prices decline or costs increase until rate of return is again at the normal level with no excess profit.

Based on the theory of a normal rate of return, some economists believe the existence of an apparently stable ROI above the normal or average can result only from monopolistic behavior.¹⁴ These economists assume that the most likely explanation for relatively high industry rate of return is that existing firms have blocked competitive entry, and therefore, stable, above-average rates are proof of a non-competitive situation. An above average ROI may, of course, result from industry structural characteristics which can be barriers to entry themselves without any anti-competitive behavior on the part of existing firms. For example, high capital or technological requirements for efficient production can prohibit competitive entry.

The veracity of attributing above-average rates of return to a lack of competition has been questioned. For instance, Stigler asks:

What is the nature of the proposition that under competition there is a tendency for rates of return on investments in various industries to approach equality? It has been taken by some economists as a definition of competition; persistently high profits

¹⁴For an example of this viewpoint, see U.S., Congress, Senate, Subcommittee on Monopoly, Competitive Problems in the Drug Industry, statement submitted by Willard F. Mueller (Washington, D.C.: Government Printing Office, 1968), pp. 1806-1861.

in an industry would be proof that the industry is not competitive. But this usage is one-sided: no one would argue that the existence of the average rate of return in an industry proved that the industry is competitive.¹⁵

A competitive but high-risk industry might have a higher than average rate of return as compensation for above average risks. A noncompetitive industry may exhibit a below average ROI because of changes in product demand to which it is difficult to adapt. This has been explained by Stanley Ornstein as follows:

The pure theory of competition and monopoly does not provide a basis for the traditional hypothesis that with few rivals a firm will earn above average profits. Unanticipated changes in demand and cost or high risk industries may lead to above average profits in competitive industries and result in differential returns both within and between high and low concentration industries. . . . Hence, above average returns may persist in competitive industries for long periods of time given sufficient disequilibrium, or a monopoly may experience below average profits for long periods depending on demand and cost conditions.¹⁶

Pure competition is, of course, an extreme or limiting case. A study relating economic concepts to basic social processes explains:

"Monopolistic competition" can be read simply as impure competition - that is, competition that fails to correspond in every detail with the hypothetical ideal of the theory of pure competition. Thus conceived, it [monopolistic competition] is the competition of any real-world economy.¹⁷

¹⁵Stigler, Capital and Rates of Return, p. 55.

¹⁶Stanley I. Ornstein, "Concentration and Profits," Journal of Business (October, 1972), pp. 519-520.

¹⁷Robert A. Dahl and Charles E. Lindblom, Politics, Economics and Welfare (New York: Harper and Row, 1953), p. 201.

Inter-Industry Comparisons

When inter-industry ROI comparisons are made, industries are grouped by their stage in the productive cycle (e.g., manufacturing or retailing) or by the nature of the product (e.g., consumer or producer good) or by some other variable. This is done on the assumption that these industry groups hold constant such characteristics as risk, growth rate in demand, elasticity of demand, or other variables that can affect ROI. A comparison of rates of return for small grocery stores and for large banks, for instance, would be meaningless because the two groups are too dissimilar. Therefore, ROI comparisons are made within broad industry groups; e.g., comparing a manufacturing industry with an all-manufacturing industries average.

The use of industry groups assumes that all the industries in a group have similar characteristics. This assumption is difficult to accept as the industries in a modern technological economy have diverse investment and structural characteristics.

The assumption of similar investment and structural characteristics can be avoided by using a model that explicitly considers these rate of return determinants. Industry structure can be held constant by using the well-known market models.¹⁸ However, these structural models

¹⁸The four basic models are pure competition, monopolistic competition, oligopoly, and pure monopoly.

do not solve the problem of comparability for several reasons. First, there are only four main categories for industry structure. This dictates that all but the most obvious differences between industries must be ignored since an industry can be placed into only one of the basic models even though the industry may have characteristics associated with several of the models.¹⁹ Second, the structural models make no allowance for investment characteristics which can affect rates of return.

Inter-industry comparisons of return on investment have been complicated by several problems. First, there is no agreement regarding the proper definition of ROI to utilize for such comparisons. Second, some economists have interpreted the propositions of competitive theory in such a manner as to equate relatively high rates of return with anti-competitive behavior. Third, the basic market models have been used to hold structural characteristics constant but these models ignore fine differences in characteristics since there are only four basic models. Also, structural models do not allow consideration of investment characteristics. What is needed is a model of ROI which explicitly considers the determinants of ROI as

¹⁹For example, an industry may have a large number of small firms, a characteristic of monopolistic competition, but a few of the largest firms may dominate the market as in oligopoly.

measured by both investment and structural characteristics.

An alternative means of making inter-industry comparisons of return is to use the investment and structural characteristics in a multiple regression model. For example, an equation with ROI as the dependent variable and risk as an independent variable would allow comparisons of rates of return with risk held constant. Other investment and structural characteristics can be explicitly considered in the same equation.

A multiple regression model of ROI that explicitly considers investment and structural characteristics is presented in Chapter V. Prior to that, the characteristics including risk and growth in addition to concentration, research intensity, company size, and advertising intensity are discussed in the next two chapters.

CHAPTER III

INVESTMENT CHARACTERISTICS

The purpose of this chapter is to review the literature pertaining to the influence of selected investment characteristics on ROI in order to provide a foundation for construction of a return on investment model. Primary emphasis is placed on risk and growth in demand inasmuch as these variables are associated with premium rates of return, even in competitive industries. The discussion of the influence of institutional or structural characteristics on ROI is deferred to Chapter IV.¹

Risk Premium

The association of risk and rate of return is widely accepted but poorly understood because the definition and measurement of risk are ambiguous. Verification of the risk/return relationship is difficult since risk is a subjective consideration, and consequently, researchers have had to use surrogate variables to measure risk. The one common element in the perception of risk is lack of predictability regarding the return to be expected from an

¹The precise definitions for the variables used in the ROI model are explained in Chapter V.

investment, and therefore, risk is defined as variability of return on investment.²

In the money markets risk and return are considered together, and certainly, this is one reason why common stocks are expected to have a higher yield than bonds.³ Bonds are generally less risky than stocks because bonds receive interest before dividends are paid, and in liquidation debt capital is returned first. Walter Hickman examined the risk/return relationship as it affects the securities markets and confirmed the traditional assumption of a positive association between risk and rate of return.⁴

To lessen the complexity of the risk/return relationship, researchers commonly utilize several simplifying assumptions. The first concerns the difficulty of observing investors' perceived expectations after the fact. Given a sufficient number of observations, it is assumed that the observed results are, on the average, the same as the results expected by the investors.⁵ Therefore, researchers use

²No distinction is made in this study between risk and uncertainty.

³Mean rate of return from stocks was found to be substantially higher than average return from bonds in Lawrence Fisher and Roman L. Weil, "Coping with the Risk of Interest-Rate Fluctuations," Journal of Business (October, 1971), pp. 408-431.

⁴Walter B. Hickman, Corporate Bond Quality and Investor Experience (Princeton: Princeton University Press, 1958).

⁵This assumption is explained in detail in Paul H. Cootner and Daniel M. Holland, "Risk and Rate of Return," (Cambridge, Ma.: MIT DST Project #9565, 1964). (Mimeographed.)

ex post information to assess ex ante risk.

A second simplifying assumption is that investors have diminishing marginal utility for income or wealth.⁶ Since diminishing marginal utility implies risk aversion, an investor is assumed to accept additional risk only if it is coupled with increased return and if the return is increased in more than a one-to-one ratio with risk. In other words, the investor values the dollar of investment which he stands to lose more than the dollar of return he hopes to gain.⁷

Variability of return as a measure of risk. It is generally accepted that there is a positive association between rate of return and uncertainty about the receipt of return, but an acceptable means of measuring the risk premium has been elusive. Explaining their procedure in the development of a risk measure, Paul Cootner and Daniel Holland state:

Risk is basically a subjective phenomenon, and not susceptible to direct measurement. What we have done therefore, is by purely deductive reasoning established that certain other, objectively measurable concepts are related to risk. Our next step is, by

⁶For an extensive discussion of the subject of utility of income, see Milton Friedman and Leonard Savage, "The Utility Analysis of Choices Involving Risk," Journal of Political Economy (August, 1948), pp. 279-304.

⁷Two references that discuss investor risk aversion are Richard A. Brealey, An Introduction to Risk and Return from Common Stocks (Cambridge, Ma.: MIT Press, 1969), pp. 47-54; and Paul H. Cootner and Daniel M. Holland, "Rate of Return and Business Risk," The Bell Journal of Economics and Management Science (Autumn, 1970), pp. 211-226.

statistical techniques, to correlate rate of return with these objective measures.⁸

They utilized the standard deviation of individual company ROI's around the industry mean for the measurement of variability of return (risk).⁹ Regression analysis produced a statistically significant positive association between rate of return and the standard deviation and thus confirmed the hypothesis that dispersion of company ROI is a determinant of return on investment.

The relationship between return on investment and variability of return is depicted by the two hypothetical distributions of ROI in Figure 1. Measured by the variance or standard deviation, dispersion of company rates of return for industry A is relatively small, while for industry B, dispersion is much larger. Similarly, uncertainty regarding occurrence of a given rate of return is much greater for industry B than for A. For B the risk of a negative rate of return is very real possibility, but for A, the risk of such a capital loss is negligible. A risk-averse investor would demand a higher rate of return from an investment in industry B because of the greater uncertainty

⁸Cootner and Holland, "Risk and Rate of Return," p. 31.

⁹For a discussion of various descriptive measures of the probability distribution of rates of return, see Appendix I. There has been much research into the question of the total risk associated with a portfolio of investments as opposed to the risk associated with the investments themselves. Such studies are commonly referred to as covariance models.

Probability
of Occurrence

Fig. 1.--Variability of return

associated with this investment.

There are two separate methods for measuring variability of return: inter-spatial variation and inter-temporal variation. Inter-spatial variation is found by calculating variability of individual company rates of return around their industry mean. Inter-temporal variation is the variability of company rate of return around its own mean over time.

The inter-temporal method is a measure of the volatility of an individual company's ROI. Stated alternatively, the inter-temporal measure indicates the extent to which company rate of return is affected by cyclical changes in the economy. To the extent that cyclical changes can be predicted, temporal variation in ROI can be predicted. If a firm's future rate of return can be predicted with any reasonable degree of accuracy, the fact that the predictions vary considerably over time does not mean that investment in the firm is uncertain or risky. Reliance on inter-temporal variability can be criticized also on the basis that economic time series tend to be autocorrelated, and therefore, the measure is unsatisfactory as a risk measure.¹⁰

Inter-spatial variability of return measures the volatility of individual company rates around the average

¹⁰This problem is emphasized in U.S., Congress, Senate, Subcommittee on Monopoly, Competitive Problems in the Drug Industry, statement submitted by Gordon R. Conrad and Irving H. Plotkin (Washington, D.C.: Government Printing Office, 1968), pp. 1746-1784.

for the industry, and is, therefore, an industry rather than a company measure.¹¹ Differences in inter-spatial variability between industries could result from such sources as:

1. Differences in the ease of entry into an industry or ease of adding to productive capacity.
2. Differences in income elasticity of demand for the industry's output which would affect response to general economic activity.
3. Differences in price flexibility.
4. Differences in raw material supply stability.
5. Differences in storability and durability of raw materials and finished goods.
6. Differences in exposure to foreign competition.
7. Differences in competition among existing products.

The unique set of these and other characteristics defines the risk environment for an industry.

The following characterization of how the investor may perceive risk demonstrates inter-spatial variability of return as a risk measure: A capital supplier can invest in an industry by either setting up a new firm or by providing capital to a going concern for asset expansion, product development, or other projects. Being reasonably

¹¹This conceptualization closely follows that in Conrad and Plotkin's testimony.

experienced, the investor assumes he can pick investments as well as anyone else which implies he at times will be particularly astute and at times will make errors. The investor might well judge the risk inherent in investing in the industry by the past impact upon ROI of errors and astute decisions experienced by firms in the industry. If the impact on ROI has been extreme as evidenced by high inter-spatial dispersion, risk would be judged high. If it appeared unlikely that a decision-making error would push ROI far from the industry mean, risk would be assumed negligible.

Concluding that inter-spatial variation is superior to the inter-temporal measure, Conrad and Plotkin summarized their rationale as follows:

Researchers who have concentrated on temporal measures of riskiness have generally found them unsatisfactory both theoretically and empirically. The inability of these measures to "explain" rates of return we attributed to the fact that they confounded predictable with nonpredictable changes. It is our feeling that the interspatial risk measure better captures the all-important nonpredictable element.¹²

Inter-spatial variability is, therefore, a summary measure that indicates the risk environment of an industry. In order to attract capital, a firm in a high-risk environment must offer a compensatory high rate of return relative

¹²Gordon R. Conrad and Irving H. Plotkin, "Risk/Return: U.S. Industry Pattern," Harvard Business Review (March-April, 1968), Supplement.

to that available from firms in lower-risk environments. The measure, of course, is applicable to investments in individual companies and not to balanced portfolios containing investments in many firms from a given industry.

The inter-spatial measure can, however, indicate high risk even though there is considerable stability in individual company rates of return. This would be the case, for example, if some firms in an industry have consistently high rates of return while others have consistently low rates. For the measure to be valid, then, both individual company rates of return and relative company rankings must vary over time.¹³

Researchers have utilized both the inter-temporal and the inter-spatial measures of risk. For example, Cootner and Holland included both measures as variables in a multiple regression equation and found the two risk variables to be highly collinear.¹⁴ Their preference for the inter-spatial measure was based on the assumption that investors find it costly to diversify within, as opposed to between, industries, and therefore, rates of return for industries with particularly high inter-spatial variation must include a risk premium as compensation for such costs.

¹³By studying temporal variation of ROI along with rank-order correlation coefficients, Conrad and Plotkin concluded that both individual company returns and relative rank do vary over time. See Conrad and Plotkin, "Risk/Return."

¹⁴Cootner and Holland, "Rate of Return and Business Risk."

Inter-temporal as well as inter-spatial variation were used in a study by Fisher and Hall.¹⁵ Although both measures were statistically significant explanatory variables for ROI, the authors adopted the temporal variable on logical grounds. Their basic argument was that temporal variation reflects risk in general terms as the uncertainty of predicting a company's future rate of return. However, as pointed out above, variation over time may be relatively predictable and therefore not at all uncertain.

In the Conrad and Plotkin study cited above, the arguments regarding the proper measure for use in inter-industry risk/return comparisons were reviewed.¹⁶ When they statistically tested the inter-spatial and inter-temporal measures, the former was found to have a significant positive association with ROI, while the latter was significant but had a negative coefficient which was contrary to their hypothesis.

Inasmuch as the goal in this study is to develop a measure that adequately reflects subjective investment risk for use in inter-industry comparisons of rate of return, it does appear from the review of the literature that the better

¹⁵I. N. Fisher and G. R. Hall, "Risk and Corporate Rates of Return," Quarterly Journal of Economics (February, 1969), pp. 79-92.

¹⁶Conrad and Plotkin, "Risk/Return."

choice is inter-spatial variation. The rationale is much like the one put forward by Conrad and Plotkin. First, the inter-spatial measure seems to reflect better the non-predictable element of investment which is presumably central to investors' perceptions of risk. In contrast, the inter-temporal measure appears to reflect the extent to which cyclical change affects a particular firm. The state of the art in forecasting cyclical change provides a basis for predicting the future movement of company ROI around its own mean.¹⁷

Second, inter-spatial variation is a true industry variable rather than an average of company variables. Although investments are made in companies, it is argued that industry statistics strongly influence choice of investment. The assumption is that investors have limited time and resources for acquiring investment information, and consequently, they rely heavily on industry statistics.

