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GRADUATE COLLEGE

PROFIT MAXIMIZING INFORMATION FROM COMPARATIVE OPERATING DATA

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BY

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PROFIT MAXIMIZING INFORMATION FROM

COMPARATIVE OPERATING DATA

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TABLE OF CONTENTS

PAGE

ACKNOWLEDGEMENT. iii

LIST OF TABLES vii

LIST OF FIGURES. ix

LIST OF APPENDIXES x

ABSTRACT xii

CHAPTER

I. INTRODUCTION. 1

Comparative Operating Data Defined. 2
Comparative Operating Data as a Unit of Study 3
Comparative Operating Data and Decision Theory 4
The Need for Maximizing of Information from Comparative Operating Data. 7
Definition of Terms 9
Organization of Thesis. 10

II. REVIEW OF RELATED LITERATURE AND RESEARCH . . 12

Literature. 12
A Survey of the Usage of Comparative Operating Data from Selected Organizations. 19
A Survey on How Comparative Operating Data are Used in the National Automotive Parts Association 25

III. DATA AND METHODOLOGY. 28

Hypotheses. 29
The Nature and Source of Data 30
Research Methodology. 33
General Procedures Used 33
Determining the Score Profile (Z Value) of the Firms. 38

IV. ANALYSIS OF COMPARATIVE OPERATING STATEMENTS. 44

Defining the Differences in Operating Data According to Profitability of Firms 45
Defining the Difference in Effect on Profit of Individual Operating Expenses. 61

Chapter Page

Analysis of the Meaning and Use of Coefficients 61
Analysis of Predictability Using Only the Most Significant Operating Expenses 68
A Validity Sample Check for the Predictor Model 76

V. ANALYSIS OF FINANCIAL STATEMENTS 81

Development of Financial Ratios 82
Defining the Differences in Financial Ratios According to Profitability of Firms 86
Defining the Difference in Effect of Individual Financial Ratios on Profit 90
Analysis of the Coefficients of the Financial Ratios 90
Analysis of Profit Predictability Using Only the Most Significant Financial Ratios . . . 91

VI. THE NEED AND SIGNIFICANCE OF COMPARATIVE OPERATING DATA IN PROFIT MAXIMIZING DECISIONS 98

Determination of Findings 98
Application of the Profit Maximizing Model to Firms 101
Additional Research Interests 114

BIBLIOGRAPHY 116

APPENDIXES 121

LIST OF TABLES

TABLE		PAGE
III-1.	Distribution of Firms That Supplied Operating Statements by Sales Volume.	32
III-2.	Firms Divided by Sales Category and Profit Quartile.	35
IV-1.	Number of Firms by Sales Category Used to Develop Models and to Test Predictive Validity of Models	46
IV-2.	Mean Operating Data for Firms in Sales Category 1, Up to $100,000 Annual Sales.	48
IV-3.	Mean Operating Data for Firms in Sales Category 2, $100,000 to $150,000 Annual Sales. . . .	49
IV-4.	Mean Operating Data for Firms in Sales Category 3, $150,000 to $200,000 Annual Sales. . . .	50
IV-5.	Mean Operating Data for Firms in Sales Category 4, $200,000 to $250,000 Annual Sales. . . .	51
IV-6.	Mean Operating Data for Firms in Sales Category 5, $250,000 and up Annual Sales.	52
IV-7.	Generalized Mahalanobis D^2 Statistic, Measure of Level of Significance of Mean Differences of Operating Variables by Profit Quartiles Within Sales Categories	53
IV-8.	Predicted Profit Quartile Membership of Firms By Multiple Discriminant Analysis, Sales Category 1.	55
IV-9.	Predicted Profit Quartile Membership of Firms By Multiple Discriminant Analysis, Sales Category 2.	56
IV-10.	Correct Profit Quartile Assignment of Firms Within Sales Categories	59
IV-11.	Percent Correct Profit Quartile Assignment of Firms Across Sales Categories	60
IV-12.	Multiple Discriminant Coefficients for 18 Operating Expenses and Profitability Quartiles	62

TABLE PAGE

IV-13. Rent and Profit Data. 67

IV-14. Operating Expense Variables Used in Reduced MDA Model 70

IV-15. Generalized Mahalanobis D^2 Statistic Measure of Level of Significance of Mean Differences of Operating Variables by Profit Quartiles Within Sales Categories for Reduced Variable Model 71

IV-16. Predicted Quartile Membership by MDA Reduced Variable Model. 73

IV-17. Reduced Variable Model Correct Quartile Assignment of Firms by Sales Category, Compared to the Original Model 75

IV-18. Summary Validity Test of Original Model on Secondary Model 78

V-1. Means of Financial Ratios by Profit Quartiles . 87

V-2. Predicted Profit Quartile Membership by Multiple Discriminant Analysis 89

V-3. Multiple Discriminant Coefficients for 12 Financial Ratios and Four Profitable Quartiles92

V-4. Financial Ratios for Reduced Variable Model Cumulative Percentage of Variance Accounted For 94

V-5. Predicted Quartile Membership by MDA Reduced Variable Model. 96

VI-1. Operating Expense Comparison of a Single Firm to a Profitable Quartile Mean 102

VI-2. Profit Maximizing Reduced Variable Model for Firm 30-05. 104

VI-3. Z Score Measure of Firm 30-05 106

VI-4. Comparison of Quartile 2 with Firm 01-61. . . .108

VI-5. Financial Ratio Comparisons 110

VI-6. Reduced Variable Model for Firm 12-04 to Attain Return on Investment Equal to Firms in Quartile 1 111

VI-7. The Long Term Debt to Total Assets Ratio Analysis. 113

LIST OF FIGURES

FIGURE		PAGE
1.	Continuum of Decision Methods.	5

LIST OF APPENDIXES

APPENDIX		PAGE
A.	The National Automotive Parts Association (NAPA)	122
B.	Form Used for Survey of Industries About Comparative Operating Data	125
C.	National Home Furnishings Association 1969 Operating Results, Top Profit Stores Compared to all Stores	127
D.	National Retail Hardware Association Comparison Between 1/3 Stores with the Highest Total Earnings and the 2/3 Making up the Balance	129
E.	Questionnaire Form Used for Personal Interview of Automotive Parts Jobber Managers to Determine the Extent to Which They Use Comparative Operating Data	132
F.	Summary of Survey of Use of Comparative Operating Data by Jobber Managers	134
G.	Letter of Instructions to NAPA Jobbers on How to Complete Comparative Data Forms	136
H.	Reporting Forms for Comparative Operating Data Used by NAPA	138
I.	Part 1-Multiple Discriminant Analysis Program BMD05M as Adapted for This Study	142
	Part 2-An Explanation Why Factor Analysis Was Not Used to Reduce the Number of Variables.	149
J.	Evaluation of Classification Group For Each Firm by Multiple Discriminant Analysis on Operating Statement Data, Sales Category I.	151
K.	Evaluation of Classification Group for Each Firm by Multiple Discriminant Analysis on Operating Statement Data, Sales Category II	154
L.	Evaluation of Classification Group for Each Firm by Multiple Discriminant Analysis on Operating Statement Data, Sales Category III	157

APPENDIX PAGE

M. Evaluation of Classification Group for Each Firm by Multiple Discriminant Analysis on Operating Statement Data, Sales Category IV 160

N. Evaluation of Classification Group for Each Firm by Multiple Discriminant Analysis on Operating Statement Data, Sales Category V. 162

O. Multiple Discriminant Coefficients, Sales Category I, Up to $100,000 Annual Sales . . 165

P. Multiple Discriminant Coefficients, Sales Category II, $100,000 to $150,000 Annual Sales 167

Q. Multiple Discriminant Coefficients, Sales Category III, $150,000 to $200,000 Annual Sales 169

R. Multiple Discriminant Coefficients, Sales Category IV, $200,000 to $250,000 Annual Sales 171

S. Multiple Discriminant Coefficients, Sales Category V, $250,000 and Up Annual Sales. . 173

T. Validity Test of Original Model on Secondary Sample. 175

U. Evaluation of Classification for Each Firm by Multiple Discriminant Analysis on Financial Ratio Data 178

DISSERTATION

PROFIT MAXIMIZING INFORMATION FROM COMPARATIVE OPERATING DATA

One of the goals of marketing managers is profit maximization. In decision making, a key need of managers is for profit maximizing information. Yet, comparative operating data, a major source of information external to the firm, is customarily averaged. Few maximizing techniques have been used.

The purpose of this study is to extract profit maximizing information from comparative data and develop this information into a predictive model that can be used to provide information to the marketing manager of the following nature:

a. The firm's relative position in a group of similar firms.

b. Specific information for developing goals to attain higher profit levels.

c. Number of variables limited to manageable proportions.

d. An indication of steps necessary in the firm's operations to reach profit goals.

e. A delineation of the significance and priorities of these steps to reach profit goals.

f. Provision of a standard[1] numerical value that measures management's progress toward desired goals at each accounting period.

To determine whether comparative operating data are sufficiently important in the decision theory of marketing management to merit this type of study, a review of literature on both decision theory and comparative data was made. The literature illustrates well comparative operating data's need and use. Additionally, a survey of selected businesses

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[1]The word "standard" is used here to indicate that numerical values of one firm can be compared to those of another.

unanimously supported the need for good comparative data. The survey further showed that firms have a working knowledge of comparative data, but its use is restricted because of lack of information.

To extract profit maximizing information from the comparative operating data and structure this information into a reliable predictive model, the following hypotheses were proposed:

a. That comparative operating data for highly profitable firms differ significantly from comparative operating data for less profitable firms.
b. That some items of comparative operating data can be identified as being of significantly greater value in determining the firm's degree of profitability than other items.
c. That comparative operating data models will reliably predict the profitability of firms other than those firms from which the model was created.

Support for these hypotheses was accomplished by using the operating statements of 451 wholesale automotive parts firms. All calculations were at a level of significance of .05 or higher. Additionally, support for (a) and (b) above was accomplished by using balance sheet data converted to financial ratios for forty firms. Balance sheets were not available from sufficient firms for support of (c), but the significance of this support with operating statement data was deemed satisfactory.