The Conrad and Plotkin study referred to earlier is an example of the use of inter-spatial dispersion to explain industry rate of return. Using data for 1950-1965 from the Compustat Tape, the authors tested the hypothesis ". . . that industries characterized by highly dispersed profit

¹⁷The investor has considerable choice among the variety of forecasting techniques and models; nevertheless, he is probably able to predict future business conditions for an industry more accurately than to predict individual company rates of return.

distributions are judged by management and investors to be riskier than those characterized by compact distributions of profit rates."¹⁸ With ROI defined as average return after taxes on total permanent capitalization, the risk/return association was positive and significant, and therefore, the hypothesis was accepted. Some of Conrad and Plotkin's results are shown in Table 3. It is interesting to note in this table that the drug industry has the highest variance and second highest ROI.

In the course of Senate hearings on the drug industry, Conrad and Plotkin's study was criticized by Willard Mueller. In his testimony, Mueller claimed: "The preponderance of economic evidence argues that the persistently high profits of the drug industry are the result of the absence of effective price competition in the sale of many products."¹⁹ He concluded that inter-spatial variation of ROI is actually a measure of relative market power:

Because of advertising and other factors, some firms in such [differentiated product] industries have a pronounced and persistent advantage over others. As a result, the most advantaged firms earn persistently higher profits than the less advantaged firms. Such a difference between the profits of the most advantaged and least advantaged firms in an industry may provide

¹⁸Conrad and Plotkin, "Risk/Return."

¹⁹U.S., Congress, Senate, Subcommittee on Monopoly, Competitive Problems in the Drug Industry, statement submitted by Willard F. Mueller (Washington, D.C.: Government Printing Office, 1968), p. 1827.

TABLE 3
RETURN ON INVESTMENT AND VARIANCE
1950-1965

Industry	Variance ^a	ROI ^b
Cosmetics	67.284	18.7
Aerospace	59.901	12.2
Radio and TV Manufacturers	57.631	15.0
Bldg. Mat. - Heating, A/C, & Plumbing	34.965	8.8
Electrical Products	27.486	11.0
Machinery Manufacturers	27.426	10.1
Beverages - Brewers	25.412	9.8
Electronic Products	22.822	13.0
Chemicals and Chemical Products	21.306	12.1
Shoe Manufacturers	20.535	8.7
Machinery - Metal Fabricating	19.580	9.0
Copper Producers	19.528	9.5
Office and Business Equipment	14.170	12.5
Building Materials - Cement	8.708	11.7
Textiles	8.477	7.5
Oil - Integrated Producers	7.494	10.6
Steel Producers	5.014	8.5
Containers - Metal and Glass	3.709	8.1
Aluminum Producers	1.579	7.8
All-Manufacturing Industries Average	23.844	10.8
Drugs - Ethical and Proprietary	74.213	17.5

^aVariance in percent squared units.

^bROI (percent) - Average rate of return after taxes on total permanent capitalization (book value).

Source: Gordon R. Conrad and Irving H. Plotkin, "Risk/Return: U.S. Industry Pattern," Harvard Business Review (March-April, 1968), p. 94.

a rough measure of the height of the entry barriers into the industry.²⁰

To back up his claims, Mueller presented a restructuring of Conrad and Plotkin's industry sample by separating consumer and producer goods industries.²¹ As a result of the restructuring, the risk/return relationship became very weak and not statistically significant for the producer goods industries which Mueller believes are more homogeneous. The strong positive association between variance and ROI remained for the consumer goods sample.

Conrad and Plotkin consider this criticism in depth in an unpublished rebuttal to Mueller's testimony.²² Regarding the claim that inter-spatial variation really reflects the height of barriers to entry, they argue that the measure has been successfully used in stock market studies.²³ The measure, in their opinion, cannot be interpreted as measuring barriers to entry in the securities markets since all industries are equally easy to enter by

²⁰ Ibid., p. 1835.

²¹ As can be seen in Table 3, Conrad and Plotkin mix consumer and producer goods industries in their sample.

²² Irving H. Plotkin and Gordon R. Conrad, "Rebuttal to Testimony Given by Dr. Willard F. Mueller, Director, Bureau of Economics, Federal Trade Commission, Before the Monopoly Subcommittee of the Select Committee on Small Business, United States Senate, Washington, D.C. - January 18, 1968," p. 2. (Typewritten.)

²³ For example, see Brealey, An Introduction to Risk; and Lawrence Fisher and James H. Lorie, "Some Studies of Variability of Return on Investments in Common Stocks," Journal of Business (April, 1970), pp. 99-134.

the purchase of stocks and bonds.

As to Mueller's restructuring of the industries to provide a more homogeneous sample, Conrad and Plotkin say:

. . . it is not necessary that all industries in any regression service the same sector of the economy - for example, producer goods or consumer goods. Nor is it necessary that all industries in the regression be purely competitive industries. Nor is there any basis for requiring product homogeneity within the industries. The only homogeneity requirement is that they represent realistic alternative possibilities for capital investment. . . .

One of the objects of this study was to isolate evidence of non-competitive returns. It is, accordingly futile and without theoretical basis to require that all industries studied be purely competitive.²⁴

Two further quotations help to characterize Conrad and Plotkin's views.

It was not our object to establish the drug industry as being uniquely risky, and we make no such claim. We merely make the claim that the capital allocation process in our economy is one which demands higher prospective rates of return for projects which it considers more risky.

. . . The condemnations implicit in listing industrial endeavors from highest to lowest profit without regard for risk variations are without economic justification.²⁵

Stigler empirically studies the view, expressed by Mueller, that competitive industries will exhibit a smaller dispersion of average rates of return than noncompetitive industries.²⁶ For the time period 1938-1947, he finds that

²⁴Plotkin and Conrad, "Rebuttal to Mueller," p. 11.

²⁵Ibid., pp. 17-18.

²⁶George J. Stigler, Capital and Rates of Return in Manufacturing Industries (Princeton: Princeton University Press, 1963), pp. 69-70.

the variance of concentrated industries is significantly greater than that for unconcentrated industries, but using a second period, 1947-1954, there is no significant difference between the two variances. These ambiguous results are further confused by the fact that the concentrated and unconcentrated samples exhibit no significant differences in rates of return. The results do not confirm the hypothesis that concentrated industries have greater dispersion in ROI.

A major study commissioned by the Bank Administration Institute deals in depth with the problem of risk measurement. In brief, the study concludes:

Almost every writer, however, believes that risk is associated with uncertainty or unpredictability. Therefore, when talking about the riskiness of securities or other assets, it seems reasonable to assert that their riskiness is related to uncertainty regarding their rates of return in the future. In addition, it seems reasonable to believe that ex ante uncertainty is related to ex post variability in rates of return. For those reasons, most studies of the relationship between risk and rate of return are studies of the relationship between some measure of variability in rates of return and average rates of return.²⁷

Another risk/return study emphasizes the problem of

²⁷Bank Administration Institute, Measuring the Investment Performance of Pension Funds (Park Ridge, Ill.: The Institute, 1968), p. 29.

management's discretion in accounting treatment.²⁸ The authors, Robert Litzenberger and Cherukuri Rao, discuss the possibility that some firms can lessen the magnitude of unanticipated swings in earnings by smoothing reported income.²⁹ The study found a statistically significant association between variation of return and ROI.

There have been a number of studies critical of the use of variation in return to measure risk. For example, the Mueller testimony discussed above is notable.³⁰ Another case in point is a study by Jon Joyce and Robert Vogel who demonstrate empirically that variance under some conditions produces conflicting rankings as regards risk.³¹ None of these critical studies has been sufficiently persuasive or conclusive to eliminate variation of return as the most widely used measure for risk.

Skewness as a measure of risk. There is considerable evidence to suggest the inclusion of higher order moments than mean and variance in describing distributions of ROI.

²⁸Robert H. Litzenberger and Cherukuri U. Rao, "Estimates of the Marginal Rate of Time Preference and Average Risk Aversion of Investors in Electric Utility Shares, 1960-1966," The Bell Journal of Economics and Management Science (Spring, 1971), pp. 265-277.

²⁹For a discussion of this topic, see Richard H. Simpson, "An Empirical Study of Possible Income Manipulation," Accounting Review (October, 1969), pp. 806-817.

³⁰U.S., Congress, Senate, Competitive Problems in the Drug Industry, pp. 1807-1961.

³¹Jon Joyce and Robert Vogel, "The Uncertainty in Risk: Is Variance Unambiguous?" Journal of Finance (March, 1970), pp. 127-134.

Use of the mean-variance approach depends on at least one of the following conditions being met: 1) that the distribution of ROI can be adequately described by a two-parameter family distribution such as the normal or Gaussian; or 2) that investors consider only mean and variance in making decisions under certainty.³² Notwithstanding the widespread use of the mean-variance framework, there have been a number of studies which demonstrate both conceptually and empirically the implausibility of these conditions.³³ Therefore, it seems reasonable to examine the measure of the third moment, skewness, as a possible determinant of rate of return. To reduce the complexity of the discussion, it is assumed in this section that variance is held constant, or in other words, skewness is considered as a variable for a given degree of variance.

The concept of skewness is depicted in Figure 2 which shows three hypothetical distributions, each with the same mean, but different skewness. The first is a symmetrical distribution showing the same frequency of occurrence of

³²For a discussion of the distribution of ROI, see James Tobin, "Liquidity Preference as Behavior Towards Risk," Review of Economic Studies (February, 1958), pp. 65-86.

³³For example, see Kenneth J. Arrow, Essays in the Theory of Risk-Bearing (Chicago: Markham, 1971); and S. C. Tsiang, "The Rationale of the Mean-Standard Deviation Analysis, Skewness Preference, and the Demand for Money," American Economic Review (June, 1972), pp. 354-371.

Fig. 2.--Symmetrical and skewed distributions

rates of return above the mean as below the mean. The second distribution is positively skewed with a high frequency of occurrence of rates of return below the mean and a low frequency of rates above the mean. Very high rates of return do occur but relatively infrequently. The third graph shows negative skewness where rates of return above the mean occur with high frequency and rates below with low frequency. As shown in graph C, the probability of a large negative rate of return (a capital loss) is considerably greater in the negatively skewed distribution.

The commonly hypothesized negative relationship between ROI and skewness results from emphasizing the small chances of a large capital loss or a high rate of return as depicted by the tails of the skewed distributions. Researchers have posited that risk-averse investors demand a risk premium to offset the small chance of a large capital loss and that investors will accept lower average rates of return in order to gain the small chance of a relatively high ROI. Such behavior is often described as resulting from a lottery effect whereby the investor prefers positive asymmetric distributions (like a lottery) and dislikes negatively skewed distributions.³⁴

³⁴Lotteries and insurance are discussed in Friedman and Savage, "The Utility Analysis of Choices Involving Risk."

In a frequently cited article regarding the effects of asymmetric distributions, Fred Arditti hypothesized a negative association between ROI and skewness.³⁵ He tested skewness as a determinant of ROI in a simple regression model using data for firms listed in Standard and Poor's Composite Index for the period 1946-1963. Although the regression coefficient for skewness was significant, its sign was positive, not negative as predicted. When skewness was included in a multiple regression with variance and other independent variables, the skewness variable was significant and had the hypothesized negative sign.

To study skewness as a determinant of ROI, Jeffrey Jarrett added a skewness variable to a previously developed model which related rate of return to the coefficient of variation.³⁶ While he did not perform any statistical

³⁵Fred D. Arditti, "Risk and the Required Return on Equity," Journal of Finance (March, 1967), pp. 19-36. When discussing the sign of the skewness/ROI relationship, there is a potential for confusion. Preference for positive skewness and dislike of negative skewness implies that investors expect a higher ROI in compensation for accepting negative skewness and that investors will accept a lower ROI in exchange for positive skewness. Therefore, a negative association between ROI and skewness is predicted.

³⁶Jeffrey Jarrett, "A Note on Earnings Risk and the Coefficient of Variation: Comment," Journal of Finance (December, 1970), pp. 1159-1160. The original model is from Richard P. Brief and Joel Owen, "A Note on Earnings Risk and the Coefficient of Variation," Journal of Finance (December, 1969), pp. 901-904.

tests on the added variable, Jarrett did show that when skewness is included, quite different predicted rates of return result.

Skewness was included as a variable in the Fisher and Hall study discussed above.³⁷ The authors hypothesized that skewness would have a negative sign implying negative skewness is associated with high rates of return. However, in a footnote which demonstrates the relationship in equation form, they explained that it is unclear whether the coefficient of the skewness variable is positive or negative. Their empirical results showed the coefficient of skewness to be negative but significant only at the 10 percent level.

Although not offering any rationale, Cootner and Holland implicitly accept the negative association between ROI and skewness.³⁸ In their multiple regression model which includes other risk measures, the coefficient of skewness was significant at the 1 percent level, but its sign was positive. The authors explain that this result may indicate no relation exists between ROI and skewness, but they also acknowledge the possibility of a conceptual error in the specification of the skewness variable.

Using an entirely different line of approach, Clayton

³⁷Fisher and Hall, "Risk and Corporate Rates of Return."

³⁸Cootner and Holland, "Rate of Return and Business Risk."

Alderfer and Harold Bierman conducted an experiment to test the effects of skewness on the investor.³⁹ For subjects, they used business school graduate students and company middle managers who were asked to choose between investments with similar means and variances but different skewness. The graduate students showed a strong preference for investments with high positive skewness but no chance of loss and completely avoided an investment with high negative skewness and some chance of a large loss. The business managers also showed a preference for the positively skewed investment; however, 14 percent of the sample of managers did choose the investment with high negative skewness and some chance of a large loss. The different behavior by the two groups may be explainable by a higher degree of risk-aversion on the part of the students. These results lend some support to the negative ROI/skewness hypothesis, but no firm conclusion is possible, because skewness, even coupled with variance, was insufficient to explain the choices made.

Understanding of the effects of skewness on rate of return has been considerably advanced by several recent studies which developed and tested three-moment capital

³⁹Clayton Alderfer and Harold Bierman, Jr., "Choices with Risk; Beyond the Mean and Variance," Journal of Business (July, 1970), pp. 341-353.

asset pricing models.⁴⁰ In an unpublished article, Alan Kraus and Robert Litzenberger derived such a three-parameter model by incorporating a measure of systematic (nondiversifiable) skewness into the mean-variance framework.⁴¹ To justify their hypothesis of a negative association between skewness and rate of return, the authors emphasized the argument that investors have non-increasing absolute risk-aversion (i.e., risk assets are not inferior goods) which implies preference for positive skewness.⁴² Using securities market data, Kraus and Litzenberger tested the effects of skewness on ROI and found the risk variable to be significant and to have the expected sign.

The assumption regarding non-increasing absolute risk-aversion was tested experimentally by Gordon, Paradis, and Rorke.⁴³ In a portfolio game, participants with different

⁴⁰These are basically portfolio models, and therefore, the variable definitions and data are somewhat different from those used in this study. However, the basic assumptions regarding the risk/return relationship are comparable.

⁴¹Alan Kraus and Robert H. Litzenberger, "Skewness Preference and the Valuation of Risk Assets," December, 1972. (Mimeographed.)

⁴²The sign of the skewness variable is discussed in Arrow, Essays in the Theory of Risk-Bearing; Arditti, "Risk and the Required Return on Equity"; and S. C. Tsiang, "The Rationale of the Mean-Standard Deviation Analysis."

⁴³M. J. Gordon, G. E. Paradis, and C. H. Rorke, "Experimental Evidence on Alternative Portfolio Decision Rules," American Economic Review (March, 1972), pp. 107-118.

wealth levels made consumption and investment decisions. The decision-makers' behavior was compatible with the condition of decreasing absolute risk-aversion.

Another three-parameter model has been formulated by Blaine Huntsman who predicted a negative association between ROI and skewness based on the ". . . normative and empirically appealing condition of decreasing absolute risk aversion. . . ." ⁴⁴ To test the model, Huntsman used financial and share price data stratified into four industry groups: electrical utilities, machinery, chemicals, and building materials. Skewness was found to be not statistically significant; however, this result can be explained on the basis of high correlation between the skewness and variance measures.

Despite the continued use of the two-moment, mean-variance framework, there is considerable theoretical and empirical evidence that skewness has an important effect on rate of return. Taken as a whole, the research reviewed above provides strong support for the hypothesis of a negative association between skewness and ROI.

Other measures of risk. There has been some research utilizing other ways of measuring risk. One measure, which deals with securities market prices, is based on the

⁴⁴Blaine Huntsman, "Natural Behavior Toward Risk and the Question of Value Determination," Journal of Financial and Quantitative Analysis (March, 1973), p. 336.

assumption that investors reveal their subjective assessment of risk by their willingness to invest in a company at a given earnings-price ratio. An empirical study by Ferry Allen relates company earnings-price ratios to rates of return on investment in common stock and finds no apparent relationship between ROI and business risk as measured by the earnings-price ratio.⁴⁵

Another risk measure deals with asset turnover, an activity ratio. Robert Mayer explains the rationale:

Generally speaking, the larger the proportion of fixed assets - whose value is extracted by the firm's operation only over a long period of years - the less the activity of the total. Any factor, internal or external, giving rise to expectation of an increase in the proportion of fixed assets thus tends to reduce the firm's prospective business productivity, i.e., to increase the business risk.⁴⁶

However, Mayer offers no empirical research to support his ideas.

Asset turnover as a risk measure is empirically tested by Alexander Barges. He correlates the total industry sales to total industry assets ratio with industry profit margins which provides an indirect comparison between risk and rate of return. The author concludes that ". . . the realized rates of return were higher for the low-turnover, high-risk

⁴⁵Ferry B. Allen, "The Measurement of Risk," Financial Analysts Journal (March-April, 1960), pp. 63-70.

⁴⁶Robert W. Mayer, "Analysis of Internal Risk in the Individual Firm," The Analysts Journal (November, 1959), p. 92.

industries than for the high-turnover, low-risk industries."⁴⁷ This association was, however, not statistically significant. Empirical work to date does not provide the foundation necessary to warrant the inclusion of asset turnover as a measure of risk in this study.

Conclusion. It is generally accepted that capital suppliers expect to be compensated both for the time value of money they invest and for the risk inherent in a particular project. A major problem in utilizing the idea of additional return to compensate for risk has been the measurement of the risk premium. Different measures have been suggested such as historical variation of return, skewness of the distribution of ROI, price-earnings ratio, and asset turnover.⁴⁸ Each of these measures has one or more shortcomings, and no researcher has claimed that any one of them accurately measures subjective risk. Logical reasoning coupled with the empirical studies outlined above lead to the conclusion that the best available measures of risk for use in inter-industry comparisons of ROI are inter-spatial variance and skewness of return on investment.

⁴⁷Alexander Barges, "Forecasting Returns from Industrial Investments," in Readings in Financial Management, ed. by Raymond G. Schultz (2d ed.; Scranton, Pa.: International, 1970), p. 70.

⁴⁸See Appendix I for a discussion of such other measures of risk as semi-variance and standard deviation.

Growth in Demand

Growth is often cited as being closely related to rate of return, but there is disagreement regarding the definition and measurement of the variable. This has led to confusion regarding the effects of growth on ROI regardless of how it is defined. Growth has come to symbolize success and efficiency in business management, and therefore, growth is linked with the higher rates of return associated with successful firms. The relation between growth, be it of assets or sales or another measure, and ROI can be empirically verified. However, such empirical work requires some framework for explaining the association.

That so little agreed upon theory about growth has been developed seems especially surprising in light of the importance growth apparently has for most businessmen. Listening to businessmen talk and reading the financial press, one would almost believe that growth is the central goal of most companies. William Baumol says, "I believe that to him [the businessman] sales have become an end in and of themselves."⁴⁹

An important difficulty in developing ideas pertaining to growth is that the concept means different things to different people. In its current usage, the term may apply to

⁴⁹William J. Baumol, Business Behavior, Value and Growth (New York: Macmillan, 1959), p. 46.

growth in earnings, growth of stock prices, growth in sales, expansion of assets, and increases in other measures of corporate dimensions.

Those who view growth as a type of risk usually emphasize rate of change in some measure of assets.

Adherents of this concept state that growth,

. . . increases the firm's profit opportunities, but also places it [the firm] in a more risky position. In general, the higher the rate of real investment per period . . ., the more vulnerable are firms to unfavorable contingencies.⁵⁰

Baumol links growth and risk, saying, ". . . growth is what strains the firm's entrepreneurial resources and adds to the company's risks. . . ." ⁵¹

Viewing growth as a form of risk implies the hypothesis that growth and ROI are positively related. If growth is measured by rate of increase in assets, especially fixed assets, the concept is much like the turnover measure of risk outlined above. Assuming the perception of risk mostly results from unpredictability of future returns, variability of ex post ROI is used as a measure of risk. Growth can contribute to this variability and therefore may be a determinant of risk. As a measure of risk, however,

⁵⁰Charles R. Whittlesey, Arthur M. Freedman, and Edward S. Herman, Money and Banking: Analysis and Policy (2d ed.; New York: Macmillan, 1968), p. 320.

⁵¹William J. Baumol, "Communication: On the Theory of Expansion of the Firm," American Economic Review (December, 1962), p. 1080.

variability of return is directly related to risk whereas growth is indirectly related through the variability measure.

Another theoretical framework for studying growth is built on the concept of capital as a basic resource. Since production requires the combining of these factors, growth in demand is fulfilled by increasing the quantity of the factors used. The resulting increase in demand for productive resources leads to rising resource costs, including capital costs. Since demand for capital is derived from product demand, capital demand increases as product demand increases. Different industries, of course, face different rates of product demand increases and therefore have different rates of capital demand growth.

The determinants of the rate of change in product demand and the determinants of the rate of growth in capital supply are for the most part independent, capital supply being a function of U.S. and international saving. This leads to differential growth rates for the two functions. Firms with rapidly growing product demand may find their needs for capital growing more rapidly than the increase in capital supply. In order to increase their share of available capital, the rapidly growing firms will have to bid up the price of capital (ROI) to meet their needs. This leads to the expectation that growth in demand will be positively related to rate of return.

An underlying assumption, of course, is that the

supply of capital is less than perfectly elastic. Eli Schwartz, who disagrees with this assumption, believes that the problem of corporate growth is not financial, that the cash throw-off of the corporate sector of the economy is more than enough to finance growth, and that the supply of capital is relatively elastic.⁵² Baumol sees a different situation. Noting that the sources of capital will not ordinarily supply unlimited amounts of capital to any single firm, he believes a company is usually well aware of an upper limit of available money capital.⁵³ It may be that capital is relatively elastic for corporations in general but not for individual firms or industries.

Even if total capital supply is perfectly elastic, firms experiencing rapidly growing demand may find investors requiring a growth premium. If on the average, the capital requirements of firms in an industry are growing more rapidly than capital supply, their capital needs can be met only by an increase in the proportion of investors' portfolios allocated to the industry. This undesired increase in portfolio concentration may cause investors to expect additional compensation in the form of a growth premium. In an industry where some firms are growing while others face declining demand, investors can switch capital

⁵²Eli Schwartz, "Note on a Theory of Firm Growth," Journal of Business (January, 1965), pp. 29-33.

⁵³Baumol, Business Behavior, pp. 34-35.

from one firm to another in the industry and thereby not disturb their portfolio balance.

Some earlier studies have distinguished between growth in demand resulting from general economic expansion and growth created by the development of new products. Ezra Solomon sees growth, as opposed to only expansion, as resulting from the ability of the firm to find and exploit opportunities to invest in products and projects that will increase ROI.⁵⁴ Peter Bernstein believes that, "The ability to create its own market is the strategic, the dominating and single most distinguishing characteristic of a true growth company."⁵⁵

While the distinction between growth and expansion may be appealing as a call for innovative managerial effort, it does not provide much insight into the relationship between growth and rate of return. With present accounting data there is no way growth and expansion can be separated empirically, short of defining growth as increases in ROI. Expansion would then be reflected as increases in absolute size; e.g., assets; which are not accompanied by increases in rate of return. Defining growth in this way does nothing

⁵⁴Ezra Solomon, The Theory of Financial Management (New York: Columbia University Press, 1963).

⁵⁵Peter L. Bernstein, "Growth Companies Vs. Growth Stocks," Harvard Business Review (September-October, 1956), p. 89.

to advance understanding of the determinants of ROI.

As noted above, there is no generally accepted analytical framework for the study of firm growth. Despite this lack of agreement, most authors posit a positive relationship between growth in demand and rate of return. This is an empirically verifiable relationship.

In a series of articles regarding the effects on ROI of differential growth rates, Barges distinguishes between growth and the concept of risk. The first study was primarily concerned with establishing a theory and empirically testing turnover as a measure of risk as discussed above, but the initial test of the turnover hypothesis was not as predicted.⁵⁶ Recognizing the importance of demand in determining ROI and considering the dynamic nature of demand, Barges used multiple regression techniques to hold the dynamic demand variable (growth) constant. Adding this independent variable had the result of showing a positive association between turnover and ROI, but the equation was not statistically significant. In a summary the author says:

The analysis of rates of return which was presented indicated that long-term growth in demand exerts a strong influence on the average rates of return realized by industries. This finding, of course, is not surprising, but it does serve to emphasize the point that growth rate must be given explicit consideration in any

⁵⁶Barges, "Forecasting Returns from Industrial Investments."

empirical analysis and in any realistic forecast of rates of return.⁵⁷

In the second article, an attempt was made to fill the void of empirical research into the rate of return/rate of growth relationship.⁵⁸ Regression analysis was utilized with average rate of return on assets as the dependent variable and average growth rate of demand as the independent variable. A positive association was found that was highly significant statistically. The author concludes that despite substantial variation in growth rate, growth in product demand is a significant factor in rate of return for firms and industries.

The third article used the growth variable to explain a specific industry's rate of return.⁵⁹ Following a review of the hypothesized effect of growth on capital supply, drug industry average rate of return was predicted using the average annual rate of change in demand. The article reports finding a growth premium of 3.9 percentage points over the average for all-manufacturing industries of 12.9 percent. Taken together, these empirical studies provide considerable basis for acceptance of a positive association between growth

⁵⁷Ibid., p. 70.

⁵⁸Alexander Barges, "Growth Rates and Debt Capacity," Financial Analysts Journal (January-February, 1968), pp. 100-104.

⁵⁹Barges and Hickey, "Drug Industry Profits."

in demand and ROI.

In a study emphasizing industry concentration, Ornstein included a growth in demand variable.⁶⁰ Defining return on investment as net income after taxes divided by net worth, the author found a highly significant association between ROI and growth in demand.

Another study, by William Leonard, attempted to ascertain the effects of growth and research activity on rate of return.⁶¹ When growth rate of sales was correlated with return (after taxes) on stockholders' equity, a strong association resulted ($r = .75$).

Like most unresolved issues, the relationship between ROI and growth in demand is characterized by conflicting and contradictory ideas and empirical findings. One view outlined above places growth and risk in the same category in their roles as determinants of ROI. This aspect of growth would be expected to lead to uncertainty as to receipt of future financial returns and would therefore be captured in the variability of return measure of risk. Another idea, defining growth as only resulting from acceptance of projects giving a higher than average rate of return, does little to guide empirical research. For

⁶⁰Stanley I. Ornstein, "Concentration and Profits," Journal of Business (October, 1972), pp. 519-541.

⁶¹William N. Leonard, "Research and Development in Industrial Growth," Journal of Political Economy (March-April, 1971), pp. 232-256.

one thing, there is no way of distinguishing growth from expansion using available published financial data. A third concept of the association between ROI and growth assumes different growth rates for capital demand and capital supply. It is argued that investors expect a growth premium as compensation for increasing their portfolio concentration when supplying capital to rapidly growing firms in an industry. Although some of the underlying assumptions about capital supply are debatable, this latter framework seems to be the most acceptable.

Although the concept of growth is still being debated, the expectation of a positive relation between growth in demand and return on investment is generally accepted. This is an empirically verifiable hypothesis, and in fact, several studies have led to acceptance of this positive association. There is ample evidence to justify the inclusion of a growth variable in the ROI model since to ignore growth would be to leave out a potentially useful explanatory concept.

Summary

In this chapter, two measures of risk as well as growth in demand have been discussed in their roles as investment characteristics that determine return on investment. The basic argument is that industries characterized

by relatively high inter-spatial variance of ROI, positive skewness in the distribution of return, or relatively rapid growth in demand for the companies' products, must offer compensatory rate of return premiums to attract capital. The next chapter discusses a set of industry structural characteristics which along with investment characteristics may affect rate of return on investment.

CHAPTER IV

STRUCTURAL CHARACTERISTICS

Industry structural characteristics are commonly used to explain above average rates of return.¹ Market structure analysis is used in recognition of the proposition that above average return on investment will attract new firms into a competitive industry with the ultimate effect of driving ROI down to the normal level. In other words, an above average rate of return should occur only for short periods in competitive industries. In noncompetitive theory firms are assumed to have some control over the market and consequently to have the potential of maintaining artificially high rates of return. Many believe firms exercise this potential as a matter of course, but there is no agreement on whether firms do indeed behave in such a manner.² Equally, the mode of such firm behavior may not always be readily identifiable.

¹For a recent summary of the subject of industry structure as it relates to performance, see John M. Vernon, Market Structure and Industrial Performance (Boston, Allyn, 1972).

²For a critical analysis of the extensive use of concentration ratios as indications of monopoly power, see Yale Brozen, "Significance of Profit Data for Antitrust Policy," Antitrust Bulletin (Spring, 1969), pp. 119-139.

Because of the difficulties involved in attempting to measure differences in behavior, market structure analysis usually relates structural characteristics directly to rate of return. Joe Bain, who has done extensive market structure research, asserts that:

. . . market conduct cannot be fully enough measured to permit us to establish empirically a meaningful association either between market conduct and performance, or between structure and market conduct. It thus becomes expedient to test directly for net association of market structure to market performance, leaving the detailed character of the implied linkage of conduct substantially unascertained.³

Industry Concentration

A widely used industry structural characteristic is the concentration ratio which measures the percent of an industry's economic activity accounted for by a specified number of its largest companies. With economic activity measured by sales, employment, value added, or assets, the higher the percent of total activity controlled by a small number of companies, the greater the assumed potential for maintaining above normal rates of return.

The main source of data for determining concentration ratios is the Census Bureau, but these census data have

³Joe S. Bain, Industrial Organization (New York: Wiley, 1959), pp. 326-327.

well-known deficiencies.⁴ In particular, the industry definitions often result in poorly delineated markets. For some industries the data are too broad to represent the relevant geographical or product market. For other industries where there are close product substitutes, the data are too limited. Also, these national data are not representative of localized industries such as bakeries. Despite these problems, census data are widely used because of their availability and widespread familiarity.

There have been a number of studies concerned with the relationship between industry ROI and the degree of concentration. One of the earliest was by Bain for the years 1936-1940.⁵ Using return after taxes to equity and eight-firm concentration ratios, he did not find a close relationship between ROI and concentration. However, the industries with eight-firm concentration ratios above 70 percent did tend to have high average rates of return.

Recently Bain's study was replicated by Yale Brozen using more recent data.⁶ Brozen's research indicated that

⁴U.S., Bureau of the Census, Census of Manufacturers, 1967, Vol. 1, Summary and Subject Statistics (Washington, D.C.: Government Printing Office, 1971). The limitations of concentration ratios are discussed in Jules Backman, Advertising and Competition (New York: NYU Press, 1967), pp. 83-86.

⁵Joe S. Bain, "Relation of Profit Rates to Industry Concentration," Quarterly Journal of Economics (August, 1951), pp. 293-324.

⁶Yale Brozen, "Bain's Concentration and Rates of Return Revisited," Journal of Law and Economics (October, 1971), pp. 351-370.

Bain's study may have been biased by inclusion of only large firms which tended to have high rates of return. If Bain's industry sample was biased, the association he found between above average ROI and the concentrated group of industries is open to question. Brozen's results using more recent data failed to confirm Bain's conclusion that high rates of return result from concentration.