Management applications of the models to individual firms illustrate that the goals of this study defined above have been reasonably attained.

The statistical methodology employed, both for extracting maximizing information and for structuring the predictive models, was a multivariate analysis--multiple discriminant analysis and factor analysis.

The predictive models established in this study constitute management guidance only from one external area of information--comparative financial operating data. Future analyses and models of this nature are needed for marketing management guidance on other predictor variables internal to the firm, and on economic, geographic, sociographic, and psychographic variables.

PROFIT MAXIMIZING INFORMATION FROM COMPARATIVE OPERATING DATA

CHAPTER I

INTRODUCTION

Marketing management decisions are influenced by a broad spectrum of facts about the operations of the firm, the environment of the business organization, the people within the organization, the firm's customers, and the complex interrelationships of all of these variables. Ideally, the marketing manager would like to use a model of these complex interrelationships such that he could experimentally manipulate the model rather than use the firm's operations to test his ideas. This provides experimentation at lower cost and much lower risk.[1]

The multifarious array of interrelationships among the variables existing in a complex marketing system cannot be meaningfully studied as a totality. Rather, the

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[1]Philip Kotler, "Some Needed Extensions in the Theory of Marketing Programming," *Proceedings of the 1968 Fall Conference of the American Marketing Association*, pp. 57-62.

interrelationships of the entire system must be subdivided into manageable units of analysis.[2]

Comparative Operating Data Defined

Within many industries, reasonably representative samples of operating data are gathered. The information for each type of data is typically averaged or similarly classified for the firms participating in the sample. These data are distributed to firms in the industry as comparative operating data. The functions of collection, analysis, and redistribution of the data are performed by trade associations, large commercial firms with branch operations, trade publications, and others.

The nature of comparative operating information falls into several categories. The following are the most common:

(1) Operating statements which reflect the proportionate expenditures on various activities. (For example: advertising may represent 2.1 percent of sales and bad debts may represent .51 percent of sales.)

(2) Financial statements which list the outcomes of the operation expenditures. (The lists of assets, liabilities, and net worth are usually converted to ratios which reflect such measures

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[2]Robert Schlaifer, *Analysis of Decisions Under Uncertainty* (New York: McGraw-Hill, 1969).

as efficiency of operation, measurement of profitability, liquidity, and solvency.[3]

(3) Data which are of particular significance to the specific industry. (For example: sales per square foot of floor space, inventory turnover rate, and percent occupancy in motel rooms.)

Comparative Operating Data as a Unit of Study

Decision theory requires that some standard exists from which one can determine reality. Because comparative operating data show what other firms in an industry are doing, they help to establish standards. It is difficult to take into account all marketing factors simultaneously. Therefore, decision makers must break down their problem and think through the implications of one set of factors at a time. Comparative operating data are one means of examining a set of factors which have been expressed in numerical form.[4]

When a decision problem is broken down and an analysis made of the parts, the degree of decision success in recombining the parts is largely dependent upon the degree of uncertainty of any one part. If the problem's facts

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[3]Letter, J. H. Plunk, Division Vice President-Finance, T G & Y Stores to Arlie L. Bowling, January 21, 1971, Oklahoma City, Oklahoma.

[4]Schlaifer, *Analysis of Decisions*.

involve materials, distance, and machine capacity, the results may be measurable, specific, and relatively direct in nature. The meaning in comparative operating data, however, is influenced by many additional variables not specifically reflected in the data, such as customer response, competitor reactions, enthusiasm, knowledge, effort of people in the organization, and general economic conditions. Therefore, comparative operating data information represents facts about how a firm operated within the opportunities and limitations imposed on it by its particular market conditions. The uncertainty introduced into comparative operating data by these differences presents a challenge and a need for improved measurement of the value this information still has to other firms.

Comparative Operating Data and Decision Theory

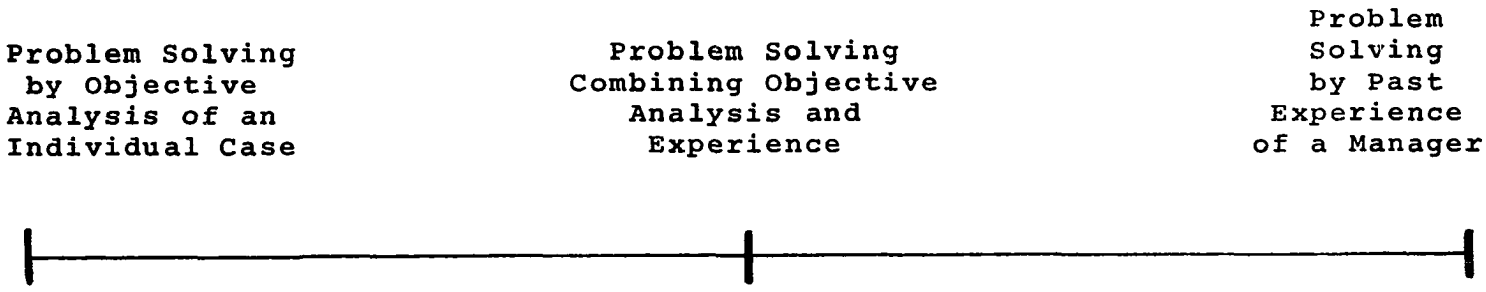
On a continuum of decision theory methods, it is academically and scientifically correct to use the objective approach as shown in Figure 1.[5] In practice, managers make many decisions from their procedures established by past experience. It is probable that most decisions fall someplace in the middle area of the continuum shown in Figure 1. The payoff on some business problems is not

---

[5]An adaptation of the theory developed in George Katona, "Habitual Behavior and Genuine Decision Making," *Psychology in Administration: a Research Orientation*, edited by Timothy W. Costello and Sheldon S. Zalkind (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965), p. 351.

FIGURE I

CONTINUUM OF DECISION METHODS



sufficient to cover the cost of using the objective approach, and sometimes information is not sufficiently complete. Therefore, standards must be developed for two purposes: (1) to aid in finding solutions to problems which involve some degree of uncertainty; and (2) to use as a standard for checking against reality when a solution to the problem is derived by the objective approach. Comparative operating data are often used as this standard.

Comparative operating data may be used when firms are confronted not only with the financial cost-payoff limitation but also with the limitations of time and the abilities of managers. An example of a time limitation might be the pressure for immediate action because of expected activity by a competitor. Comparative operating data are frequently used as a guide for the actions of managers for multiple branch operations as well as a basis for central office measure of their performance.[6]

Comparative data are normally used as historical information or as past experience. If more future-directed information can be extracted from comparative operating data, marketing problems can be solved more objectively.[7]

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[6]Peter D. Bennett, "SM's Exclusive Survey of Marketing Costs: a Preliminary Report," *Sales Management, the Marketing Magazine*, November 10, 1970, pp. 43.

[7]Edward I. Altman, "Financial Ratios, Discriminate Analysis, and the Prediction of Corporate Bankruptcy," *The Journal of Finance*, September, 1968, p. 604.

The Need for Maximizing of Information From Comparative Operating Data

The needs in marketing decisions are well illustrated by Philip Kotler.[8] He states:

> Marketing management in particular is in great need of specific normative theory to guide decision making in the five major decision areas:
>
> 1. The best product assortment.
> 2. The best level of total marketing effort.
> 3. The best allocation of marketing efforts over products, territories, and customers.
> 4. The best mix of different types of marketing effort.
> 5. The best timing of marketing effort.
>
> The word "best" is interpreted to mean decisions that maximize the firm's objectives subject to the constraints under which it operates.[9]

Terms used by Kotler and other writers such as "best," "optimal," and "maximizing," stress that information for marketing decisions be better than an "average" for the industry. A definite need exists to increase the predictive value of information from comparative operating data used for marketing decisions.[10]

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[8]Philip Kotler, "Some Needed Extensions in the Theory of Marketing Programming," *Proceedings of 1968 Fall Conference of the American Marketing Association*, pp. 57-62.

[9]*Ibid.*

[10]See results of industry survey, Chapter 2, p. 19.

Interest in this subject has been stimulated by the need to make decisions such as the following:

1. If one has an inventory greater than the average shown in comparative operating data, what is the probability it will result in more (or perhaps less) net profit?
2. Can one justify a large increase in advertising? What is the normal effect on net profit of larger than average advertising expenditures?
3. What is the effect of a high rent, high traffic location as compared to a low rent, low traffic location?
4. Can an increase in sales force be justified? What percent of sales seems optimal to spend on salesmen's salaries?
5. To increase capital assets, are firms usually more successful when they finance through long-term debt or through the sale of equity? What is the best capital structure?

These are the types of questions that need answering to facilitate "best" decisions as suggested by Kotler.[11] More information from comparative data would be helpful.

---

[11]Kotler, "Marketing Programming," pp. 57-62.

Definition of Terms

Terms frequently used in this study which may be subject to varying interpretations are defined for clarity.

1. *Comparative Operating Data* -- The United States Chamber of Commerce defines comparative operating data as follows:

> The statistics collected by associations or organizations are the basic, significant facts concerning various operational phases of the industry concerned. More specifically, they may relate to sales or shipments of the industry's products, production, cost of operation, wage rates, working conditions, and even the credit standing of customers.[12]

Interestingly the United States Chamber of Commerce states,

> Without appropriate statistical studies as a guide, many business enterprises would make about as much progress as a blind-folded burro in a revolving door.[13]

2. *Trade Association* --

> A nonprofit, cooperative, voluntarily-joined organization of business competitors designed to assist its members and its industry in dealing with mutual business problems in several of the following areas: accounting practices, business ethics, commercial and industrial research, standardization, statistics, trade promotion, and relations with Government, employees, and the general public.[14]

---

[12]Chamber of Commerce of the United States, *Modern Day Trade and Professional Associations* (Washington, D.C.: Chamber of Commerce of the United States, 1964), p. 11.

[13]*Ibid.*

[14]*National Trade and Professional Associations of the United States* (Washington, D.C.: Columbia Books, 1970), p. 7.