A well-known study by George Stigler related concentration to rate of return on total assets.⁷ By using various cut-off levels, he divided three-digit SIC industries into concentrated and unconcentrated groups. The hypothesis of a significant association between ROI and concentration ratio was not confirmed. However, partly because of the high level of aggregation (three-digit SIC level), his results were ambiguous.⁸

Using a multiple regression model, Marshall Hall and Leonard Weiss related several variables, including the concentration ratio, to two measures of ROI: income after taxes to book equity and income after taxes to total assets.⁹

⁷George J. Stigler, Capital and Rates of Return in Manufacturing Industries (Princeton: Princeton University Press, 1963).

⁸For a discussion of the problems of using data that are aggregated above the four-digit SIC level, see Lester G. Telser, "Advertising and Competition," Journal of Political Economy (December, 1964), pp. 537-562.

⁹Marshall Hall and Leonard Weiss, "Firm Size and Profitability," Review of Economics and Statistics (August, 1967), pp. 319-331.

Concentration, measured by four-firm ratios, was a statistically significant determinant of ROI, but its influence on rate of return was less important than that of company size, a possible capital barrier to entry.

Considering these ambiguous results from studies relating concentration ratios to ROI, the conclusion that concentration and performance are positively related can be only weakly accepted at best. Concentration ratios may be useful as substitute measures for company behavior which determines performance. The ratios, however, really measure only the potential for market control. As a consequence, additional information can be gained by studying the possible barriers to entry that are erected and maintained by firms in a noncompetitive industry. Therefore, it seems prudent to couple the concentration variable with measures of possible barriers to entry such as the advertising to sales ratio, average company size, and research and development intensity.

Research and Development Intensity

As a determinant of ROI, research and development (R&D) can be considered in two ways: 1) R&D activity may or may not produce a marketable or patentable product, and therefore, such activity is uncertain as to return, or risky; 2) Past and present R&D expenditures produce

knowledge and techniques which give the existing firms in an industry an advantage over prospective entrants, and as a result, R&D outlays can be a barrier to entry. R&D intensity is a measure of the amount of research and development input in relation to output, with a commonly used figure being R&D expenditures as a percent of sales.

Research and development can be an ambiguous concept. Here the term refers to those outlays for materials, facilities, and wages with the ultimate goal of producing new products or more efficient production techniques. R&D can be separated into basic research where there is no well-defined goal in terms of products or techniques, and development where a specific product or technique is being perfected into an economically feasible output. In reporting financial data, companies lump development expense and outlays for basic research together as R&D expenditures.¹⁰

Research and development activity is often associated with risky ventures because the return from R&D expenditures is uncertain. This is explained by one author who says that research is undersupported because of the uncertainty involved, ". . . uncertainty as to income in general and as

¹⁰Another problem is that for diversified companies R&D expenditures are not broken out by product area. For example, ethical drug companies' R&D figures include outlays for research related to non-drug products as well as for drug research.

to the ability of the sponsoring firm to exploit a specific discovery."¹¹ The authors of an article pertaining to the aerospace industry express a similar view:

Concerning total risk, it is obvious that the greater the percentage of any firm's business which involves research and development the higher the total risk. Production work is not as risky since past experience can be more easily applied as a yardstick to estimate future performance regarding quality, timing, and costs.¹²

This view leads to the conclusion that R&D outlays constitute a special type of risk, and therefore, R&D intensity and ROI should be positively related in the same manner as risk and ROI.

When the uncertainty related to R&D outlays is considered, the similar effects of expenditures on research and increasing production to fulfill growth in demand become apparent. These effects are not the same as general business risk, however, because management consciously subjects the firm's future earnings to this uncertainty. Consequently, the degree of uncertainty can be controlled to some extent by limiting growth or research activity.

A second way of relating R&D intensity and ROI utilizes the concept of market power. Extensive research

¹¹Daniel Hamberg, R&D Essays on the Economics of Research and Development (New York: Random, 1966), p. 23.

¹²Aerospace Research Center, Aerospace Profits Vs. Risks (Washington, D.C.: Aerospace Industries Association of America, 1971), p. 2.

and development activity, especially coupled with the patent privilege, can create products and productive processes that cannot be duplicated or matched by other firms, particularly by prospective entrants into an industry. Thus, R&D outlays are a possible barrier to competitive entry. For example, Hugh Walker describes how this may be very important to ethical drug manufacturers:

The principal sources of market power are the peculiar protection enjoyed by drug manufacturers because of the brand names used in the ethical drug industry and the provision of patent protection for the more recently introduced drugs. Brand names and patent protection permit firms to charge prices which are very much higher than the prices that would exist in the absence of market power.¹³

Some view the market power and economic rewards accruing from R&D activity as completely compatible with a competitive system. R&D expenditures are characterized as capital attracted by the potential for above average rates of return. It is argued that the market power given by patents was consciously created to generate just such research activity. For example, Jesse Markham states:

The drug industry's record of profits and expenditures for research and development suggests that the private interests of the individual drug firms and the public interest are served compatibly by the search for new and improved drugs. . . . Competition through vigorous inventive effort has also been highly profitable, keeping the ethical

¹³Hugh D. Walker, Market Power and Price Levels in the Ethical Drug Industry (Bloomington: Indiana University Press, 1971), p. 3.

drug industry among the top three most profitable industries. . . .¹⁴

There are, then, two views of the effects of R&D expenditures as a source of market power. One holds that this potential for some market control leads to socially desirable research, that firms compete to do this research in order to obtain the reward of a higher rate of return. The other sees patents and other aspects of market control arising from R&D activity as an undesirable means of holding rates of return above competitive levels. Both views predict that relatively high R&D intensity will be associated with higher than average ROI.

There has been only limited empirical research relating R&D intensity to ROI. Such research has been greatly hampered by the almost total lack of data for individual companies and limited industry data. The main data source, the National Science Foundation (NSF), publishes industry R&D figures at the two- and three-digit SIC levels, but such highly aggregated figures are of only limited value for studying industry ROI.¹⁵ Also, the NSF reports are incomplete in that data for various years and

¹⁴Jesse W. Markham, "Economic Incentives and Progress in the Drug Industry," in Drugs in Our Society, ed. by Paul Talahay (Baltimore: Johns Hopkins Press, 1964), pp. 175-176.

¹⁵U.S., National Science Foundation, Research and Development in Industry, 1970 (Washington, D.C.: Government Printing Office, 1971).

industries are missing. Only limited R&D information is obtainable from annual reports and such reference sources as Moody's Manuals.¹⁶

Of the few empirical studies, most find a significant, but weak, positive relationship between ROI and R&D intensity. The first of two such studies by William Leonard related growth rate of R&D intensity to growth rates of sales, assets, and net income.¹⁷ R&D intensity was measured by research expenditures as a percent of sales and by the number of research scientists and engineers per 1000 employees. Using a sample of sixteen manufacturing industries, Leonard found a significant correlation between growth in R&D intensity and change in both sales and assets. However, the correlation with growth in net income after taxes was not significant, although it was positive as predicted.

A second, unpublished, study by Leonard concerned the effects of market structure, especially R&D intensity as a barrier to entry, on rates of return.¹⁸ The correlation between return after taxes on stockholders' investment

¹⁶Moody's Industrial Manuals (New York: Moody's Investors Services, Inc., 1963-1971).

¹⁷William N. Leonard, "Research and Development in Industrial Growth," Journal of Political Economy (March-April, 1971), pp. 232-256.

¹⁸William N. Leonard, "Significance to the Pharmaceutical Industry of the Article 'R&D, Product Differentiation and Market Performance,'" Hempstead, N.Y., June 2, 1971. (Typewritten.)

and R&D expenditures as a percent of sales was .80 for the period 1960-1969.

In two studies, Edwin Mansfield found some support for a significant relation between ROI and R&D expenditures. One of his articles related research and development outlays as a percent of sales to rates of return for industries where direct government financing is limited (e.g., chemicals, petroleum, drugs, glass, and steel).¹⁹ Although his empirical results lend some support to the hypothesis of a positive R&D/ROI association, the results are hardly conclusive. There was little evidence to support the related hypothesis that larger companies spend a higher percentage of sales on R&D than do smaller firms.

Instead of relating R&D intensity to ROI, Mansfield attempted to calculate the marginal rate of return from R&D expenditures in his second study.²⁰ Using a series of simplifying assumptions, he estimated very high marginal rates of return on R&D outlays for ten petroleum and chemical firms. For example, the petroleum sample's average rate was about 40 to 60 percent a year for the period 1946-1962.

¹⁹ Edwin Mansfield, "Industrial Research and Development Expenditures," Journal of Political Economy (August, 1964), pp. 319-340.

²⁰ Edwin Mansfield, "Rates of Return from Industrial Research and Development," Papers and Proceedings of the Seventy-Seventh Annual Meeting of the American Economic Association (Chicago, 1964), pp. 310-322.

Although Mansfield's results are not very precise and should be treated cautiously, they suggest that firms with high R&D intensity should exhibit high rates of return on investment.²¹

Jora Minasian has also calculated marginal rates of return from research and development expenditures.²² Using 1948-1957 data for a sample of seventeen chemical firms, Minasian found an average rate of return on gross investment of 9 percent while the return on research expenditures was 54 percent.

Although not conclusive, the statistical evidence reinforces the expectation of a positive association between R&D intensity and ROI. The most likely explanation for this association is that research and development activity gives existing firms in an industry an advantage over prospective entrants. Uncertainty regarding the return from R&D outlays adds to the hesitancy of new firms in entering the industry.

Company Size

When the effects of imperfect competition on ROI are

²¹For a summary article on research and development activity and its effects on rates of return, see Edwin Mansfield, "Industrial Research and Development: Characteristics, Costs, and Diffusion of Results," Papers and Proceedings of the Eighty-First Annual Meeting of the American Economic Association (Chicago, 1968), pp. 65-71.

²²Jora R. Minasian, "Research and Development, Production Functions, and Rates of Return," Papers and Proceedings of the Eighty-First Annual Meeting of the American Economic Association (Chicago, 1968), pp. 80-85.

being considered, firm size is often cited as a possible barrier to entry. Prospective entrants may be reluctant to join an industry where a large minimum amount of capital is necessary to start production. Explaining the relationship between size and rate of return, Baumol says,

. . . increased money capital will not only increase the total profits of the firm, but because it puts the firm in a higher echelon of imperfectly competing capital groups, it may very well also increase its earnings per dollar of investment. . . .²³

There have been a number of empirical studies that test the hypothesis of a positive association between average firm size and average industry rate of return. For example, Roger Sherman and Robert Tollison added average firm size to the Fisher and Hall model described above.²⁴ They found the association between size, measured by averaging 1957 and 1964 total assets, and income after taxes to net worth to be significant and positive. However, when a risk variable (variance of return) was added to the regression, the size/ROI relation became not significant.²⁵

²³William J. Baumol, Business Behavior, Value and Growth (New York: Macmillan, 1959), p. 33.

²⁴Roger Sherman and Robert Tollison, "Technology, Profit Risk, and Assessments of Market Performance," Quarterly Journal of Economics (August, 1972), pp. 448-462. The original model is described in I. N. Fisher and G. R. Hall, "Risk and Corporate Rates of Return," Quarterly Journal of Economics (February, 1969), pp. 79-92.

²⁵The problems that complicate interpretation of variance as discussed above preclude any meaningful conclusions about this result.

The proper accounting figure to use as a size measure has been discussed by Hall and Weiss. In explaining their definition, the reciprocal of the logarithm of total assets, the authors argue that, "assets are superior to equity . . . because it is the size of the total lump of capital, however financed, that determines the opportunities available to the firm."²⁶ Use of the logarithmic form is based on their assumption that raising an additional percentage of assets is more nearly comparable between firms of disparate size than the difficulty of raising an additional absolute amount of capital. The authors chose the reciprocal as they believed a larger firm finds it easier to raise an additional percentage of assets than does a smaller firm. With either of two ROI measures, income after taxes to net worth or income after taxes to assets, the regression coefficient for the size variable was significant and positive as hypothesized.

In an intra-industry comparison of ROI and size, Malitzahu Marcus found only a weak association.²⁷ Although his definitions for ROI (income before taxes to net assets) and for size (net assets) are not unusual, Marcus' study

²⁶Hall and Weiss, "Firm Size and Profitability," p. 322.

²⁷Malitzahu Marcus, "Profitability and Size of Firm: Some Further Evidence," Review of Economics and Statistics (February, 1969), pp. 104-107.

is unique in its use of intra-industry data since most studies relate size and rate of return by industry rather than by firm. The weak results indicate there is little association between ROI and size within industries.

The evidence is sufficient to conclude that firm size may very well be a significant determinant of ROI. Although the best means of measuring size is the subject of continued debate, any one of the commonly used asset measures seems to exhibit a positive association with rate of return.

Advertising and Promotional Intensity

Advertising and other promotional activity can be such an important determinant of sales that a company with a well-established marketing program may have significant advantages over potential competitors. High advertising and promotional intensity may, therefore, be a barrier to entry.

There have been a number of studies relating advertising and rate of return, including a well-known report by William Comanor and Thomas Wilson.²⁸ Using a regression equation with income after taxes to net worth as the

²⁸William S. Comanor and Thomas Wilson, "Advertising, Market Structure, and Performance," Review of Economics and Statistics (November, 1967), pp. 423-440.

dependent variable and the advertising to sales ratio as one of the independent variables, the authors identified advertising as a significant explanatory variable. This reinforces the belief that extensive advertising can be an important barrier to entry.

Whereas Comanor and Wilson used a consumer goods industry sample, Richard Miller conducted a similar study but included both consumer and producer goods industries.²⁹ His results also confirm a significant positive association between advertising intensity and rate of return.

A monograph by Jules Backman attempted to test the claim that intensive advertising can lead to anti-competitive behavior and above normal rates of return. In reporting the empirical results, he says:

Intensive advertising tends to be accompanied by higher reported profit rates. However, the difference in return among companies with varying rates of advertising intensity tends to be moderate.³⁰

Backman suggests that the effects of advertising cannot be separated from other ROI determinants such as R&D intensity, growth in demand, or risk, and therefore, these variables must be considered together.

A researcher who has written extensively about advertising is critical of accepting the belief that advertising leads to monopoly power. Lester Telser states:

²⁹Richard A. Miller, "Market Structure and Industrial Performance," Journal of Industrial Economics (April, 1969), pp. 104-118.

³⁰Backman, Advertising and Competition, p. 154.

Everyone knows the contention that advertising is a source of monopoly and, therefore, expects a positive association between the two. But intensive advertising is often an instrument of competition as well. The entry of new firms and the offering of new brands is frequently accompanied by high advertising expenditures. Hence advertising can enhance competition. Even if advertising does reduce competition in some cases, it can increase it in others. The net effect reveals itself by the absence of a dependable relation between the advertising and the concentration ratios.³¹

The controversy goes on as to whether advertising creates monopoly and ultimately leads to higher than competitive rates of return. As stated above by Telser, no dependable relation between advertising and concentration has been established. Apparently there is a significant, positive association between advertising and ROI, but the linkage between the two is not clear.

Another thorny problem is the question of causality, since regression and correlation cannot establish the direction of cause and effect. It is possible that a positive relation exists between advertising and ROI because a high rate of return provides the financing to utilize intensive advertising. Comanor and Wilson, who explicitly review this question, offer arguments supportive of the conclusion that the direction of causality is from advertising to rate of return.³²

³¹Lester G. Telser, "Another Look at Advertising and Concentration," Journal of Industrial Economics (November, 1969), p. 94.

³²Comanor and Wilson, "Advertising, Market Structure, and Performance," p. 437.

Multicollinearity and Interaction

In the studies cited above there are numerous statements suggesting interaction among the determinants of ROI. Growth in demand and R&D activity both may contribute to variability of return, a measure of risk; advertising and promotional intensity may be correlated with the concentration ratio; several of the variables may be closely related to company size. Multicollinearity among independent variables can cause a variable that is significant as a determinant of ROI by itself to become not significant when included with other independent variables.

Interaction among the determinants may have important effects on rates of return, and these effects may be more than just additive. High growth in demand coupled with high risk might result in extremely high rates of return as investors demand to be compensated for this unique combination of investment characteristics. Similar results could be forthcoming if high R&D intensity and high minimum size are combined, in this case because of the potential for market control. These examples, of course, are merely indicative of the many combinations that might occur.

Summary

Two types of ROI determinants have been identified--investment characteristics and structural characteristics.

In Chapter III, investment characteristics including risk and growth in demand were discussed along with an explanation of how these determinants of ROI could lead to above normal rates of return even in a competitive industry.

The structural characteristics, discussed in this chapter, are measures of market power which also may determine rate of return. Of the structural characteristics, the concentration ratio is an indication of potential market control while R&D intensity, company size, and advertising intensity are measures of possible barriers to competitive entry.

There may be other determinants of ROI than the ones considered here. However, with the concepts developed to date and with the available data, it is unlikely that the inclusion of more variables in the ROI model would provide much additional information. Most likely the added variables would be closely related statistically to the ones already discussed.

The methodology of this study is to combine as many of the determinants of ROI as possible into a multiple regression model and to evaluate their individual and joint effects on ROI. The next chapter explicitly defines each of the variables, describes the model, and discusses the hypotheses the model is designed to test.

C H A P T E R V

A RETURN ON INVESTMENT MODEL

The ROI model developed in this chapter is designed to determine if the ethical drug industry's relatively high rate of return can be explained statistically. Objective testing of the hypothesized relationships between ROI and its determinants is facilitated by the use of a symbolic model.

Hypotheses

The initial set of hypotheses concerns the relationship between ROI and each of the determinants of return. In this study, a positive association between rate of return and each of the investment and structural characteristics is hypothesized.

Once these relationships have been tested, the central question regarding the drug industry's rate of return can be considered. The hypothesis is that ethical drug industry average return on investment is the same as all-manufacturing industries' average return on investment after consideration of investment and structural characteristics.

General Form

To test the hypotheses regarding the association

between ROI and each of the determinants of ROI, a simple, linear, least-squares regression model is used of the form:

$$Y = B_0 + B_1X_1 + e$$

where Y is ROI, B_0 the intercept term, B_1 the coefficient for the independent variable, X_1 the independent variable, and e the error term. The error term indicates the degree of variation of individual observations around the regression line. Using data for each independent variable in turn, statistical techniques including t and F tests are exploited to evaluate the resulting equations. These statistical results, along with the logical arguments presented in Chapters III and IV, are used to specify the variables included in the final ROI model.

The model of return on investment is a cross-sectional, least-squares, multiple regression equation with ROI as the dependent variable and a series of investment and structural characteristics for independent variables. Expressed symbolically, the model is

$$Y = B_0 + B_1X_1 + B_2X_2 + \dots + B_nX_n + e$$

As in the simple regression model, Y is ROI, B_0 the intercept, B_n the coefficients of the independent variables, X_n the independent variables, and e the error term.

The intercept term, B_0 , has special economic significance since it can be interpreted as a rate of return

after consideration of investment and structural characteristics. The influence of these characteristics on ROI is, of course, measured by their respective regression coefficients. As an adjusted rate of return, B_0 can be compared to rates of return from investment in certain government securities which are assumed to be unaffected by the type of investment and structural characteristics associated with the independent variables.

Definition of the Variables

In this section each of the variables identified as a possible determinant of ROI is defined. The first three explanatory variables (variance, skewness, and growth) are investment characteristics, while the other four (concentration ratio, R&D intensity, company size, and advertising intensity) are structural characteristics.

Use of data for only one year in the cross-sectional model would tie the results to the unique economic characteristics of that year, and attempts to generalize such results would be of questionable validity. Therefore, data over several years are averaged to give a single figure for each variable for each industry. Unless otherwise noted, the time period, t , is nine years for each variable;¹ n ,

¹For some companies, R&D expenditures are not reported for all nine years. In those cases, R&D intensity is computed from the data for the years reported. The number of years, t , then becomes less than nine.

the number of companies, is four to twelve per four-digit SIC industry;² X is an observation on ROI for one company in one year.

Return on investment. With the goal of making inter-industry comparisons in mind, ROI is defined as net income after taxes (NI) divided by net worth (NW). Each observation is as follows:

$$\text{Industry Average ROI} = \frac{1}{t} \sum \frac{1}{n} \sum \text{NI/NW}$$

Net income after taxes divided by net worth is used in the expectation that competitive entry and exit of firms would bring this figure towards equality. Net worth is used in the denominator because it is rate of return on equity which managers should seek to maximize if they are acting in the stockholders' best interests. Even under pure competition, it would not be expected that diverse industries would have equal rates of return on assets because of different capital structures. For example, if banks, with their very high debt ratios, earned the same rate of return on assets as manufacturing firms, the banks would have extremely high rates of return on equity. Therefore, it is expected that in competitive long-run equilibrium, rate of return on equity would tend to be equalized.

²Table 10 in Appendix II lists the industries with the number of companies in each.

It was noted in Chapter II that there is disagreement among researchers regarding the effects of capital structure on ROI and on the risk/return relationship. To evaluate the possibility that using return on net worth biases the relationship between ROI and the risk measure, two alternative configurations of the regression model are tested. First, the ROI variable is redefined as rate of return on net book assets which gives a return figure not affected by financial leverage. Second, the ratio of total debt to total assets is added to the regression equation with ROI defined as return on net worth.

Variance. Two measures of risk are incorporated into the model. The first is average variance of individual company rates of return around the industry mean averaged over time:³

$$\text{Industry Average Variance} = \frac{1}{t} \sum \frac{\sum (X - \bar{X})^2}{n-1}$$

This is an inter-spatial measure of variance of return. The denominator of the variance formula is one less than the number of firms in the industry (n-1) to adjust for the small sample sizes.⁴

³See Appendix I for additional discussion of the use of variance as a measure of risk.

⁴The number of companies per industry ranges from four to twelve.

Since squared deviations give greater weight to extreme values, it is possible that variance may be a biased risk measure when applied to industries with relatively high variability of return. Bias could be present for individual industries even though variance and standard deviation as measures of risk are highly correlated for an all-manufacturing industries sample.⁵ To test for the possible existence of bias, the standard deviation is substituted for variance in the final equation and the results evaluated.

A positive association between ROI and variability of return is hypothesized under the assumption that the higher the ex post variability of return, the greater the uncertainty associated with the return. Risk-averse investors are assumed to dislike uncertainty and, therefore, to expect a higher rate of return to offset the uncertainty.

Skewness. The second risk variable is skewness, measured by a dummy variable to eliminate the difficulties of interpreting the units of the skewness variable.⁶ In any case, the hypothesis only relates to the sign of the skewness measure, not to its value. To compute skewness requires finding the second and third moments, m_2 and m_3 ,

⁵See Appendix I for evidence of the degree of correlation between standard deviation and variance.

⁶For a brief discussion of the ambiguities inherent in calculating and interpreting values for the coefficient of skewness, see Samuel B. Richmond, Statistical Analysis (New York: Ronald, 1964), pp. 73-76, 90-95.

respectively, of the distribution of ROI:

$$m_2 = \frac{\sum (X - \bar{X})^2}{n-1}$$

$$m_3 = \frac{\sum (X - \bar{X})^3}{n-1}$$

The coefficient of skewness, B, is the ratio of the third moment squared to the second moment cubed:

$$B = \frac{(m_3)^2}{(m_2)^3}$$

Therefore,

$$\text{Industry Average Skewness} = \frac{1}{t} \sum B$$

Each industry is assigned a dummy variable with a value of 0, 1, or 2 corresponding to an average coefficient of skewness that is positive, zero, or negative.⁷ As explained in Chapter III, investors are presumed to like positive skewness and dislike negative skewness which implies a negative ROI/skewness relationship. By assigning a higher number (2) to negative skewness and a lower number (0) to positive skewness, a positive association is predicted between ROI and the dummy skewness variable.

⁷For a discussion regarding the use of dummy variables, see Daniel B. Suits, "Use of Dummy Variables in Regression Equations," Journal of the American Statistical Association (December, 1957), pp. 548-551.

Growth in demand. As growth is a time concept, a cross-sectional study requires the averaging of annual rates of growth in demand for individual firms. Annual company rates are calculated by fitting a least-squares trend line to company sales over time to find the slope (S). The industry figure is,

$$\text{Industry Average Growth} = \frac{1}{n} \sum S$$

The predicted positive association between ROI and growth in demand is based on the following rationale: When the firms in an industry experience more rapid growth in capital requirements than growth in capital supply, they must bid up ROI to attract the desired capital. This growth premium is required by investors to compensate for the costs associated with increasing the proportion of their portfolios allocated to firms in the rapidly growing industry. A growth premium would be required also, to the extent investors associate above average growth with future uncertainty.

Industry concentration. Concentration is measured by Bureau of the Census, four-digit SIC industry concentration ratios (CR). Three different sets of ratios are used: four- and eight-firm ratios based on value added in manufacture and four-firm ratios of total employees. In several cases the industries used are defined slightly

differently in the data source (Standard and Poor's Compustat Tape) than the industries in the Bureau of the Census data.⁸ To obtain concentration ratios for these industries, a technique suggested by Stigler is used whereby the desired ratios are calculated by combining industries using industry value added as weights.⁹

A positive association between ROI and concentration ratio is hypothesized based on the rationale that the potential for market control is greater in a concentrated industry. Exercise of this potential is expected to lead to artificially high rates of return.

Research and Development Intensity. The measure for R&D intensity is average company R&D expenditures divided by company net sales in each time period (R&D/S). The form of the variable is,

$$\text{Industry Average R\&D Intensity} = \frac{1}{t} \sum \frac{1}{n} \sum \text{R\&D/S}$$

Company R&D expenditures are used because R&D outlays are reported in this manner in the data source. For inter-industry comparisons, company outlays seem to be the proper figure as opposed to total industry R&D expenditures since

⁸U.S., Bureau of the Census, Census of Manufacturers, 1967, Vol. 1, Summary and Subject Statistics (Washington, D.C.: Government Printing Office, 1971).

⁹George J. Stigler, Capital and Rates of Return in Manufacturing Industries (Princeton: Princeton University Press, 1963), pp. 206-211.

the latter figure includes government outlays.

R&D intensity is expected to be positively associated with rate of return on the assumption that research activity can create a barrier to entry allowing existing firms to insulate themselves from potential competitors. This situation could result in artificially high rates of return.

Company size. Size, which may represent a capital barrier to entry, is measured as total assets less accumulated depreciation (TA). Two configurations are considered: absolute total assets in dollars and the logarithm to the base ten of total assets. The hypothesis of a positive association between ROI and each of these size measures derives from size being a possible barrier to competitive entry. The form of the variable is,

$$\text{Industry Average Company Size} = \frac{1}{t} \sum \frac{1}{n} \sum \text{TA}$$

Use of the logarithmic form is based on the assumption that raising an additional percentage of assets is more nearly comparable between firms of disparate size than the difficulty of raising an absolute amount of capital.

Advertising and Promotional Intensity. This possible ROI determinant is measured by the ratio of company advertising and promotional expense to company sales (AE/S):

$$\text{Industry Average Advertising and Promotional Intensity} = \frac{1}{t} \sum \frac{1}{n} \sum AE/S$$

Many companies do not report advertising and promotional expenses as a separate item but lump these outlays with general and administrative expense.

The regression model does not include an advertising intensity variable, in part because of the ambiguous results of other studies, but more importantly, only about 10 percent of the sample of firms taken from the Compustat Tape included data on advertising and promotional expense.¹⁰

It was decided that the addition of data from a different sample of firms to get an average advertising intensity figure for each industry would lead to interpretational problems.

Multicollinearity

Two methods are used to evaluate the extent of multicollinearity among the ROI determinants used in the model. The first is to study the partial correlation coefficients. The second method uses correlation techniques: certain determinants of ROI are picked for use as the dependent variable with other determinants as independent variables in a regression equation. Particular

¹⁰See Chapter IV for a review of prior research regarding the association between ROI and advertising intensity.

combinations are based on the logical associations discussed in Chapters III and IV. For instance, some researchers have suggested that growth in demand and R&D intensity are related to ROI because investments with high growth rates or high R&D intensity are riskier than investments without these characteristics. Therefore, the risk measure, variance of return, is used as the dependent variable with growth in demand and R&D intensity as independent variables.

A second test uses the concentration ratio as the dependent variable with R&D intensity and company size as independent variables. This combination relates the concentration ratio as a measure of potential market power to two measures of possible barriers to entry.

The correlations calculated using these combinations of structural and investment characteristics help to explain why some of the variables are not statistically significant and help also in the evaluation of whether R&D intensity and growth in demand are in fact alternative risk measures.

Summary

A cross-sectional, multiple regression model was formulated in this chapter which relates ROI to interspatial variance of return, skewness of return, growth in demand, concentration ratio, R&D intensity, and company size. Each of these investment and structural characteristics

was defined explicitly using a rationale developed by logical reasoning and a review of prior research.

The hypothesized relationships between rate of return and each of these possible ROI determinants are tested in Chapter VI leading to a final model of return on investment which is used to study ethical drug industry ROI.

CHAPTER VI

TESTING AND USING THE MODEL

One purpose of developing a model of ROI is to provide a means of testing statistically hypotheses regarding industry rates of return. The model described in the previous chapter is used to compare ethical drug industry ROI with the rate of return for a sample of other manufacturing industries.

Before using the model to study the drug industry, it is necessary to test statistically the significance of the industry's apparent high rate of return. Second, the significance of the model's components must be tested and evaluated. The entire model is then evaluated using various statistical methods and using the aerospace industry in a test run. The final step is to forecast ethical drug industry ROI and compare the result with the observed rate.

Hypotheses

The main hypothesis is that ethical drug industry average return on investment is the same as all-manufacturing industries average return on investment after consideration of the determinants of ROI. Use of these determinants in the model requires acceptance of the hypothesis that there is a significant positive association between ROI and each

of the six determinants which are measured by variance of return, skewness of return, growth in demand, concentration ratio, R&D intensity, and company size.¹

Data

Book value data were obtained from Standard and Poor's Compustat Tape for a random sample of 350 companies grouped into 41 manufacturing industries. Elimination of all industries containing fewer than four companies resulted in a sample of 145 companies in 23 industries.² For each company, the observations were then adjusted for mergers and acquisitions and transformed into the measures of the ROI determinants.³ Industry concentration ratios were taken from the 1967 Census of Manufacturers.⁴

¹Throughout this chapter, any relationship termed significant refers to its being statistically significant.

²See Appendix II for a list of the industries along with their SIC numbers and the number of companies in each industry. Industries with fewer than 4 companies were eliminated to lessen the statistical effects of extremely small industry samples.

³Adjustments for mergers and acquisitions were made to the extent the data for making such adjustments were reported in Moody's Industrial Manuals (New York: Moody's Investors Services, Inc., 1963-1971). A number of companies were eliminated because there were insufficient adjustment data available.

⁴U.S., Bureau of the Census, Census of Manufacturers, 1967, Vol. 1, Summary and Subject Statistics (Washington, D.C.: Government Printing Office, 1971).

Rates of Return

When rates of return are compared without holding the ROI determinants constant, average rate of return for the ethical drug industry is significantly higher than for the all-manufacturing sample. This relationship is depicted in Figure 3 by plotting all-manufacturing ROI along with the least-squares trend line for the years 1963-1971.⁵ As the trend line is calculated from a sample, it is necessary to establish a confidence interval for the trend line.⁶ The equation for the boundaries of the confidence interval is

$$Y = B_0 + B_1X_1 \pm tS$$

where B_0 is the Y intercept, B_1 is the slope of the trend line, X_1 denotes time, t is the student's t value, and S is the standard error of the trend line. Ethical drug industry ROI is then plotted with the least-squares trend line for the same time period.⁷

The drug industry observations and their trend line

⁵The data are listed in Appendix II. The all-manufacturing sample does not include the ethical drug industry.

⁶For an explanation of this technique, see Samuel B. Richmond, Statistical Analysis (2d ed.; New York: Ronald, 1964), pp. 188-190; and Arthur S. Goldberger, Econometric Theory (New York: Wiley, 1964), p. 179.