3. *Automotive After Market* -- The automotive *after market* is generally recognized as the market for automotive materials and services provided the consumer after his initial purchase of an automobile.
4. *The National Automotive Parts Association (NAPA)* -- The National Automotive Parts Association is an independent association of manufacturers, regional distributors, and jobbers in the automotive after market. Refer to Appendix A for additional information.

Organization of the Thesis

Chapter One shows the function of comparative operating data in marketing decision theory and the resulting need for profit maximizing information.

In Chapter Two a review of studies that have been made and a review of recent literature shows the position and significance of comparative operating data in decision theory as it relates to marketing management and marketing research. Chapter II also examines the increased need for better analysis in addition to fact gathering, as our use of electronic data processing advances.

To supplement the existing literature on the use of comparative operating data, a survey of several major corporations and trade associations was made. In

an attempt to discover whether this data is actually being used at the operating level, an additional survey of operating managers was made. These surveys are presented in Chapter II.

Chapter III describes the hypotheses tested and the source and nature of the comparative operating data used in this study. It also defines the methodological procedures used in the data analysis.

Chapters IV and V present the results of the analysis made. Chapter IV shows the findings derived from analyzing operating statements, and Chapter V shows the findings derived from analyzing financial ratios from balance sheets. Chapter VI presents the results of statistical analysis necessary to validate the comparative operating data predictive model. Particular application of the predictive model to specific firms is proposed to illustrate the information it can provide to the decision maker. Finally, areas of interest and additional research are discussed in Chapter VI.

CHAPTER II

REVIEW OF RELATED LITERATURE AND RESEARCH

Literature

In the search to determine if significant improvement can be made in the use of comparative operating data in marketing management decisions, a study of previously reported literature supports the need for this study and indicates procedures that might be used.

As a point of departure, the basic ingredient of problem solving and decision making theory may be defined as the individual. The exact way a decision is made is still a moot question. However, Costello and Zalkind state:

> An aspect of the thinking and problem-solving process. . .is concept formation. The formation of a concept is often a necessary step in problem solving; it may be the problem at times.[1]

This description concerning the necessity of an individual to develop a concept in order to solve a problem is

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[1]Timothy W. Costello and Shelton S. Zalkind, *Psychology in Administration: a Research Orientation* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965), p. 353.

applicable to the procedures used by individuals in defining and solving marketing organization problems.[2] The specific question being asked is, how are these concepts formulated in the business world?

In life reality is not an absolute but is determined by relative standards.[3] Our judgments about a present situation are frequently determined by making a comparison of the present situation to standards we have acquired.[4]

Relating this fundamental approach of problem solving to accounting and the business world, Anthony says,

> . . .it is the process of comparison that makes figures meaningful. In general terms, the process of analysis can be described as one of comparing what actually happened with a standard.[5]

Anthony lists several inherent difficulties in making such comparisons:

(1) Accurate comparative accounting data is difficult to obtain.

(2) Situations being compared may have differences.

(3) Definitions of terms are not always consensual.

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[2]Robert N. Anthony, *Management Accounting* (Homewood, Illinois: Richard D. Irwin, 1964), p. 293.

[3]Milton Rokeach, *Beliefs, Attitudes, and Values* (Los Angeles: Houghton-Mifflin, 1969), p. 138.

[4]Anthony, *Management Accounting*.

[5]*Ibid.*

(4) Comparative data are historical and may not be appropriate for future decisions.

Nevertheless, the need for information to use as standards or goals persists.

To illustrate the need for and use of comparative operating data as standards, Dr. Peter D. Bennett quotes from a firm's budget conference between the sales manager and the marketing vice president:

> Salesmen's salaries are running $420 per account (per year) handled, and $12 per sales call. How do these stack up with the rest of the industry, or for other firms in similar industries who also sell direct? Do they vary much by the size of the firm?
>
> Your travel funds indicate that you expect salesmen's travel to run $27 per travel day. How does that compare with other firms in the industry? How does it compare with anything?[6]

Dr. Bennett further states that "A crucial aspect of the cost accountant's methods is the development of *standards*."[7] He surveyed 500 firms to determine the extent of their interest in detailed comparative operating data which were applicable to their particular operation and its needs. Dr. Bennett reports:

> . . .96 percent of the sales and marketing executives said that such a set of standards would make substantial contributions to marketing efficiency. Eighty percent of the financial executives responding felt that

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[6]Bennett, "SM's Exclusive Survey," p. 43.

[7]*Ibid.*

> sales and marketing executives would realize the value of cost standards and utilize them effectively. It appears that marketing people realize that their performance is based on results per dollar of cost, and that a survey of marketing costs would be used by them, not on them.[8]

The Federal Trade Commission (FTC) published reports on 80 industries in 1941, including marketing costs. These data were crude and very general in nature. The FTC lumped similar costs together such as selling expenses and advertising. As a result, the variables studied lost much of their value for finding and solving problems.[9]

Robert M. Kaplan reports that computers have been used on routine, repetitive accounting tasks in business. He further states:

> The next level of sophistication in EDP (Electronic Data Processing) usage for business is in simulating complex business systems and in employing mathematical formulations (models) for analyzing business alternatives (operations research). However, this is a very young branch of computer application.[10]

Kaplan's motif when combined with the need for accurate and timely information for decision making, illustrates the need for marketing management simulation models.

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[8] *Ibid.*

[9] *Ibid.*

[10] Robert M. Kaplan, "Computer Applications in Marketing: An Analysis of Corporate Experience," *Proceedings of 1967 Winter Conference of the American Marketing Association* (Washington, D.C.: American Marketing Association, 1967), p. 118.

A study by Wilson and Greenidge[11] adds support to this study in two respects. First, it demonstrates that the use of return on investment data is extremely useful in analyzing and isolating the effect of information on the retailer's business. (Return on investment is used as the dependent variable in this study for financial statement analysis.) Second, it shows simulation to be a quality technique in performance measurement.

In a paper presented before the American Marketing Association, Leslie M. Harris states:

> Perhaps the most important area of computer utilization in the future will be simulation programs where a number of marketing and general business strategies can be evaluated to measure the effect of various marketing inputs on profitability.[12]

Net profit is used in this study as the dependent variable in analysis of the operating statements.

Edward I. Altman[13] has developed general procedures which might be used to maximize information from comparative operating data. He developed a two-way classification model for the purpose of predicting corporate bankruptcy.

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[11]Leslie M. Harris, "Electronic Magic for the Marketing Decision Maker," *Proceedings of the 1969 Fall Conference of the American Marketing Association* (Cincinnati, Ohio: American Marketing Association, 1969).

[12]*Ibid.*

[13]Edward I. Altman, "Financial Ratios, Discriminate Analysis and the Prediction of Corporate Bankruptcy," *The Journal of Finance*, September, 1968, p. 589.

Altman used numerous Multiple Discriminant Analysis (MDA) computer runs on different combinations of financial ratios. He continued this operation until he found an optimal group of five of twenty-two ratios that would most accurately assign firms to one of two classifications, "bankrupt" or "non-bankrupt." Altman also proposed a method for adjusting discriminant coefficients to accurately measure the relative significance among variables.[13] By contrast to Altman's use of two-way classification, in this study the investigator uses a multiple discriminant classification analysis to predict the profitability of firms.[14]

Using the discriminant coefficient model, Altman was able to assign firms to the correct classification of either bankrupt or non-bankrupt groups with 96 percent accuracy. The financial data used were from the year preceding bankruptcy. In Altman's study, the secondary sample was similar in size and nature to the primary sample from which the discriminant model was developed. The accuracy of Altman's predictive model using data from two

---

[13]Lester A. Neidell, "Procedures and Pitfalls in Cluster Analysis," *Proceedings of the 1970 American Marketing Association Conference* (Boston, Massachusetts: American Marketing Association, 1970), p. 20.

[14]When input data is expressed as deviations from their means, the discriminant coefficient for each variable should be multipled by the standard deviation for comparison of significance between variables in assignment to groups.

years prior to bankruptcy diminished to 72 percent. Though Altman's model worked well with a two year time lag, the difference between 96 percent with first year data and 72 percent with second year data indicates the need to use the most current data possible. The data used for this study were for the most recent annual accounting period.

Altman's study illustrates the use of discriminant coefficients, classification assignment (two way), and testing of the predictive model on a secondary sample for a validity check. A study by William F. Massey[15] extends these concepts to multiple classification and to development of a reduced variable model using factor analysis to identify the significant variables.

William F. Massey has developed a predictive model using a five group classification multiple discriminant analysis program to measure differences in radio audiences. The first step in the analysis is to reduce the 47 socio-economic variables from an audience survey to a manageable number which he did by factor analysis. He reduced the 47 variables to 12, and these serve as summaries of the original set. The 12 variables are subjected to the five-way multiple discriminant analysis as an attempt to predict which radio stations survey respondents would listen to. Using his model, Massey was able to predict audience

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[15]William F. Massey, "Discriminate Analysis of Audience Characteristics," *Journal of Advertising Research*, Vol. 5, No. 1 (March, 1965), pp. 39-48.

membership with 36.8 percent accuracy. Assuming that *a priori* probabilities are equal for membership in any of the five audiences (20 percent), the 36.8 percent predictive ability is statistically significant. Furthermore, Massey showed a statistically significant difference among the five audience classifications.

By examining the numerical values assigned to each variable in each group, Massey was able to determine those variables which were most indicative of the audiences of each station.

Through his model Massey provided marketing management with specific information from a close examination of differences among groups and differences within groups.

These examples from recently reported research illustrate the potential for maximizing comparative data information, utilizing statistically determined numerical values. They are of further assistance in telling the predictor how to use these numerical values to identify the variables of greatest significance.

A Survey of the Usage of Comparative Operating Data from Selected Organizations

In the first part of this chapter, it was shown that current literature supports the need for, and improved use of, comparative operating data. The researcher conducted a survey to determine the importance of these data to selected agencies, as well as how they collect, analyze, and use them.