⁷The companies in the ethical drug industry sample are listed in Appendix II.

Fig. 3.--Rates of return--ethical drug industry and all-manufacturing industries.

are above the upper boundary of the all-manufacturing confidence interval; this establishes that before consideration of the ROI determinants, ethical drug industry average rate of return is significantly higher than all-manufacturing industries average ROI. The trend lines for the two samples are roughly parallel and have a negative slope over the nine years. This coordinated movement of the rates of return indicates that ROI for the drug industry is affected by cyclical change in about the same way as that of manufacturing industries in general. Because the time span is relatively short, no meaningful interpretation of the negative slope is possible.⁸

Regression Results

The first step in attempting to establish the determinants of ROI as significant explanatory variables is to use each individually in a simple linear regression. In this way, the regression coefficient of each of the variables and the summary statistics in Table 4 are calculated.⁹

In the simple regression runs, skewness and growth are significant; none of the other variables is significant; and only variance and R&D intensity have the hypothesized positive

⁸The years 1963-1971 roughly cover one business cycle. To interpret the meaning of the negative slope would require at least several cycles and preferably more.

⁹The regression data are listed in Appendix II.

TABLE 4
STATISTICAL RESULTS--SIMPLE REGRESSION

Independent Variable	R	F Test	t Test	(D.F.)	Level of Significance
Variance	.28	1.69	1.31	20	Not Significant
Skewness	.43	4.61	2.15	20	.05
Growth	.60	11.45	3.39	20	.01
R&D Intensity	.12	0.20	0.45	15	Not Significant
Size:					
Total Assets	.08	0.12	0.35	20	Not Significant & Negative
Log ₁₀ Total Assets	.07	0.11	0.32	20	Not Significant & Negative
Concentration Ratio:					
4-Firm Value Added	.05	0.04	0.20	20	Not Significant & Negative
8-Firm Value Added	.02	0.01	0.10	20	Not Significant & Negative
4-Firm Total Employees	.33	2.39	1.55	20	Not Significant & Negative

sign. Although not quite significant, the t value for variance is sufficiently high to indicate that this variable is a potentially useful explanatory variable for ROI. Of the remaining variables including R&D intensity, size, and concentration ratio, only the 4-firm total employees measure of the concentration ratio has any indication of potential significance; however, its coefficient has the wrong sign. Although the discussion of these regression results is deferred until later, it should be noted here that a non-significant variable in a simple regression equation may become significant when included with other independent variables.

The next stage in evaluating the significance of the ROI determinants is to test the six measures together in a multiple regression model. For the first run, only the 17 industries with R&D intensity data are included.¹⁰

As summarized in Table 5, the statistical results indicate that only skewness is significant. Again, the t statistic for variance is sufficiently high to indicate at least potential explanatory value. Growth, a significant variable in the previous run, is not significant in this multiple regression; however, it does have the predicted positive sign. Size, R&D intensity, and concentration ratio

¹⁰For 5 of the 22 industries sampled, data on R&D expenditures are not reported on the Compustat Tape.

TABLE 5
STATISTICAL RESULTS--MULTIPLE REGRESSION
(17 Industries)

Independent Variable	t Test (10 DF)	Level of Significance
Variance	1.76	Not Significant
Skewness	1.86	.10
Growth	0.90	Not Significant
R&D Intensity	0.65	Not Significant
Concentration Ratio (4-Firm Value Added)	0.21	Not Significant & Negative
Size (Log ₁₀ Total Assets)	0.10	Not Significant & Negative

Correlation Matrix

	ROI	VARIANCE	SKEWNESS	SIZE	R&D	GROWTH	CR
ROI	1.0	.403	.426	-.079	.114	.523	-.090
VARIANCE		1.000	-.267	-.281	.483	.479	.281
SKEWNESS			1.000	.105	-.276	.145	-.492
SIZE				1.000	-.264	-.225	.160
R&D					1.000	.204	.165
GROWTH						1.000	.207
CR							1.000

are all again not significant, and of these three variables, only R&D intensity has the expected positive sign. Just one measure for the concentration ratio and one measure for size are used as earlier results indicated that the different measures for each variable are essentially interchangeable. In this first run of the multivariate model, statistical testing is hampered by the few degrees of freedom available.¹¹

By eliminating the R&D intensity variable it is possible to include all 22 industries in the second run of the multiple regression model.¹² Variance, skewness, and growth are all significant, and each has the predicted positive relation with ROI. Neither the concentration ratio nor size is significant, and the concentration ratio has a negative sign.

In the two multiple regressions and in the simple regression runs, the concentration ratio, R&D intensity, and size are nowhere significant. Therefore, these three variables are dropped from further consideration. This lack of significance may be accounted for by collinearity between the variables that are significant including

¹¹The first multiple regression run which includes the R&D intensity variable has only 10 degrees of freedom. With so few degrees of freedom, the F and t values must be relatively high to be significant.

¹²The statistical summary of this run is contained in Table 6.

TABLE 6
STATISTICAL RESULTS--MULTIPLE REGRESSION
(22 Industries)^a

Independent Variable	t Test (16 DF)	Level of Significance
Variance	1.73	.10
Skewness	2.08	.05
Growth	2.96	.01
Concentration Ratio (4-Firm Value Added)	1.47	Not Significant & Negative
Size (Log ₁₀ Total Assets)	.93	Not Significant

Correlation Matrix

	ROI	VARIANCE	SKEWNESS	SIZE	GROWTH	CR
ROI	1.0	.279	.433	-.072	.603	-.045
VARIANCE		1.000	-.368	-.348	.304	.102
SKEWNESS			1.000	.100	.098	-.279
SIZE				1.000	-.120	.294
GROWTH					1.000	.458
CR						1.000

^aR&D Intensity omitted for lack of data.

variance, skewness, and growth, and those that are not significant. For example, the partial correlation coefficient for variance and R&D intensity is 0.48. Collinearity can cause a variable to be not significant because the significant variable with which it is collinear steals the nonsignificant variable's explanatory power.

A third run of the multivariate model uses only those variables that are significant in at least one previous run: variance, skewness, and growth.¹³ In this run, each of the independent variables is statistically significant and has the predicted sign. As measured by the F test, the equation is significant at the .01 level. By using a Durbin-Watson Test, it is concluded that no serial correlation exists in the error terms.¹⁴ This final equation is accepted as a significant model of ROI for use in inter-industry comparisons.

Two modifications to the final equation are made to isolate possible bias created by variations in capital structure. First, return on net book assets is substituted for return on net worth. Using this configuration, the same three variables are significant (variance, skewness, and growth) while all the other independent variables are

¹³See Table 7 for the statistical summary.

¹⁴This test is described in J. Durbin and G. S. Watson, "Testing for Serial Correlation in Least Squares Regression," Biometrika (December, 1950), pp. 409-428.

TABLE 7
STATISTICAL RESULTS--FINAL EQUATION

$$\text{ROI} = .0440 + 3.468(\text{Variance}) + 0.020(\text{Skewness}) + 0.232(\text{Growth})$$

R = 0.77 F Test = 8.74 (4,18 DF) Equation significant at .01

Independent Variable	t Test (18 DF)	Level of Significance
Variance	2.10	.05
Skewness	3.02	.01
Growth	2.75	.05

Correlation Matrix

	ROI	VARIANCE	SKEWNESS	GROWTH
ROI	1.0	.279	.433	.603
VARIANCE		1.000	-.368	.303
SKEWNESS			1.000	.098
GROWTH				1.000

Durbin-Watson Test (k=3 n=22)

Positive Test = 2.52
Negative Test = 1.48

not significant. Second, the debt ratio, total debt to total assets, is included as an independent variable in the equation with return on net worth as the dependent variable. The debt ratio is not significant and has a negative sign. Consequently, there is no evidence that using return on net worth biases the risk/return relationship.

To evaluate the extent of collinearity, several regressions are run using different combinations of the determinants of ROI. First, variance is used for the dependent variable with R&D intensity and growth as independent variables to test the idea that relatively high R&D expenditures and rapid growth create risk. The coefficient of multiple correlation (R) for this run is 0.65. As an explanatory variable for variance, growth is just barely significant at the .05 level, and R&D intensity is not significant at all. These results provide weak support for the contention that relatively high growth results in high risk.

A second collinearity test relates R&D intensity and size as measures of barriers to entry to the concentration ratio, a measure of potential market power. The multiple correlation coefficient is only 0.31, and neither size nor R&D intensity is significant. Although this test provides no support for a significant association between the concentration ratio and the two measures of barriers to entry, the interpretation of the result is hampered by the limited

R&D data and by the problems which are inherent in the concentration ratio as a measure of market power.¹⁵

Discussion of Regression Results

Using the ROI model to study ethical drug industry rate of return depends on acceptance of the individual variables chosen as ROI determinants. The model and the data can be evaluated to some extent by comparing these empirical results with the results of previous studies. In this section, such comparisons are made in addition to a review of why each variable is included or left out of the final model.¹⁶

Intercept term. The intercept term is the rate of return left after allowing for the investment characteristics measured by variance, skewness, and growth, and therefore, it can be compared to the rate of return on government securities presumably not affected by these characteristics. At .0440 or 4.4 percent, the intercept term is slightly lower than the 4.74 percent, 1963-1971 average yield on three month U.S. Treasury Bills.¹⁷ As

¹⁵See the discussion of the R&D intensity and concentration ratio variables in Chapter IV for a review of these problems.

¹⁶The final model and the associated summary statistics are shown in Table 7.

¹⁷The figures are from, U.S., Department of Commerce, Survey of Current Business (Washington, D.C.: Government Printing Office, 1963-1971).

the intercept term is about the same as the Treasury Bill rate, the conclusion is that the equation does take out premiums associated with risk and growth leaving a rate of return adjusted for these investment characteristics.

In models using fewer explanatory variables, the intercept term is considerably higher than the Treasury Bill rate. For example, the figure in Cootner and Holland's equation is 8.20 percent, and Conrad and Plotkin find an intercept term of 8.6 percent.¹⁸ In both studies, only variance is considered. If the effects of skewness and growth are included, the expected result would be a lower intercept figure such as the one predicted by this model.

Variance. As hypothesized, inter-spatial variance of return is a statistically significant explanatory variable for rate of return, and therefore, it is used in the final ROI model.

Skewness. The prediction of a positive association between ROI and the dummy skewness variable is confirmed by the regression results. This is in agreement with prior studies which have generally found a negative association between ROI and the value of the coefficient of skewness;

¹⁸Paul H. Cootner and Daniel M. Holland, "Rate of Return and Business Risk," The Bell Journal of Economics and Management Science (Autumn, 1970), p. 218; Gordon R. Conrad and Irving H. Plotkin, "Risk/Return: U.S. Industry Pattern," Harvard Business Review (March-April, 1968), p. 95.

an inverted result is obtained in this study by assigning a lower number (0) to the dummy variable for positive skewness and a higher number (2) for negative skewness.¹⁹ Use of a dummy variable eliminates the interpretive problems and concentrates on the sign of the skewness measure. There may be additional information to be gained by using the value of the skewness coefficient as well as its sign, but in the absence of a measure of skewness which can be adequately interpreted as a risk measure, use of a dummy variable seems more reasonable and logical. The conclusion is that given present understanding of skewness as a determinant of ROI, only tests regarding the sign of the coefficient can be meaningfully interpreted. The empirical results provide support for the hypothesis that there is a significant association between ROI and skewness, and therefore, the variable is used in the final model.

Growth in demand. The finding of a significant positive association between return on investment and growth in demand confirms the hypothesis, and growth is used in the ROI model. An attempt is made to test empirically the contention that growth is a form of risk by using variance as the dependent variable and growth as an independent variable in a multiple regression. As growth is not a

¹⁹The use of a dummy variable to measure skewness is explained in Chapter III.

significant explanatory variable for the risk measure, there is no support for a risk and growth association.

Industry concentration. Although the expectation of an association between concentration and rate of return is central to the theory of noncompetitive markets, the concentration ratio is not a significant variable in the regression model. This is not too different from other studies' empirical results which provide weak support for the hypothesis of a positive association.²⁰ Consequently, the variable is not included in the final model.

Lack of significance for the concentration variable has several possible explanations. First, the ratio only measures potential market control, and companies may not consistently exercise that power. In other words, the variable may not be significant because the concentration ratio data are inadequate for the task of measuring the actual use of market power. Second, the well-known shortcomings of the Bureau of the Census data may affect the significance of the variable.²¹ A third possible explanation is multicollinearity. For example, the coefficient of partial correlation with skewness is 0.28 and with growth is 0.46.

²⁰See Chapter IV for reviews of research pertaining to the concentration ratio.

²¹These shortcomings are described in the section on concentration ratios in Chapter IV.

Research and Development Intensity. The hypothesis that R&D intensity is positively associated with ROI is not confirmed, and as a result, the variable is not used. Testing this variable is hampered by incomplete data. In five of the 22 industries sampled, no R&D data were obtainable, and in the remaining 17 industries, data for many firms were available only for a portion of the nine year sample period. Until more adequate data are available, little satisfactory testing can be done regarding the effects of R&D outlays on ROI.

The collinearity R&D intensity has with other determinants of ROI also may cause the variable to be not significant. For example, the coefficients of partial correlation are 0.48 with variance, 0.28 with skewness, and 0.26 with size. The degree of correlation with variance lends some support to the idea that high R&D expenditures create risk. When R&D intensity is correlated with the concentration ratio, there is only a weak association, and consequently, little evidence that concentration is associated with R&D outlays. As stated previously, the poor R&D data preclude drawing any defensible conclusions.

Company size. The size variable's coefficient is not significant, and its sign is negative rather than positive as hypothesized. These results are compatible with those of Hall and Weiss who find a significant positive association between ROI and the reciprocal of the logarithm of total

assets.²² A positive association with the reciprocal of a measure is comparable to a negative association with the measure itself.

Lack of significance for the size variable may well be inherent in the data sample. The Compustat Tape contains data on those companies that have the greatest investor appeal which tends to bias the sample towards large companies. As a result, inter-industry size differences may not be revealed. Hall and Weiss' use of the much broader Internal Revenue Service data may account for the variable being significant in their study.

Another possible explanation for size not being significant is that variable's collinearity with variance; the partial coefficient of correlation is 0.35. Because size is not a significant explanatory variable for ROI, it is not included in the final model.

Evaluation of the statistical results leads to the conclusion that the final equation is an acceptable model which relates ROI to variance of return, skewness of return, and growth in demand. The choice of the independent variables is based on both statistical and logical relationships. That only three out of the six ROI determinants considered are jointly significant is not surprising, given

²²Marshall Hall and Leonard Weiss, "Firm Size and Profitability," Review of Economics and Statistics (August, 1967), pp. 319-331.

current understanding of these variables. As shown by the partial correlation coefficients, the measures tend to overlap which may result in the explanatory power of the excluded variables being stolen by the significant variables.

Test of the Model

The final regression equation which explicitly considers investment characteristics is used to forecast ethical drug industry average ROI, and the forecast is then compared to the industry's observed rate. Before doing this, it seems prudent to test the model by forecasting ROI for a manufacturing industry other than the drug industry.

For several reasons the aerospace industry has been chosen for this test. In a recent study, the claim is made that this industry has an ROI below what is necessary to compensate investors for the risk involved.²³ Conrad and Plotkin similarly find that the aerospace industry exhibits relatively high risk while ROI is near the all-manufacturing mean.²⁴ A lower than expected ROI is, of course, the opposite situation than exists for the ethical

²³Aerospace Research Center, Aerospace Profits Vs. Risks (Washington, D.C.: Aerospace Industries Association of America, 1971).

²⁴Conrad and Plotkin, "Risk/Return: U.S. Industry Pattern," p. 94.

drug industry which is charged with having a rate that is too high.

Using data for the aerospace industry should indicate if the model is biased. In light of claims that the industry has a rate of return below what would be expected given the investment characteristics of the industry, the model should produce a forecasted ROI above the observed rate. The procedure used is first to locate observed all-manufacturing average ROI and observed aerospace industry average ROI in Figure 4.²⁵ Forecast aerospace industry ROI is then computed by substituting aerospace industry values for the independent variables into the model which gives a conditional expectation on ROI. By exploiting the t distribution, the lower boundary of the forecast interval can be found:

$$\text{Forecast Interval} = \text{Forecast ROI} \pm tS_f$$

where t is the t value at the .01 confidence level and S_f is the forecast error.²⁶

Observed aerospace ROI is below both the all-manufacturing industries average ROI and below the lower boundary of the 99 percent confidence interval forecast

²⁵The aerospace industry is not included in the all-manufacturing industries sample in this test.

²⁶For an explanation of this technique, see Goldberger, Econometric Theory, pp. 168-171.

Fig. 4.--Aerospace industry - forecasted ROI

from the model; therefore, aerospace industry average rate of return is indeed less than would be expected after consideration of the investment characteristics measured by variance, skewness, and growth.

This result could occur also because the aerospace industry is so unique as to not belong in the same regression as the all-manufacturing sample. The Chow Test is designed to determine if one or more additional sets of observations belong to the same regression as a previous set.²⁷ The equation for the test is

$$\text{Chow Test} = \frac{A-B/df}{B/df}$$

where A is the error sum of squares of the original set plus the additional observations and B is the error sum of squares for just the original set. Each sum of squares is adjusted for the respective degrees of freedom (df). The test is distributed as the F ratio. Adding the aerospace industry observations to the all-manufacturing regression produces a Chow Test figure of 2.27. As this is less than the F value of 4.41 at the .01 level of significance, it is concluded that the aerospace observations belong to the same regression as those of the other

²⁷This test is explained in Gregory C. Chow, "Test of Equality Between Sets of Coefficients in Two Linear Regressions," Econometrica (July, 1960), pp. 591-604.

manufacturing industries.

Use of the model to forecast aerospace industry rate of return generates the expected result. Considering its level of risk and rate of growth, one would expect the industry to have a higher ROI than it does. Taken with the statistical tests performed, this result reinforces the conclusion that the regression model is a suitable device for forecasting ROI for manufacturing industries.

Ethical Drug Industry Rate of Return

Using the same methods and techniques as in the previous section, a forecast is made of ethical drug industry ROI, and the result is compared to the observed rate of return for the industry. The hypothesis to be tested is that ethical drug industry average return on investment is the same as all-manufacturing industries average return on investment after consideration of the characteristics measured by variance, skewness, and growth.

The sequence for forecasting drug industry ROI is as follows: first, all-manufacturing average ROI and observed ethical drug industry average ROI are located in Figure 5.²⁸ Ethical drug industry ROI is then forecast by substituting the industry's figures for the three independent variables

²⁸The all-manufacturing industries sample does not include the ethical drug industry in this test.

Fig. 5.--Ethical drug industry--forecasted ROI

which provides a conditional expectation on ROI. Finally, the forecast interval is calculated by use of the t value, and the upper boundary of the interval located.

A Chow Test is again used to test the hypothesis that the ethical drug data belong to the same regression as the all-manufacturing sample. The 3.53 test figure allows acceptance of the hypothesis.

As the drug industry forecast is less than the observed industry rate, the forecast alone does not account for the observed industry ROI. Both observed and forecast ethical drug industry rates of return are well above the observed all-manufacturing rate. The forecast rate of 18.0 percent is 4.8 percentage points above the observed all-manufacturing rate of 13.2 percent which reflects a premium for risk and growth. However, the forecast rate is still 4.2 percentage points below the observed drug industry rate of 22.2 percent.

A confidence interval must be calculated because the forecast is based on the regression line which contains errors as shown by the error term and because the drug industry data introduced into the equation are a sample which contains potential errors. As the question being considered is whether drug industry ROI is above what would be expected given its investment characteristics, only the upper boundary of the forecast confidence interval is plotted.

The width of the confidence interval reflects the

lack of precision of the data and of the model as a forecasting device. Although a more precise model would produce a narrower confidence interval, this does not necessarily imply that the upper boundary of the confidence interval would be lowered. A more precise model might generate a higher forecast rate of return.

Ethical drug industry observed ROI is below the upper boundary of the forecast interval, and therefore, the hypothesis is accepted that ethical drug industry average return on investment is the same as all-manufacturing industries average return on investment after consideration of the three investment characteristics. Alternatively stated, the excess of observed drug industry ROI can be statistically explained by variance, skewness, and growth.

Drug industry ROI is also forecast using the standard deviation in place of variance as the measure of risk. The forecast figure is then 17.86 percent, and the upper boundary of the forecast interval is 23.59 percent. These results show that ethical drug industry risk is not exaggerated by using variance instead of the standard deviation to measure risk.

It should be noted that the investment characteristics included in the model are not measures of market structure. According to the model, a perfectly competitive industry might exhibit an average rate of return above the all-manufacturing average as the result of high variance,

positive skewness, and rapid growth. This is not to suggest that the ethical drug industry is competitive or monopolistic, only that market structure is not related to the final model and that drug industry ROI can be explained without reference to noncompetitive advantages.

These empirical results can be compared to those of several other studies which have attempted to explain drug industry ROI. By holding growth in demand constant, Barges and Hickey can explain only part of the excess of drug industry ROI over the all-manufacturing average rate.²⁹ Their results show a 3.9 percentage point growth premium which leaves an additional 8.4 percentage point gap of unexplained rate of return over the 12.9 percent all-manufacturing industries rate. The observed drug industry rate is 25.2 percent return on assets (before taxes).

Conrad and Plotkin study risk as a determinant of ROI.³⁰ Using regression techniques to hold risk constant, they also are unable to explain completely drug industry rate of return. Their model predicts a rate of approximately 15.0 percent, but the observed drug industry rate is 17.5 percent which leaves an unexplained portion of 2.5 percentage points.

²⁹Alexander Barges and Brian R. Hickey, "Drug Industry Profits," Financial Analysts Journal (May-June, 1968), pp. 75-83.

³⁰Conrad and Plotkin, "Risk/Return: U.S. Industry Pattern."

By jointly considering the effects of two measures of risk, variance and skewness, along with the effects of growth in demand, this study statistically explains the excess of observed drug industry rate of return over all-manufacturing ROI.

Summary

This chapter describes the testing of the ROI model and its use in comparing drug industry ROI to all-manufacturing ROI. The components of the model are evaluated by testing the hypothesis of a significant association between ROI and each of the six ROI determinants. For variance, skewness, and growth the hypothesis is accepted, but for the determinants measured by R&D intensity, concentration ratio, and firm size, it is rejected as the latter variables are not statistically significant. Advertising and promotional intensity could not be tested for lack of data.

The final ROI model with variance of return, skewness of return, and growth in demand as explanatory variables is evaluated as a forecasting device using aerospace industry data. Forecast industry ROI is slightly above the all-manufacturing industries average which agreed with the a priori prediction. Considering the results of the statistical tests along with successfully forecasting aerospace ROI, it is concluded that the model is a suitable device

for forecasting rates of return for manufacturing industries.

By explicitly allowing for various possible statistical errors, the model is able to explain the ethical drug industry's relatively high rate of return using the determinants of ROI. Therefore, the hypothesis is accepted that ethical drug industry average return on investment is the same as all-manufacturing industries average return on investment after consideration of the determinants of ROI.

These empirical results have a variety of useful implications. One comes from the unsuccessful attempt to include as many as six ROI determinants in the same explanatory equation. Use of this many variables together is not successful because the variables are imprecise and overlap in their association with ROI. Also, the available data are less than ideal for use in relating ROI to its determinants.

The research does result in a model that can be used to explain ROI for manufacturing industries where risk and growth are important determinants of ROI. Various statistics including the F, t, and Durbin-Watson tests which are used to evaluate the model lead to the conclusion that the model is an acceptable and adequate device for forecasting manufacturing industries' rate of return. The model does explain the ethical drug industry's relatively high ROI, an accomplishment that other models have not achieved.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The ethical drug industry has been extensively examined with particular attention having been focused on its relatively high rate of return on investment. Both governmental investigators and academic researchers have attributed the relatively high return on investment to the noncompetitive structural characteristics exhibited by the industry. The existence of product differentiation through effective advertising of brand-name products, extensive research activity coupled with the patent privilege, and the existence of other barriers to competitive entry are examples of the industry's structural characteristics. High relative and absolute rate of return is often cited as a summary measure for these indications that competition, at least in the classical sense, is absent.

The drug industry's rate of return, then, has been used as an indication, if not proof, of anti-competitive behavior. However, use of ROI as evidence of noncompetitive advantages has led to disagreement regarding the definition of ROI, the determinants of ROI, and the proper method for making inter-industry ROI comparisons.

Of the various definitions of return on investment, each of which has its own interpretation, there is no agreed

upon form for use in inter-industry comparisons. The definition used in this study is based on the contention that in competitive equilibrium net income after taxes to net worth tends to be equalized. It was further argued that an after taxes figure properly reflects the effects of capital structure as a part of the input mix.

To identify the determinants of ROI, a series of structural and investment characteristics were studied which generally have been associated with rate of return. The linkage between ROI and the investment characteristics was derived from the proposition that under competitive conditions there is a normal rate of return composed of pure interest plus a premium for relatively high risk and/or growth in demand.

The hypothesis of a positive association between risk and rate of return resulted from assuming investors are risk averse. In other words, investors were posited to require a risk premium as compensation for uncertainty regarding future receipt of return on investment. Two measures of risk were used: inter-spatial variance and skewness of the distribution of ROI.

Another investment characteristic, growth in demand, was hypothesized to be positively associated with rate of return utilizing the following rationale: To fulfill relatively rapid growth in product demand, the firms in

an industry must increase their share of available capital supply. Investors are assumed to demand a growth premium as compensation for increasing the concentration of their investment portfolios when they provide the required capital.

Assuming that under noncompetitive conditions firms can maintain artificially high rates of return, several structural characteristics were examined as potential ROI determinants. Average company size and R&D intensity represented measures of possible barriers to entry, and the concentration ratio, a measure of potential market power. The structural characteristics were hypothesized to have a positive relationship with ROI through the implied linkage of anti-competitive behavior.

Statistical Findings

Regression and correlation techniques were utilized to test the variables as potential determinants of ROI. The hypothesized positive association with rate of return was supported for the two risk measures and for growth in demand but rejected for each of the structural characteristics. A model of return on investment was formulated based on the arguments presented in Chapters III and IV and the statistical analysis set forth in Chapter VI.

The three measures of investment characteristics were combined into a cross-sectional, multiple regression model of ROI. Various statistical techniques including t and F

tests and the Durbin-Watson statistic were used to evaluate the explanatory value of the equation. In a trial run using aerospace industry data, the model performed as expected. The prediction that aerospace ROI would be higher after consideration of risk and growth in demand was confirmed.

Ethical drug industry ROI was studied by introducing data for the industry into the model to obtain a forecast of rate of return with variance, skewness, and growth held constant. After adjusting the resulting rate of return figure for possible forecasting errors, the ethical drug industry forecast and observed rate of return were compared. A Chow Test was used to verify that the drug industry data belonged to the same regression as the all-manufacturing industries sample data.

Comparing the forecast with the observed rate showed observed ethical drug industry average ROI to be below the rate that could result given the particular set of investment characteristics exhibited by the drug industry sample. Therefore, the hypothesis was accepted that ethical drug industry average return on investment is the same as all-manufacturing industries average return on investment after consideration of investment characteristics.

Conclusions

Ethical drug industry average return on investment is

significantly higher than all-manufacturing industries average ROI before consideration of investment characteristics. In fact, the industry's average rate of return is higher than that of nearly all other manufacturing industries. However, inter-industry comparisons of rates of return without consideration of the determinants of ROI are misleading at best, and therefore, explicit attention must be paid to the determinants.

Return on investment as a performance measure remains an ambiguous concept. The implications of various definitions of ROI are unclear, and there is continued disagreement regarding which form of the variable is best for use in inter-industry comparisons. Consequently, there is need for additional research regarding the definition and measurement of ROI.

Of the many possible determinants of ROI suggested by previous studies, the ones discussed here are the most important, or at the very least, the most obvious. Each of the variables, however, is an imperfect explanatory variable and has various undesirable characteristics.

A review of the investment characteristics shows one risk variable, variance of return, can be measured either spatially or temporally with researchers disagreeing on the proper method for inter-industry comparisons. Arguments were presented explaining the choice of the inter-spatial measure for this study. There has been only limited research

regarding skewness, the other risk measure. Review of prior research coupled with this study's empirical results leads to acceptance of the hypothesis that investors desire positive and dislike negative skewness. The third investment characteristic, growth in demand, was found to have a positive association with ROI as predicted in both this and most other studies of growth, but the logical framework for explaining the relationship requires additional development. All of the investment characteristics were statistically significant explanatory variables for rate of return.

There are a variety of possible explanations as to why none of the structural characteristics had the predicted positive association with ROI. For example, the concentration ratio is a measure of potential market control which can lead to artificially high rates of return, but it may fail to distinguish between industries where this potential results in anti-competitive behavior and where the potential goes unexploited. Also, industries used in the Census Bureau concentration data may not represent the relevant product market. A case in point is the ethical drug industry which is relatively unconcentrated as a whole but may be significantly concentrated at the individual product level.

The other structural variables were measures of possible barriers to competitive entry into an industry. Although R&D intensity appears to be an important ROI

determinant, the paucity of data severely limits the variable's usefulness in empirical research. Development of a more extensive data base very likely would result in researchers finding R&D intensity to be an important ROI determinant. Average company size exhibited moderate collinearity with the other independent variables indicating it has little independent explanatory value. It is possible that size was not significant because data from the Compustat Tape is mostly for large companies, and consequently, diversity in size was not present. At the same time, the theoretical framework for linking size and ROI is unclear. One additional structural characteristic, advertising intensity, was not included in the statistical analysis because most of the companies sampled did not report advertising expense separately. Prior research has generally predicted a positive ROI/advertising association, but empirical results have been ambiguous.

This study clearly demonstrates the difficulties of formulating a multivariate model of ROI for use in inter-industry comparisons. Although the study successfully explained ethical drug industry ROI by statistical means, the need for additional research regarding the definition of ROI and its determinants as well as the need for better data were decidedly evident throughout. The fact that only three of the seven ROI determinants considered were statistically significant and included in the final model

emphasizes the problems of multicollinearity and overlapping created by relatively imprecise data and variable definitions. The conclusion is that future research would be better directed at refinements in definition and measurement of the ROI determinants rather than at attempts to build ROI models containing additional variables.

By considering the individual and joint effects of a larger number of variables than prior studies, this research did produce a statistically significant explanatory model of ROI capable of explaining drug industry ROI. There are several possible explanations of why this research was successful in explaining drug industry ROI where previous studies have failed. First, this study utilized data only for firms primarily engaged in the manufacture of ethical drug products rather than data for both ethical and proprietary drug firms as in other research. Second, this study's more recent data may reflect changed economic relationships, both within the drug industry and between the drug and other industries, not captured in earlier data. Third, the model formulated includes more variables than prior models. Also, the definition and measurement of the variables benefited from research performed in the interim since previous drug industry studies were completed. Fourth, explicit consideration was made of possible statistical errors in both the regression equation and in the

forecast of drug industry rate of return. As a model of ROI, the regression equation is particularly useful in that it can be used without reference to noncompetitive structural characteristics.

That ethical drug industry ROI can be explained statistically without reference to noncompetitive advantages, however, is far from proof that the industry operates under competitive conditions. The results also do not prove that the industry is uniquely risky. Even a conservative view of the findings, though, reveals that a considerable portion of the excess of industry ROI over the all-manufacturing rate is explainable by the investment characteristics of the industry. The extreme reaction of some to the size of the difference between drug industry rate of return and that of other manufacturing industries should be modified by attention to these results.

This study does not and has not sought to answer the normative question of whether ethical drug industry rate of return is too high. Such a question must be answered by social and political decision-makers. The goal of this study was to provide additional knowledge regarding return on investment in general and about the interpretation of ethical drug industry rate of return.