A copy of the survey form is shown in Appendix B. This survey form, with an accompanying letter of explanation was sent to seven major United States corporations. These corporations were selected because they represent a large number of merchandising outlets which have a need for comparative operating data. The survey form was also sent to seven major trade associations who serve large memberships and who had sufficiently large operating budgets that studies of comparative operating data could be handled. Six responses were received from major corporations and six from the trade associations. One corporation and one trade association made only token responses to the questionnaire. However, all other respondents indicated strong interest in comparative operating data, and many offered additional information through procedural publications. A brief summary of procedures used by some trade associations and firms are as follows:

Sears Roebuck and Company generates internally detailed operating data on all branches and subsidiaries in 52 merchandising categories. These data are distributed to administrative headquarters on a monthly as well as an annual basis. No procedures for maximizing information were noted.[16]

T G & Y gathers comparative operating data on all of its 800 stores. These data are analyzed by size and

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[16]Letter, J. F. Kincannon, Comptroller, Sears Roebuck and Company to Arlie L. Bowling, January 22, 1971, Chicago, Illinois.

type of store. Computer programs are used to detect controllable expense variations which have deviated from preset standards. This makes it possible to pin point problem areas for individual stores as early as possible. Although data are used to pin point problems, no procedures for maximizing profits were noted.[17]

Continental Oil Company generates information from within their own system to use for standards of operation for wholesalers and service stations.[18]

Phillips Petroleum Company operates similarly to Continental. However, they noted that E. K. Williams, a national auditing firm, specializes in service station statistics for improving operations.[19]

S. S. Kresge Company collects comparative operating data on 14 competitors in the mass merchandising industry. They use these data to establish ratios to be used as aids in measuring competitive standing and determining management operating standards for their merchandising industry. Their sources of information are: annual reports, annual reviews,

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[17]Letter, J. H. Plunk, Division Vice President, T G & Y Stores Company to Arlie L. Bowling, January 21, 1971, Oklahoma City, Oklahoma.

[18]Letter, J. J. Veteto, Coordinator-Accounting Policies, Continental Oil Company, to Arlie L. Bowling, January 20, 1971, Ponca City, Oklahoma.

[19]Letter, H. B. Stead, Comptroller, Phillips Petroleum Company to Arlie L. Bowling, January 5, 1971, Bartlesville, Oklahoma.

and *Standard and Poor's*[20] *Basic Industry Analysis I;* "Market Action" Section. The five groups of ratios used by the Kresge Company are liquidity, solvency, efficiency, profitability, and market action. No procedures for maximizing data were noted.[21]

The National Home Furnishings Association collects operating and financial statements plus other merchandising statistics from 1,000 firms. These data are analyzed and the information redistributed to approximately 10,000 firms. They use computerized procedures to convert raw data to ratios. Averages are computed for all classes of firms, by sales volume. However, first and fourth quartiles are omitted from the average computations. As a maximizing guide, an average of net profit and total expenses for the top one-fourth most profitable firms is computed. This average is then compared to an average of all firms.[22] Appendix C illustrates this procedure.

The National Retail Merchants Association collects financial and operating statements from 204 firms plus

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[20]Standard & Poor's, *Corporation Records* (New York: Standard & Poor's Corporation, 1971).

[21]Letter, B. V. Carrico, Jr., Assistant to the Treasurer, S. S. Kresge Company to Arlie L. Bowling, December 28, 1970, Detroit, Michigan.

[22]Letter, Robert P. Gruenberg, National Home Furnishings Association to Arlie L. Bowling, January 21, 1971, Chicago, Illinois.

merchandising statistics from 190 firms. They use computerized programs to convert raw data to percentages and to divide these percentages into sales volume categories. The resulting averages are reported to each firm that submitted data. The final report tells the firm how it ranks, ratio by ratio, compared to other stores of similar size and type.[23]

National Candy Wholesalers does not collect comparative operating data because of budget limitations.[24]

The National Retail Hardware Association collects operating statements, financial statements, and merchandising statistics from 782 stores. They analyze these data in detail using the following variables:

a. Size of sales

b. Type of store location

c. Product mix

d. High margin vs. low margin operations

e. Geographical area

f. Establishing ten-year trend of key ratios

g. Showing seasonal fluctuations in sales.

These data are distributed to approximately 10,000 hardware dealers and published in the *Hardware Retailer* which has a distribution of more than 40,000 hardware dealers.[25]

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[23]Letter, Jay Scher, General Manager, National Retail Merchants Association, to Arlie L. Bowling, January 19, 1971, New York, New York.

[24]Letter, Ray Foley, Executive Vice President, National Candy Wholesalers Association to Arlie L. Bowling, January 19, 1971, Washington, D.C.

[25]Letter, Thomas H. Jenkins, Research Director, National Retail Hardware Association, to Arlie L. Bowling, January 11, 1971, Indianapolis, Indiana.

To guide their retailers toward greater profits, the National Retail Hardware Association provides a comparison between the one-third stores with the highest total earnings and the two-third stores making up the balance. Appendix D shows this data comparison for 1969.

The National Builders Hardware Association collects data from 62 builder's hardware distributors in the form of operating statements, financial statements, and merchandising statistics. Data are analyzed and information redistributed to 437 member firms. On some variables the data are divided into sales categories of high, average, and low groupings of firms.[26]

The large number of data that are examined by industries indicates the importance of and need for operating standards. Although two organizations prepare information on the most profitable firms as a guide to maximizers, no measurement of the significance of the differences in most profitable versus less profitable data have been made.

The survey responses indicate that comparative operating information is generally used more to avoid operation errors than as a guide to profit maximization.

Telephone calls were used as a follow-up to part of the surveys to clarify some responses, to provide additional information and to verify the significance of comparative operating data.

[26]Letter, Richard M. Hornaday, Director of Member Service, National Builders Hardware Association to Arlie L. Bowling, January 5, 1971, New York, New York.

Some of the more significant calls are listed in the bibliography.

A Survey on How Comparative Operating Data Are Used in the National Automotive Parts Association

A limited survey of National Automotive Parts jobbers was conducted by personal interviews to determine the extent and value of comparative operating data in making marketing management decisions at the jobber level. Nine managers, who own or operate a total of sixteen jobber operations within Oklahoma were interviewed. A copy of the survey questionnaire which was used as a guide for the open-ended interviews is shown in Appendix E.

All nine jobber managers were familiar with the NAPA's comparative operating statements. Seven of the nine made at least some comparison between their operating data and the NAPA data. Five of the seven who made comparison received "limited" value from the comparisons, and two received "real" value from the comparison.

Operating statement items most frequently compared were as follows: labor (all seven times); rent (five times); gross profit (two times); and utilities, inventory turnover, bad debts, and advertising (one time each). A summary of this survey is shown in Appendix F.

Specific decisions made by using comparative data were as follows:

1. "Determined both rent and labor on opening a new store."
2. "Used it as a guide on inventory turnover and gross margin."
3. "Determined total expenditures for salaries and commissions."
4. "Primarily on wages. Wages can be changed. Utilities and many other factors cannot be changed so easily."
5. "Increased advertising 25 percent to comparative level--result was 1/3 increase in business in 1970."

Additional comments made by jobber managers were as follows:

1. "Need data classification by type of clientele."
2. "Needs to be condensed to fewer variables."
3. "Question Data--it seems too low, particularly labor figure."
4. "Need data by geographical location such as metropolitan, suburban, rural, etc."
5. "Too many variables for small operations."

In summary, the survey made by the researcher showed that jobbers are familiar with operating data. They endeavor to make comparisons but feel that the value of such comparisons is limited. The comparative data are used to make some specific decisions, but according

to the jobbers, usually just as a mental guideline. Additional comments volunteered by five jobber managers indicated a need for more information from comparative data. None explicitly suggested the need for profit maximizing comparative data; implicitly, it is inferred from their continuing use of the averaged data and their expressed desires for more information that profit maximizing comparative data would enhance the value of comparative data.

CHAPTER III

DATA AND METHODOLOGY

As shown in Chapter I, some form of comparative operating data is a vital element in management decision making. It may serve as a standard against which firms compare their own results, or it may serve as a goal for firms to seek. The need for maximizing information is illustrated by Kotler's[1] emphasis on making the best decisions and on maximizing the firm's objectives in the five major decision areas.[2]

The literature review in Chapter II illustrates that methods and techniques have been used to develop predictive models from comparative data. Altman's model predicted the probability of bankruptcy for firms. Massey's model predicted characteristics of the listeners of radio stations. The state of the art is that predictive models can be developed if differences in data are adequately defined.

A survey by this writer of selected organizations showed that they collect and use comparative operating

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[1]Kotler, "Marketing Programming," pp. 57-62.

[2]Refer to page eight.

data. They would like more information from it. A survey of National Automotive Parts Association jobber managers verifies that they use their comparative operating data. They are not satisfied, however, with the information they get from averaged comparative operating data.

The purpose of this study is to extract profit maximizing information from comparative operating data and to develop this information into a predictive model that will aid the marketing manager in profit making decisions.

Hypotheses

In the search to determine whether significant improvement can be made in comparative operating data for use in marketing management decisions, the hypotheses fall into three categories.

For comparative operating data to be used for profit maximizing decision purposes, some identifiable differences would need to exist between the data for profitable firms and the data for less profitable firms. Thus, one of the hypotheses to be tested is:

H-1: That comparative operating data for highly profitable firms do not differ significantly from the comparative operating data for less profitable firms.

If data for profitable firms do differ from data for less profitable firms, then profit maximizing managers need

to know which items of comparative operating data are most significant in determining the profitability of the firm. Thus, the second hypothesis to be tested is:

H-2: That no items of comparative operating data can be identified as being of significantly greater value in determining the firm's degree of profitability than other items of comparative operating data.

If the effect on profit of the various items of comparative operating data is defined, a model to predict profitability can be developed from a group of firms with some degree of accuracy. The application of this model to firms not used in developing the model measures the precision or validity of the model. Thus, the third hypothesis to be tested is:

H-3: That comparative operating data models will not predict the profitability of firms other than those firms from which the model was generated.

Rejection of the above three null hypotheses should provide information for the development of a model to supply profit maximizing information from comparative operating data.

The Nature and Source of Data

The comparative operating data used in this research were provided by the National Automotive Parts Association.