Besides its value in explaining drug industry rate of return, the model can aid decision-making regarding regulation and control of specific industries. If an

industry is identified as having a higher rate of return than is indicated by its investment characteristics, regulatory agencies can attempt to force ROI down with less concern that their actions will result in the withdrawal of capital from the industry. Regulators may decide not to disturb other industries with relatively high rates of return which can be explained on the basis of high risk and/or growth in demand. Therefore, the model should be a welcome tool to aid in making predictions of the likely effects of regulating ROI.

A P P E N D I X I

MEASUREMENT OF RISK

The return on investment model contains two variables to measure risk: variance and skewness of the distribution of ROI. Variance is measured by the sum of the squared deviations of individual company rates of return around their industry mean. In view of the importance of the variable for acceptance of the model, this particular measure of risk deserves additional explanation.

Variance as a risk measure can be stated more precisely in equation form. Using the idea of expected utility maximization, the following utility function can be written with I being investment (or wealth) and Y being income, a random variable:¹

$$U = (Y + I) \quad (1)$$

ROI will be $r = Y/I$. Thus (1) may be rewritten as

$$U = U(rI + I) \quad (2)$$

¹The mathematical exposition follows that in Fred A. Arditti, "Risk and the Required Return on Equity," Journal of Finance (March, 1967), pp. 19-36.

With $E(rI)$ as the expected value of income, U may be expanded in a Taylor series about $I + E(rI)$. Taking expected values of both sides of the expansion produces:

$$E(U) = U[I + E(rI)] + \frac{I^2}{2!} U''(I + Iu_1)u_2 + \frac{I^3}{3!} U'''(I + Iu_1)u_3 + \text{Terms involving higher order moments.} \quad (3)$$

In equation (3), u_1 , u_2 , and u_3 are the first, second, and third moments of the probability distribution of ROI.²

Nothing is said above regarding investor attitude towards risk. If risk aversion is assumed, then the investor has diminishing marginal utility for additional income or wealth. Mathematically:

$$U''(I) < 0 \quad (4)$$

This states that the coefficient of the second moment, u_2 , must be negative. In other words, the greater the variability of ROI, the lower the expected value. This leads to the hypothesis that there is a positive association between variance and ROI.

Different definitions of the second moment can be used to measure risk, including variance, semivariance,

²For a discussion regarding the omission of higher order moments, see S. C. Tsiang, "The Rationale of the Mean-Standard Deviation Analysis, Skewness Preference, and the Demand for Money," American Economic Review (June, 1972), pp. 354-371.

and standard deviation. One study that tested these and other definitions empirically found they were interchangeable as risk measures. Of six definitions, including the three mentioned above, the study reports:

The simple correlations among the first four measures are so high that one measure can be regarded as essentially a linear transformation of any of the others. The simple correlation coefficients involving the last two measures are less high but are still high.³

Actually the differences in calculating these different risk measures are not great. For example, the semivariance is found in the same way as variance except only deviations below the mean are considered which reflects the investor's fear of loss. As semivariance is infrequently used, there is little familiarity with the measure. The only difference between the standard deviation and variance is that the latter is in squared units, and therefore, larger deviations are given more weight.⁴ Under the assumption of diminishing marginal utility, giving greater weight to extreme deviations seems logical.

³Bank Administration Institute, Measuring the Investment Performance of Pension Funds (Park Ridge, Ill.: The Institute, 1968), p. 31.

⁴Based on the data used in this study, the standard deviation is highly correlated with variance ($r = .98$). To evaluate the effects of using squared deviations in calculating the drug industry's forecasted rate of return, the standard deviation was substituted for variance. The forecasted rate using the standard deviation was not significantly different than the rate calculated using variance.

A review of the literature reveals that nearly all researchers utilize either variance or the standard deviation as the measure of risk.⁵ Preference for the standard deviation or variance seems to be about equal with no strong theoretical or practical evidence to recommend one measure over the other. As variance is a familiar concept that apparently explains ROI as well as any other definition of the second moment, it was chosen as the measure to use in the model.

⁵A series of articles about risk are reviewed in Chapter III.

A P P E N D I X I I

INDUSTRY DATA

TABLE 8

RATES OF RETURN ON STOCKHOLDERS' INVESTMENT^a

Industry ^b	Percent				
	1962	1964	1966	1968	Average
Meat Products	5.2	8.5	5.3	8.1	6.8
Dairy Products	10.0	11.4	12.0	11.0	11.1
Sugar	8.1	8.3	10.0	8.0	8.6
Candy	15.1	15.6	13.6	12.3	14.2
Malt Liquor	8.3	10.4	11.0	12.1	10.5
Distilled Liquor	6.1	6.5	9.1	7.6	7.3
Fabrics and Yarn	7.3	9.0	10.5	8.3	8.8
Pulp, Paper and Paperboard	8.2	9.3	10.6	9.2	9.3
Paperboard Boxes	9.2	9.3	12.6	9.8	10.2
Periodicals	6.3	14.4	20.1	12.7	13.4
Petroleum Refineries	10.5	11.3	12.2	12.4	11.6
Fabricated Rubber Products	8.4	10.1	11.5	11.9	10.5
Footwear	9.1	10.4	13.1	14.8	11.9
Glass and Glasswear	11.1	12.9	14.7	12.0	12.7
Hydraulic Cement	9.8	8.8	6.1	7.0	7.7
Steel Mills	5.3	8.7	8.5	8.2	7.7
Iron and Steel Foundries	6.0	9.0	10.0	8.1	8.3
Non-Ferrous Metals	7.0	8.9	14.4	10.3	7.7
Machine Tools	8.6	11.4	17.0	12.9	10.2
Radio and TV Equipment	10.2	13.4	19.8	15.0	14.6
Motor Vehicle Parts	9.4	11.1	14.1	12.3	11.7
Aircraft	12.1	13.7	14.6	13.2	13.4
Shipbuilding	4.9	6.1	6.2	10.2	6.9
All-Manufacturing Average	8.5	10.4	12.0	10.8	10.2
Ethical & Proprietary Drug	17.1	18.9	21.1	18.8	19.0
Ratio of Drug to All-Mfg.	2.0	1.8	1.8	1.7	1.9

^aNet Income after Taxes divided by Net Worth - Book Value.

^bAverage for 12 largest firms in each industry.

Source: U.S., Federal Trade Commission, Rates of Return in Selected Manufacturing Industries (Washington, D.C.: Government Printing Office, 1970).

TABLE 9
RATES OF RETURN ON STOCKHOLDERS' INVESTMENT^a

Industry	1963	1964	1965	1966	1967	1968	1969	1970	1971	Ave.
Textile Products	9.3	9.7	12.1	13.4	9.9	9.6	8.2	6.5	5.8	9.4
Chemicals - Major	12.8	14.9	14.8	14.3	11.7	12.2	11.6	9.7	9.7	12.4
Chemicals - Specialty	9.7	9.7	11.5	13.7	13.3	14.0	12.8	10.4	10.6	11.7
Proprietary Drugs	22.7	24.1	23.6	21.2	21.3	23.5	24.4	20.7	20.6	22.4
Cosmetics	29.0	28.9	21.9	24.1	25.2	22.6	21.9	19.8	18.8	23.6
Oil - Integrated Domestic	12.4	13.3	15.2	15.8	15.0	13.9	12.9	11.8	10.3	13.4
Cement	9.1	8.9	9.2	6.5	5.8	6.5	5.2	3.6	6.1	6.8
Smelting and Refining	7.5	8.8	11.8	13.1	6.3	10.7	15.9	14.6	4.6	10.4
Machinery - Metal Fabric.	8.4	11.4	12.5	18.4	21.1	16.3	13.0	11.5	10.2	13.6
Building Materials	10.1	13.4	17.7	18.8	16.4	14.9	13.9	11.1	11.6	14.2
Machine Tools	9.2	10.1	12.0	14.8	13.9	10.9	8.8	1.2	-0.7	8.9
Machinery - Industrial	11.1	11.8	15.8	19.2	18.1	12.6	10.3	11.9	10.0	13.4
Office & Business Equip.	11.6	11.8	11.0	10.6	10.5	12.2	11.4	5.3	7.8	10.2
Electrical Equipment	10.0	13.5	15.4	17.3	15.8	14.9	17.5	13.2	13.5	14.6
Electronics	13.0	12.0	13.7	14.7	14.3	11.7	10.0	3.7	-0.9	10.3
Aerospace	13.4	14.0	13.7	14.5	9.7	13.3	9.8	1.1	9.3	11.0
Lab. & Research Equip.	13.4	12.6	14.3	14.5	16.2	13.9	11.7	10.2	10.3	13.0
Brewers	11.3	13.8	16.3	15.3	11.0	13.8	15.3	13.4	11.3	13.5
Soap	14.0	13.4	14.2	14.9	16.0	15.8	15.3	14.4	15.2	14.8
Shoes	11.9	14.8	15.8	16.1	17.5	19.4	17.0	16.9	14.7	16.0
Metal & Glass Containers	9.7	11.0	12.8	13.3	13.3	15.4	15.6	14.3	11.9	13.0
Radio & TV Manufacturers	12.6	11.3	14.2	20.1	13.1	14.2	10.3	3.1	8.6	11.9
All-Manufacturing Mean	12.4	13.3	14.5	15.7	14.3	14.2	13.3	10.4	10.0	13.1
Ethical Drugs	20.7	23.0	24.4	28.5	22.6	21.5	21.0	19.4	18.8	22.2
Ratio - Drugs to All-Mfg.	1.7	1.7	1.7	1.8	1.6	1.5	1.6	1.9	1.9	1.7

^aNet Income after taxes/Net Worth in Percent - Book Value.

Source: Standard and Poor's Corporation, Compustat Tape, 1971 Edition.

TABLE 10
INDUSTRIES SAMPLED

Industry #	SIC #	Number of Companies	Industry Title
1	2200	7	Textile Products
2	2801	11	Chemicals - Major
3	2803	5	Chemicals - Specialty
4	2835	9	Drugs - Ethical
5	2836	5	Drugs - Proprietary
6	2844	7	Cosmetics
7	2912	6	Oil - Integrated Domestic
8	3241	4	Building Materials - Cement
9	3331	4	Primary Smelting & Refining
10	3400	6	Machinery - Metal Fabricating
11	3430	6	Building Materials - Heat & A/C
12	3540	5	Machine Tools
13	3560	4	Machinery - Industrial
14	3570	10	Office and Business Equipment
15	3610	4	Electrical Equipment
16	3670	11	Electronics
17	3721	5	Aerospace
18	3811	4	Engineering, Lab & Research Equip.
19	2082	12	Beverages - Brewers
20	2841	4	Soap
21	3141	5	Shoes
22	3221	6	Containers - Metal and Glass
23	3651	5	Radio-TV Manufacturers
		145	Total Companies
		136	Total Companies without Ethical Drug Industry

TABLE 11
ETHICAL DRUG INDUSTRY SAMPLE

1	Abbott Laboratories
2	Lilly (Eli) & Co.
3	Merck & Co., Inc.
4	Pfizer Inc.
5	Schering - Plough Corporation
6	G. D. Searle & Co.
7	Smith Kline & French Laboratories
8	Syntex Corp.
9	Upjohn Company

TABLE 12

REGRESSION DATA, 1963-1971

Industry Number	ROI %	Variance Squared	Skew- ness	Growth %	R&D Inten- sity %	Size		Concentration Ratio		
						Total Assets \$000	Log ₁₀ Total Assets #	4-Firm Value Added %	8-Firm Value Added %	4-Firm Employees %
1	9.4	14.45	-	12.4	0.4	383035	5.353	30	42	26
2	12.4	10.41	-	13.5	3.3	1587085	6.132	42	55	38
3 ^b	11.7	12.01	-	18.2	3.6	269304	5.257	42	55	38
4	22.2	65.54	-	30.4	8.6	315679	5.390	25	48	20
5	22.4	37.42	-	25.7	4.4	290790	5.329	25	38	20
6	23.6	117.91	-	32.0	3.5	160891	5.026	43	56	16
7	13.4	14.23	-	17.4	0.8	1896440	6.200	32	57	30
8	6.8	12.08	+	4.6	0.3	151591	5.125	28	46	30
9	10.4	28.31	+	14.1	2.8	583228	5.472	61	79	46
10	13.6	31.32	+	27.5	1.1	143590	5.062	51	62	44
11	14.2	49.88	-	23.9	2.1	315765	5.288	31	44	25
12	8.9	15.52	-	7.7	4.0	130479	5.032	16	26	16
13	13.4	63.32	+	15.5	1.5	190542	5.101	28	42	28
14	10.2	54.09	+	33.6	4.4	864244	5.311	71	86	61
15	14.5	61.43	-	28.0	3.8	128940	4.949	52	64	44
16	10.3	102.31	+	22.0	8.1	113182	4.883	39	48	35
17	11.0	101.18	+	17.8	4.9	803705	5.807	55	74	53
18	13.0	22.55	-	15.9	5.9	105200	4.960	29	38	25
19	13.5	83.72	-	16.2	c	123010	4.792	37	58	34
20	14.8	15.59	-	18.9	c	985733	5.682	71	82	52
21	16.0	41.86	-	23.8	c	145210	5.009	28	34	22
22	13.0	13.81	-	28.1	c	646042	5.626	61	76	59
23	11.9	119.02	+	14.2	c	232022	5.266	44	66	36

^aSee Table 10 for Industry names and SIC numbers.^bIndustry 4 is the ethical drug industry.^cData not available.

A P P E N D I X I I I

NET RESIDUALS

In using regression techniques there is always a question regarding the assumption of linear relationships. This appendix offers some evidence of the relationships between ROI and the three independent variables.

Figures 6, 7, and 8 are graphs of the residuals associated with the final ROI equation.¹ Each graph depicts a net relationship between ROI and one independent variable with the other two independent variables held constant. For example, Figure 6 relates ROI and variance with the mean values for skewness and growth substituted into the equation. The equation, the coefficient of multiple correlation, and the partial correlation coefficient are all shown on the graph. These graphs are particularly useful as evidence of the validity of assuming a linear relation instead of some more complicated arrangement.

¹See Table 10 in Appendix II for the names of the industries that correspond to the numbers on the graphs.

Fig. 6.--Net Residuals--ROI Vs. Variance.
 All-Manufacturing (22 industries -
 drug industry excluded)

Fig. 7.--Net Residuals--ROI Vs. Skewness.
All-Manufacturing (22 industries -
drug industry excluded)

Fig. 8.--Net Residuals--ROI Vs. Growth.
All-Manufacturing (22 industries -
drug industry excluded)

A P P E N D I X I V

THE EXCLUDED VARIABLES

When a regression variable is not significant in a linear form, there is always a possibility that a different relationship exists. The graphs in this appendix give a visual representation of the association between ROI and each of the variables excluded from the final equation because they are not statistically significant.

Each graph shows the plots for the 23 industries, including the ethical drug industry, along with the least squares regression line for the all-manufacturing sample.¹ The graphs are used to help ascertain if some more complex mathematical relation exists between ROI and each of the excluded variables than the formulation used. As shown by the individual plots, no such relationships are apparent.

¹See Table 10 in Appendix II for the names of the industries that correspond to the numbers on the graphs. The drug industry is not included in the all-manufacturing sample.

Fig. 9.--ROI Vs. R&D Intensity.
All-Manufacturing (17
industries - drug
industry excluded)

Fig. 10.--ROI Vs. Size (Total Assets).
All-Manufacturing (22
industries - drug industry
excluded)

Fig. 11.--ROI Vs. Size ($\log_{10}$ Total Assets).
All-Manufacturing (22 industries -
drug industry excluded)

Fig. 12.--ROI Vs. Concentration Ratio (4-firm value added).
All-Manufacturing (22 industries - drug industry
excluded)

Fig. 13.--ROI Vs. Concentration Ratio (8-firm value added).
All-Manufacturing (22 industries - drug
industry excluded)

Fig. 14.--ROI Vs. Concentration Ratio (4-firm employees).
All-Manufacturing (22 industries - drug industry excluded)

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