The National Automotive Parts Association is generally known in the automotive after market as NAPA. The NAPA organization is described in Appendix A.

The NAPA comparative operating data used consisted of the operating statements for 451 jobbers and the balance sheets for 40 jobbers for the 1969 fiscal year. The operating statements are solicited annually from member jobbers on a standardized form. An example of the letter of instructions to the jobbers accompanying the form is shown in Appendix G. An example of the report form used is shown in Appendix H. After the forms are returned by the jobbers to NAPA headquarters, they are examined for completeness and comparability by an accounting firm and forwarded to the *NAPA Distribution Center* in Columbus, Ohio, to be readied for Electronic Data Processing (EDP).

The operating statement data supplied were entered into the computer program from IBM cards. Each card represented one line of information from the operating statement of one of the sample firms. The data from the 451 firms fell into the sales categories shown in Table III-1. These data were transcribed to a computer tape to facilitate programming and to avoid excessive card sorting time.

The balance sheets received from NAPA were limited to 40 statements, all in the largest sales category (over $250,000 of annual sales). These statements are also examined by a certified public accountant to assure

TABLE III-1

DISTRIBUTION OF FIRMS THAT SUPPLIED OPERATING STATEMENTS BY SALES VOLUME

Sales Category	Number of Firms
Up to $100M Sales	83
$100M to $150M Sales	95
$150M to $200M Sales	85
$200M to $250M Sales	60
Over $250M Sales	128
Total	451

comparability. These data for this study were supplied by NAPA in work sheet matrix form. Upon receipt, the data were converted to financial ratios, and the ratios were punched on computer cards for programming purposes.

Some bias in these NAPA data is inevitable since :

(1) A general tendency among firms reporting in cases of this sort is for more of the successful firms to submit reports than firms that have a poor profit period.

(2) Firms that are branch operations of corporations operating regional distribution warehouses are not included in these comparative data. (The data in the study represent independent franchise jobbers.) However, selection bias did not seriously affect the objective of this research study, since its purpose was to demonstrate that information much more useful for marketing decisions than "average" information can be extracted from comparative operating data. This bias would be of some concern in the use of a model developed to analyze firms not represented by the data collected.

Research Methodology

General Procedures Used

A review of literature in relation to the hypotheses set forth reveals that a statistical test

called a *Multiple Discriminant Analysis* has been used quite extensively and successfully in previous studies.[3]

In the analysis of the operating statements, an attempt is made to show how these can be used to maximize profitability.[4] This is accomplished by several analysis steps. First, 220 firms randomly selected for the model building group have been divided into one of five sales categories. (See Table III-2) The one-fourth most profitable firms are then place in the first quartile. The second one-fourth most profitable firms are placed in the second quartile; and so on. Next, those areas of the firm's reports that are most significant to the operating profit of the company have been identified. Some of these areas are as follows (1) salaries, (2) car expenses, (3) salesmen's salaries, (4) taxes, (5) depreciation of equipment, (6) insurance, (7) utilities, and (8) incidental supplies. For statistical purposes these areas of expense are

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[3]Paul E. Green and Donald S. Tull, *Research for Marketing Decisions* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966), p. 369.

[4]*Maximize Profitability* is used here in an accounting sense, referring to profit as a percent of sales and is not concerned with the general question of whether firms do or do not maximize profit.

TABLE III-2

FIRMS DIVIDED BY SALES CATEGORY AND PROFIT QUARTILE

Profit Quartile	Sales Category				
	Up to $100,000	$100,000 to $150,000	$150,000 to $200,000	$200,000 to $250,000	$250,000 and up
1st Quartile	N = 10	N = 12	N = 10	N = 7	N = 16
2nd Quartile	N = 10	N = 12	N = 10	N = 7	N = 16
3rd Quartile	N = 10	N = 12	N = 10	N = 7	N = 16
4th Quartile	N = 10	N = 12	N = 10	N = 7	N = 16
TOTALS:	N = 40	N = 48	N = 40	N = 28	N = 64

referred to as variables. Each of these variables represented a certain amount of the total budget of the firm. In order to be able to compare the variables in a meaningful way, each of the variables was converted to a percentage by dividing the amount spent for each variable by net sales. These percentages were used as the predictors in determining the profitability of the firms. In other words, the MDA statistical program compares the operating percentages of the most profitable firms with the operating percentages of the less profitable firms. The questions being answered with the MDA program might well be as follows:

(1) What are the differences between the predictors in the profitable and unprofitable firms?

(2) If these differences are in the operating decisions of the firm, how do the more profitable firms conduct their operations differently from the less profitable firms?

In other words, do the more profitable firms have a way of distributing their finances that makes them the most profitable?

After the variables or expense accounts of each firm have been given a numerical value (a percentage of sales) these percentages are combined into a profile for that firm. This profile is simply a score or numerical value made up of individual percentages of the budget items. The multiple discriminant analysis (MDA) statistic

actually compares the profiles of each of the different firms in the four profit quartiles. By comparing these profile scores, a comparison of the expenses of each of the firms can be made to determine their differences. *Second*, the MDA can determine which variables cause most of the differences among the firms of any one quartile or group. *Third*, the MDA can determine those variables which can be used most successfully for predictors of future success or failure of the firm. *Fourth*, the MDA can establish procedures for assigning new firms into profit quartiles by the profile score assigned to them.

The MDA actually compares the financial data of a particular firm by considering each of the expense items of the firm individually. According to the amount of the total budget spent for each item, a firm is then assigned a profile score. These profile scores are compared for each of the firms of the profit quartile involved. The budgets of those firms in profit quartile number one are compared to the budgets of firms in profit quartile number two, three, and four; the firms in profit quartile number two are compared to firms in profit quartiles number three and four; etc. Through these comparisons of budgets and expenses, an eventual pattern may emerge that will distinguish the more profitable firms from the less profitable firms. The results of such calculations can be checked by entering the data from several other firms

(not those on whom the prediction model was developed), and checking the model's ability to categorize these firms correctly.

It seems necessary to inject a note of explanation concerning the use of a computer to execute the multiple discriminant analysis statistic on the data collected in this study. Contrary to common belief, there is nothing magic or mystical about computers or computer-based statistical analysis. Equally mystical is the belief that "If I can only get the data on IBM cards everything will be all right." This is not so. The only justifiable reason for using a computer in statistical analysis is when the amount of calculations is simply not feasible by hand. Such is the case in this study. The number of variables of each firm (18), and the number of firms (220) must be compared on all the possible combinations of variables and firms. Since this computes to be approximately 876,245 to the 100th power ($876,245^{100}$) the calculations of such comparisons is virtually insurmountable in any way except by computer. Through computer analysis these computations were completed in a fraction of the time needed to do the same thing by hand.

Determining the Score Profile (Z value) of the Firms

Before the firms can be compared in a meaningful way, it is necessary to assign them a common or standard number based on their budgetary distribution of funds. This

profile is computed by multiple discriminant analysis. Multiple disciminant analysis involves four main objectives.[5]

1. Testing whether significant differences exist among the average "score" profiles of the *a priori* defined groups, assuming group covariation and dispersion are equal and the distributions are multinormal.[6]
2. Determining which variables account most for such inter-group differences in average profile.
3. Finding linear combinations of the predictor variables that enable the analyst to represent the groups by maximizing among-group relative to within-group separation.
4. Establishing procedures for assigning new individuals whose profiles, but not group identity, are assumed to be from one of the *a priori* defined groups.[7]

Objectives one and four will be used in solving hypothesis one, regarding the difference between operating data for profitable firms and less profitable firms. Objective two will be used in solving hypothesis two, regarding the extent to which various items of comparative operating data determine the firm's profitability. Objectives two and three will be used in solving hypothesis three, regarding the ability of the model to predict for other firms.

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[5]Paul E. Green and Donald S. Tull, *Research for Marketing Decisions* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966), p. 369.

[6]The quartiles of firms in descending order of profitability are the *a priori* defined groups for this study.

[7]Green and Tull, *op. cit.*

The multiple discriminate analysis (MDA) technique has the advantage of considering an entire profile of characteristics common to the relevant firms, as well as the *interaction* of these properties. A univariate study, on the other hand, can only consider the measurements used for group assignments one at a time.

Through multiple discriminant analysis the investigator will attempt to find linear combinations of the original variables that maximize the *ratio* of among- to within-group variability. Therefore, the analysis is transformed into its simplest form, one plane with two dimensions. The discriminant function of the form

$$Z = c_1x_1 + c_2x_2 + \ldots + c_nx_n$$

where $c_1, c_2, \ldots c_n$ = Discriminate coefficients

where $x_1, x_2, \ldots x_n$ = Independent variables,

transforms individual variable values to a single discriminant score of Z value which is then used to assign a firm to the appropriate category. The MDA computes the discriminant coefficients, c_j, while the independent variables, x_j, are the actual input values.

The initial MDA[8] programs for both operating statements (See Chapter IV) and for balance sheet data (See Chapter V) had such a large number of independent variables, that the strength of the more significant variables was not readily apparent. To enhance the value, both for analysis purposes and for use by marketing managers, the

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[8]Computer program used for multiple discriminant analysis is BMD05M, *Biomedical Computer Programs* (Berkeley: University of California Press, 1970), as programmed by IBM for 360-50 computer but modified to increase the number of independent variables from 10 to 18.

number of variables had to be reduced.[9] This was done by selecting those independent variables with the largest coefficient absolute values and rerunning the multiple discriminant analysis program with fewer variables. A difficulty of this procedure is that there is no satisfactory measure of the within-group variance that is still retained in the problem after reduction in the number of variables. In order to reduce the number of variables and still retain most of the information of the original problem, a factor analysis program[10] was run to relate the reduction of quantity of variables to the within-group variance, in the reduced variable model. The within-in group variance accounted for by each of the original independent variables is reflected in the cumulative percentage of eigen values when the program is started with a zero eigen value.[11] The zero eigen value results in no reduction in the number of factors when the factor analysis program is run. For example, the cumulative percentage of within-group variance accounted for by six of the eighteen variables may represent 95 percent of the variance. In this case the six variables would be the significant independent variables.

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[9]Ideally, it would be desirable to use the rotated factor matrix (varimax) to reduce the number of variables to be used as input for the multiple discriminant analysis program, but this procedure was ruled out for reasons described in Appendix I, Part 2.

[10]*BMD03M, Biomedical Computer Programs* (Berkeley, California: University of California Press, 1970), as programmed by IBM for the 360-05 computer.

[11]Eigen value problems are concerned with boundary value problems of differential equations containing parameters. As used here the zero eigen value provides maximum boundaries to avoid reduction in the vectors of the factor analysis program such that cumulative within variance can be observed for n-1 variables.

After the final MDA run with a reduced number of variables, the success of the model is determined in two ways:

1. The MDA program computes the generalized Mahalanobis D^2 statistic. This statistic may be used in a contingency table to test the hypothesis that the mean values are the same in all the groups for all the variables.
2. The *a priori* probability of a firm being assigned to one of the four quartiles is 25 percent. The extent to which the model exceeds 25 percent correctly assigning firms to groups is a measure of the predictive index of the model.

To demonstrate the ability of the model to classify firms to groups, confusion matrices as illustrated by Massey[12] are used in Chapters IV and V. The diagonal data denote correct assignment, and the off diagonal denote error in assignment. Significant variables are identified in Chapters IV and V by matrices of discriminant coefficients relating independent variables to group functions.

Some of the more prominent writers who have developed the mathematical and statistical concepts to make possible the development of such predictive models are Cooley and Lohnes,[13] Frank, Massey, and Morrison,[14] Anderson,[15] Rao,[16] and Schlaifer.[17] A more

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[12]William F. Massey, "Discriminant Analysis of Audience Characteristics," *Journal of Advertising Research*, Vol. 5, No. 1 (March, 1965), pp. 39-48.

[13]W. W. Cooley and P. R. Lohnes, *Multivariate Procedures for the Behavioral Sciences* (New York: John Wiley and Sons, Inc., 1962).

[14]R. E. Frank, W. F. Massey, and G. D. Morrison, "Bias in Multiple Discriminant Analysis," *Journal of Marketing Research*, Vol. 2, August, 1965, pp. 250-58.

detailed description and mathematical presentation of multiple discriminant analysis is presented in Appendix I, Part 1.

In Chapter IV, we see the results of this analysis on the operating statements studied.

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[15]T. W. Anderson, *Introduction to Multivariate Statistical Analysis* (New York: John Wiley and Sons, Inc., 1958).

[16]C. R. Rao, *Advanced Statistical Methods in Biometric Research* (New York: John Wiley and Sons, Inc., 1952).

[17]Robert Schlaifer, *Analysis of Decisions Under Uncertainty* (New York: McGraw-Hill Book Company, 1969).

CHAPTER IV

ANALYSIS OF COMPARATIVE OPERATING STATEMENTS

The preceding chapters have defined the nature of comparative operating data and their significance and use in decision making in several areas of marketing management. The nature and source of data used in this study have been defined, and the methodological procedures to be used have been presented. This chapter, using the methodology described in Chapter III, shows the results obtained by analyzing operating statements. The goals of these analyses are as follows:

1. To determine whether comparative operating data for highly profitable firms differ significantly from comparative operating data for less profitable firms.
2. To determine if certain operating expense variables have greater significance than others in determining the firm's level of profit and to measure this significance.
3. To determine if predictive models structured from a primary sample of firms will correctly predict profitability for a second sample of firms.

Defining the Difference in Operating Data According to Profitability of Firms

Using the 451 operating statements of automotive parts jobbers supplied by the National Automotive Parts Association, an analysis was made to determine whether there is a significant difference in the operating expenses for high profit firms as compared to low profit firms.[4] Because the operating data differ according to sales volume, the firms' operating statements were sorted according to sales volume as shown in Table IV-1.

The firms used in multiple discriminant analysis were then sorted into quarile groups for each sales category. For example, the 40 firms in Sales Category I were sorted into equal sized quartiles as follows:

10 firms with profit ratios 10.35% and higher in group 1.
10 firms with profit ratios 10.34% to 5.59% in group 2.
10 firms with profit ratios 5.58% to 3.12% in group 3.
10 firms with profit ratios 3.11% and lower in group 4.

Profit ratios fell in ranges as shown above. The data were maintained in this format throughout the multiple discriminant analysis.

Having separated the firms within sales categories into four levels of profitability, the investigator determined whether there was a significant difference

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[4]The dollar information for firms was converted to percentages of net sales. Profit is defined in terms of operating net profit/net sales.

TABLE IV-1

NUMBER OF FIRMS BY SALES CATEGORY USED TO DEVELOP MODELS AND TO TEST PREDICTIVE VALIDITY OF MODELS

Sales Categories	Number of Firms Used in MDA to Build Model	Number of Firms Used For Validity Test of Model	Total Number of Firms
Up to $100,000 Sales	40	43	83
$100,000 to $150,000 Sales	48	47	95
$150,000 to $200,000 Sales	40	45	85
$200,000 to $250,000 Sales	28	32	60
Over $250,000 Sales	64	64	128

among the mean operating expense data for these four groups.

The means of the operating expense variables for each of the four groups for all five sales categories are shown in Tables IV-2 through IV-6. To determine whether a significant difference existed among the means of these four groups of firms in each sales category, two methods were used. The generalized Mahalanobis D^2 statistic is a statistical significance measure and shows the significance of the differences of the means of the variables among the four quartiles of profitability. When a difference in the means of the variables among the four quartiles is established, additional information is provided by the second method--constructing confusion matrices.[5] The confusion matrix shows the group assignments of firms correctly made to profitability quartiles and those incorrectly made by multiple discriminant analysis of the operating data of the firms.

The statistical significance of these group means differences is shown in Table IV-7. The information in Table IV-7 was calculated in Tables IV-2 through Table IV-6.

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[5]William F. Massey, "Discriminant Analysis of Audience Characteristics," *Journal of Advertising Research*, Vol. 5, No. 1 (March, 1968), pp. 39-48.

TABLE IV-2

MEAN OPERATING DATA FOR FIRMS IN SALES CATEGORY 1,
UP TO $100,000 ANNUAL SALES
(Data in terms of percent of net sales.)

Expense Variable	Group 1 Most Profitable Quartile	Group 2 Second Most Profitable Quartile	Group 3 Third Most Profitable Quartile	Group 4 Least Profitable Quartile
Shop Labor Sales*	0.19	0.00	0.46	0.19
Managers' Salaries	6.69	6.72	5.72	8.28
Salesmen's Salaries	0.34	0.73	0.37	1.64
Other Salaries and Wages	6.85	7.57	11.74	9.02
Total Wages and Salaries	13.88	15.02	17.83	18.94
Advertising and Sales Expense	0.48	0.38	0.54	0.63
Bad Debts	0.27	0.33	0.49	0.91
Car Expense-Sales	0.00	0.00	0.03	0.32
Car and Truck Expense-Delivery	0.81	0.99	1.09	0.81
Depreciation	0.31	0.53	0.42	0.48
Freight, Express, Parcel Post and Postage	0.73	0.87	1.13	0.95
Insurance	0.56	1.21	0.64	0.67
Heat, Light, & Water	0.48	0.88	0.74	0.79
Rent (or Equivalent)	1.42	2.25	1.89	1.99
Office and Store Supplies and Expense	0.72	0.79	0.98	0.59
Taxes	0.87	1.40	1.23	1.63
Telephone and Telegraph	0.67	0.76	1.02	1.04
Miscellaneous and General Expense	1.87	1.53	1.69	1.83

Mahalanobis D^2 statistic 202.63 with 54 d.f.is significant at .005 which allows the rejection of the null hypothesis that the means of the variables of the four groups are the same.

*Expenditures for shop labor expense were not available, so sales of shop labor was used as an expense variable on the assumption that a close relationship exists.

TABLE IV-3

MEAN OPERATING DATA FOR FIRMS IN SALES CATEGORY 2,
$100,000 to $150,000 ANNUAL SALES
(Data in terms of percent of net sales.)

Expense Variable	Group 1 Most Profitable Quartile	Group 2 Second Most Profitable Quartile	Group 3 Third Most Profitable Quartile	Group 4 Least Profitable Quartile
Shop Labor Sales*	1.62	1.32	1.48	0.68
Managers' Salaries	5.06	5.88	7.15	7.44
Salesmen's Salaries	1.14	0.82	0.85	0.88
Other Salaries and Wages	7.70	9.41	8.32	9.60
Total Wages and Salaries	11.86	16.10	16.33	17.92
Advertising and Sales Expense	0.68	0.48	0.35	0.68
Bad Debts	0.22	0.39	0.21	0.70
Car Expense-Sales	0.16	0.02	0.15	0.31
Car and Truck Expense-Delivery	0.50	1.23	1.62	0.88
Depreciation	0.72	0.56	0.42	0.89
Freight, Express, Parcel Post and Postage	0.82	0.76	0.45	0.96
Insurance	0.69	1.16	0.74	0.96
Heat, Light and Water	0.69	0.59	0.53	0.69
Rent (or Equivalent)	1.40	1.85	2.11	1.56
Office and Store Supplies and Expense	0.66	0.53	0.67	0.79
Taxes	1.62	1.59	1.33	1.73
Telephone and Telegraph	0.59	0.76	0.81	0.85
Miscellaneous and General Expense	1.38	1.72	1.54	1.88

Mahalanobis D^2 Statistic 119.35 with 54 d.f. is significant at .005 which allows the rejection of the null hypothesis that the means of the variables of the four groups are the same.

*Expenditures for shop labor expense were not available, so sales of shop labor was used as an expense variable on the assumption that a close relationship exists.

TABLE IV-4

MEAN OPERATING DATA FOR FIRMS IN SALES CATEGORY 3,
$150,000 to $200,000 ANNUAL SALES
(Data in terms of percent of net sales.)

Expense Variables	Group 1 Most Profitable Quartile	Group 2 Second Most Profitable Quartile	Group 3 Third Most Profitable Quartile	Group 4 Least Profitable Quartile
Shop Labor Sales*	1.45	0.34	2.35	1.27
Managers' Salaries	3.14	4.72	4.87	7.82
Salesmen's Salaries	0.27	0.72	1.00	1.26
Other Salaries and Wages	10.79	10.47	10.85	11.16
Total Wages and Salaries	14.21	15.90	16.71	20.24
Advertising and Sales Expense	0.50	0.45	0.47	0.48
Bad Debts	0.27	0.46	0.50	0.50
Car Expense-Sales	0.07	0.04	0.00	0.06
Car and Truck Expense-Delivery	0.82	1.18	1.47	1.47
Depreciation	0.58	0.32	0.33	0.74
Freight, Express, Parcel Post and Postage	0.76	0.83	0.71	0.54
Insurance	0.80	0.61	0.80	1.07
Heat, Light and Water	0.52	0.36	0.54	0.60
Rent (or Equivalent)	1.41	1.17	1.94	1.58
Office and Store Supplies and Expense	0.52	0.69	0.56	0.76
Taxes	1.15	1.01	1.39	1.57
Telephone and Telegraph	0.78	0.59	0.83	0.93
Miscellaneous and General Expenses	1.09	0.94	1.79	1.39

Mahalanobis D^2 Statistic 713.38 with 54 d.f. is significant at .005 which allows the rejection of the null hypothesis that the means of the variables of the four groups are the same.

*Expenditures for shop labor expense were not available, so sales of shop labor was used as an expense variable on the assumption that a close relationship existed.

TABLE IV-5

MEAN OPERATING DATA FOR FIRMS IN SALES CATEGORY 4,
$200,000 to $250,000 ANNUAL SALES
(Data in terms of percent of net sales.)

Expense Variable	Group 1 Most Profitable Quartile	Group 2 Second Most Profitable Quartile	Group 3 Third Most Profitable Quartile	Group 4 Least Profitable Quartile
Shop Labor Sales*	3.78	2.43	0.88	1.91
Managers' Salaries	1.85	2.71	6.80	7.43
Salesmen's Salaries	0.51	1.61	0.50	1.60
Other Salaries and Wages	12.09	11.28	10.85	10.68
Total Wages and Salaries	14.44	15.60	18.16	19.72
Advertising and Sales Expense	0.44	0.45	0.57	0.43
Bad Debts	0.63	0.25	0.23	0.57
Car Expense-Sales	0.10	0.38	0.03	0.10
Car and Truck Expense-Delivery	0.67	0.69	1.54	1.19
Depreciation	0.56	0.55	0.58	0.80
Freight, Express, Parcel Post and Postage	1.21	0.91	0.48	0.64
Insurance	0.92	0.88	0.72	1.21
Heat, Light and Water	0.65	0.64	0.47	0.48
Rent (or Equivalent)	1.29	2.16	1.71	1.38
Office and Store Supplies and Expense	1.21	0.84	0.34	0.82
Taxes	1.42	1.45	1.38	1.38
Telephone and Telegraph	0.88	0.50	0.66	0.64
Miscellaneous and General Expense	1.23	1.17	1.58	0.86

Mahalanobis D^2 Statistic 214.90 with 54 d.f. is significant at .005 which allows the rejection of the null hypothesis that the means of the variables of the four groups are the same.

*Expenditures for shop labor expense were not available, so sales of shop labor were used as an expense variable on the assumption that a close relationship existed.

TABLE IV-6

MEAN OPERATING DATA FOR FIRMS IN SALES CATEGORY 5,
$250,000 AND UP ANNUAL SALES
(Data in terms of percent of net sales.)

Expense Variable	Group 1 Most Profitable Quartile	Group 2 Second Most Profitable Quartile	Group 3 Third Most Profitable Quartile	Group 4 Least Profitable Quartile
Shop Labor Sales*	2.11	3.20	1.43	4.11
Managers' Salaries	3.59	5.21	4.40	5.56
Salesmen's Salaries	1.49	2.58	2.05	2.80
Other Salaries and Wages	10.62	9.13	10.70	10.27
Total Wages and Salaries	15.70	16.92	17.16	18.64
Advertising and Sales Expense	0.47	0.62	0.36	0.57
Bad Debts	0.52	0.28	0.37	0.40
Car Expense-Sales	0.12	0.42	0.14	0.26
Car and Truck Expense-Delivery	0.58	0.64	1.06	0.86
Depreciation	0.50	0.63	0.56	0.81
Freight, Express, Parcel Post and Postage	0.66	0.65	0.45	0.61
Insurance	0.84	0.86	1.09	1.04
Heat, Light and Water	0.42	0.53	0.44	0.47
Rent (or Equivalent)	1.61	1.28	1.35	1.67
Office and Store Supplies and Expense	0.43	0.81	0.71	0.64
Taxes	1.59	1.41	1.54	1.52
Telephone and Telegraph	0.64	0.61	0.59	0.69
Miscellaneous and General Expense	1.11	1.09	1.26	2.39

Mahalanobis D^2 Statistic 111.05 with 54 d.f. is significant at .005 which allows the rejection of the null hypothesis that the means of the variables of the four groups are the same.

*Expenditures for shop labor expense were not available, so sales of shop labor were used as an expense variable on the assumption that a close relationship existed.

TABLE IV-7

GENERALIZED MAHALANOBIS D^2 STATISTIC MEASURE OF LEVEL OF SIGNIFICANCE OF MEAN DIFFERENCES OF OPERATING VARIABLES BY PROFIT QUARTILES WITHIN SALES CATEGORIES

Sales Category	D^2 Statistic	df**	Level of Significance*
1	202.63	54	.005
2	119.33	54	.005
3	713.38	54	.005
4	214.90	54	.005
5	111.05	54	.005

*D^2 Statistic applied to contingency table.

**Degrees of Freedom.

At .005 level of significance, the generalized Mahalanobis D^2 statistic allowed the researcher to reject the null hypothesis that the variable means of the profit quartiles within each sales category were the same. However, more information was needed to determine the specific group differences. Therefore, discriminant coefficients were computed[6] which were multipled times each firms operating expenses. This provided a discriminant (Z) score[7] for each firm by which the firm was assigned to quartiles representing one of the four levels of profitability. Through this assignment process, confusion matrices were derived from the group assignments by multiple discriminant analysis. The assignment of individual firms to groups and their probabilities are shown in Appendix J through N.

In Table IV-8 scores on the diagonal represent correct quartile assignments. Scores off the diagonal represent incorrect quartile assignments. The *a priori* probability that a firm would be assigned to the correct quartile is 25 percent. The computed t score of 9.85 with n = 40 is significant beyond the .005 critical level which indicates the discriminant scores computed by the MDA are legitimate.

Table IV-9 shows group assignment for firms in sales category two through five. The same interpretation applied to these tables as Table IV-8.

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[6]Refer to Step 7, Appendix I. [7]See page 40.

TABLE IV-8

PREDICTED PROFIT QUARTILE MEMBERSHIP OF FIRMS BY MULTIPLE DISCRIMINATE ANALYSIS*

(SALES CATEGORY I, SALES UP TO $100,000)

Actual Quartile Membership	Predicted Quartile Membership				
	1	2	3	4	Total
1	10	0	0	0	10
2	2	7	1	0	10
3	0	0	10	0	10
4	0	0	0	10	10
					40

Correct Assignments: 37 or 92.5 percent.
t score of 9.85 is significant at .005 level.

*Quartile 1 represents 25 percent most profitable firms. Quartile 2 represents 25 percent next most profitable firms, etc.

TABLE IV-9

PREDICTED PROFIT QUARTILE MEMBERSHIP BY MULTIPLE DISCRIMINATE ANALYSIS

(SALES CATEGORY 2, $100,000 to $150,000 ANNUAL SALES)

Actual Quartile Membership	Predicted Quartile Membership				
	1	2	3	4	Total
1	11	1	0	0	12
2	1	9	1	1	12
3	0	2	10	0	12
4	1	0	2	9	12
					48

Correct assignments = 39 or 81.25 percent.
t score of 9.05 is significant at .005 level.

(SALES CATEGORY 3, $150,000 to $200,000 ANNUAL SALES)

Actual Quartile Membership	Predicted Quartile Membership				
	1	2	3	4	Total
1	10	0	0	0	10
2	6	0	0	4	10
3	7	0	3	0	10
4	1	0	0	9	10
					40

Correct assignments = 22 or 55 percent.
t score of 2.98 is significant at .005 level.

(SALES CATEGORY 4, $200,000 to $250,000 ANNUAL SALES

Actual Quartile Membership	Predicted Quartile Membership				
	1	2	3	4	Total
1	5	0	1	1	7
2	2	5	0	0	7
3	0	0	7	0	7
4	1	0	0	6	7
					28

Correct assignments = 23 or 82.14 percent.
t score of 7.14 is significant at .005 level.

(SALES CATEGORY 5, $250,000 AND UP ANNUAL SALES

Actual Quartile Membership	Predicted Quartile Membership				Total
	1	2	3	4	
1	13	1	0	2	16
2	4	8	3	1	16
3	5	1	5	5	16
4	0	1	0	15	16
					64

Correct assignments = 41 or 64 percent.
t score of 7.22 is significant at .005 level.

The ability of the model to correctly assign firms to appropriate profitability groups by comparing their expenditures for operations is very high.

The percentage of overall correct assignment to profitability quartiles within sales categories is highest in sales category 1 which covers the smallest firms with annual sales up to $100,000. But predicting percentages for all categories as shown in Table IV-10 are sufficiently high to indicate that there is significant meaning in operating expenditures that can predict profitability.

Correct assignment to individual quartiles across sales categories is shown in Table IV-11. The model's ability to predict level of profitability from operating expenses is greater in the two quartiles representing the most profitable firms and the least profitable firms. These groups were predicted with 88.8 percent accuracy. Group 2 was predicted with 53.5 percent accuracy and Group 3 was predicted with 68.9 percent accuracy.

The null hypothesis that comparative operating data for highly profitable firms (Quartile 1) does not differ significantly from the comparative operating data for less profitable firms is rejected.

TABLE IV-10

CORRECT PROFILE QUARTILE ASSIGNMENT OF FIRMS WITHIN SALES CATEGORIES

Sales Category	Number	Percent*
1	37 out of 40	92.5
2	39 out of 48	81.2
3	22 out of 40	55.0
4	23 out of 23	82.1
5	41 out of 64	64.0

A priori probability of correct assignment is 25 percent.

TABLE IV-11

PERCENT CORRECT PROFIT QUARTILE ASSIGNMENT OF FIRMS ACROSS SALES CATEGORIES

	First Most Profitable Quartile	Second Most Profitable Quartile	Third Most Profitable Quartile	Fourth Most Profitable Quartile
Sales Category	1	2	3	4
1	100.0	70.0	100.0	100.0
2	91.5	75.0	83.5	75.0
3	100.0	0.0	30.0	90.0
4	71.5	71.5	100.0	85.6
5	81.2	50.0	31.2	93.6
Average	88.8	53.3	68.9	88.8

DEFINING FIRM DIFFERENCES IN EFFECT ON PROFIT OF INDIVIDUAL OPERATING EXPENSES

If the manager can measure the relative influence of each operating expenditure on profit, this would improve his ability to make profit maximizing decisions.

Analysis of the Meaning and Use of Coefficients

In multiple discriminant analysis, discriminant coefficients are computed by quartiles for each of the independent variables which in this problem were the eighteen operating expense items.[8] These coefficients themselves yield information about the relative importance of each operating expense insofar as discrimination between profitability groups is concerned.[9]

Table IV-12 presents the coefficients of the 18 operating expense variables from the four profit quartiles. Each coefficient represents the effect of the expense variable on the probability of classification in the

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[8]From a methodological point of view what we have done is to take our eighteen dimensional space and collapse the object points onto a single (discriminate) axis. This axis was found by computing a set of weights (coefficients) that maximize the separation between the four groups relative to their within variability.

[9]Green and Tull, *Research for Marketing Decisions*, p. 375.

TABLE IV-12

MULTIPLE DISCRIMINANT COEFFICIENTS FOR EIGHTEEN OPERATING EXPENSES AND PROFITABILITY QUARTILES

(Sales Category I)

Operating Expenses	Group 1 Most Profitable Quartile	Group 2 Second Most Profitable Quartile	Group 3 Third Most Profitable Quartile	Group 4 Least Profitable Quartile
Shop Labor Sales	-13.56	-17.03	-16.32	-20.03
Managers' Salaries	-30.26	-18.12	-135.07	-54.03
Salesmen's Salaries	-31.73	-19.05	-136.84	-55.13
Other Salaries & Wages	-30.86	-19.03	-135.84	-55.15
Total Wages & Salaries	34.64	23.02	140.53	60.05
Advertising & Sales Expense	11.73	10.30	13.34	18.28
Bad Debts	4.77	4.73	5.90	8.58
Car Expense, Sales	12.41	11.55	15.92	17.61
Car & Truck Expense-Delivery	8.38	10.04	11.00	12.49
Depreciation	.46	-3.60	-1.72	-1.75
Freight, Express, Parcel Post & Postage	8.36	10.17	11.22	12.34
Insurance	-1.27	1.90	-2.76	-3.17
Heat, Light & Water	10.25	15.79	16.47	17.80
Rent (or Equivalent)	-1.55	1.41	-1.41	-1.20
Office & Store Supplies and Expenses	5.03	4.15	6.91	4.12
Taxes	10.78	14.69	14.32	18.65
Telephone & Telegraph	15.46	18.97	21.96	24.83
Miscellaneous & General Expense	3.76	2.36	3.73	4.34

quartile. The coefficients are more sensitive measures of profit quartile characteristics than a similar table of the means of the expense variables. (See Tables IV-2 through IV-6) Moreover, the discriminant coefficients take into account correlations among operating expenses.[10]

Certain quartile characteristics can be observed by looking at the largest values of the discriminant coefficients for each of the operating expense variables in Table IV-12. An expense variable coefficient contributes most to the probability of classification in that profitability quartile for which its absolute values are largest. Expense variables whose coefficients are near zero for any quartile have little effect on the firm assignment probability for that quartile.

To illustrate the meaning of these coefficients, examine bad debt expense in Table IV-12. Group 1 and Group 2 are closely related at values of 4.77 and 4.73. Group 3 is somewhat higher at 5.90 and Group 4 jumps to 8.58. Bad debts are nearly twice as significant in assigning firms to Group 4 as they are in Groups 1 and 2.

In addition to analysis across columns, one can analyze the information within columns. For example, the 18.28 coefficient for advertising and sales expense in Group 4 is 2.1 times larger than the 8.58 coefficient for

[10] *Ibid.*, p. 44.

bad debt expense. If an equal change of expenses on these two items were made, the increase or decrease in expenditure on advertising and sales expense would have approximately twice the influence on profit that the comparable change on bad debts would have. These statements assume, of course, a comparability between the specific firm and those represented in the comparative data. Each situation needs to be considered by the decision maker as to whether this comparability may or may not exist.

The analysis of salaries as shown in Table IV-12 needs some explanation. It seems desirable to know the level of significance of the various forms of salary expenditures, so the three types of expenditures for salaries--Manager, Salesmen, and Other--were included in the analysis as well as their sum which is total wages plus salaries. Total Wages and Salaries is shown as a positive coefficient score. The three expense variables which constitute total wages have negative coefficient scores. In each quartile the values for these three wage variables are almost identical. This indicates that it did not matter whether the wages were spent for salesmen, managers, or other; the effects on profit results were the same. If the mean of these three labor variables is subtracted from total labor costs, the resulting figure represents the coefficient that should be used for comparison with other operating expense coefficients. In Table IV-12, Quartile 4 coefficient for total wages is 60.05. The coefficient for managers salary is -54.03.

salesmen's salary is -55.13, and other wages is -55.15. The mean of these three of -54.77 added to 60.05 gives a total wages and salary coefficient of 5.28 for comparative analyses.

The value of these discriminant coefficients can be more closely determined by examining the coefficient's function in the model formula:

$$Z = c_1x_1 + c_2x_2 + \cdots c_nx_n$$

where Z = the discriminant score which assigns firms to profitability groups
c = the multiple discriminant coefficient
x = operating expense independent variable expressed as a percent of net sales

The decision maker can examine the coefficients in Group 1 in Table IV-12 and make an incremental application to the above formula. For example, use only Advertising and Sales Expense and Rent for the variables. The coefficient for Advertising and Sales Expense is 11.73 and for Rent is -1.55. The mean for Group 1 (Table IV-2) for Advertising and Sales Expense is 0.48 percent of sales and for Rent is 1.42 percent of sales. Inserting these data into the model formula, we have:

$$Z = (11.73)(0.48) + (-1.55)(1.42)$$

$$Z = 5.67 - 2.20$$

$$Z = 3.47$$

Then, if we have a management decision to increase rent by .5 percent of sales by moving to a new location, the Z score would change to a lower figure:

$$Z = (11.73)(0.48) + (-1.55)(1.92)$$

$$Z = 5.67 - 2.98$$

$$Z = 2.69$$

The group assignment model is so structured that lower Z scores are assigned to the more profitable groups. From this information the decision maker can judge that in this particular group and sales category those firms who are spending more than the mean of 1.42 percent of the group for rent are making higher profits than those who spend less than the group mean of 1.42 percent. The operating data on rent and profit for firms in Group 1 of Sales Category 1 are presented in Table IV-13. When these figures were compared the analysis appeared to be correct.

The rent mean for the four most profitable firms was 2.25 percent of sales. These firms had an operating profit mean of 13.45 percent of sales. By comparison the four firms with lowest rent, a mean of .96 percent of sales, showed a mean operating profit of 12.06 percent of sales. This showed a mean profit advantage to the higher rent firms of 1.39 percent of sales.

Two possible implications of this analysis might be:

TABLE IV-13

RENT AND PROFIT DATA

Firms in Quartile 1, Sales Category 1* (Up to $100,000 sales per year)
(Data are expressed as percent of sales)

	Rent			Profit		
Firm Number	Percent of Sales	Computed Means of Selected Firms	Rank Order	Percent of Sales	Computed Means of Selected Firms	Rank Order
4868	3.46	2.25	1	10.35	13.45	9
4703	2.12		2	15.83		2
3037	1.99		3	15.97		1
2222	1.44		4	11.82		5
0107	1.38		5	10.67		7
3560	1.16	0.96	6	10.62	12.06	8
2718	1.16		7	14.47		3
3222	1.08		8	11.19		6
0118	.44		9	11.96		4

*This information was extracted from a magnetic tape containing common-form operating statements for all firms.

a. Firms with non-modern or less effective premises obtained at lower rental costs show less profit as a percent of sales.

b. Firms who pay more rent for high traffic locations show a higher profit return than those who rent low traffic locations.

Other explanations may be equally plausible. The manager of each firm must examine his particular situation.

Analysis of Profit Predictability Using Only the Most Significant Operating Expenses

To determine the extent to which management concern and control might suitably be restricted to a limited number of expense variables, a second multiple discriminant model was developed. If a high level of correct group assignments could be made with fewer variables, this would guide management's actions toward those operating expenditures most likely to yield results.

In order to select the correct expense variables, the following questions might be posed:

a. Which are the most significant expense variables?

b. How much of the within group variance will still be accounted for by the reduced number of variables?

To accomplish (a), the tables of multiple discriminant coefficients, Appendix O through S, were examined

to identify those expense items with largest absolute value coefficients.

To accomplish (b) a factor analysis[11] has been performed on the variables. The variables used in each sales category for the reduced variable multiple discriminant analysis model are shown in Table IV-14.

Like the first multiple discriminant model with 18 operating expense variables, the purpose of the reduced variable model is to determine whether significant differences existed among the group means. If they do, the attention of management when making decisions can be concentrated on fewer variables. The significance of the difference among group means is measured by the generalized Mahalanobis D^2 statistic and by the percentage of correct classification of firms to profitability quartiles. The statistical significance of group mean differences by sales categories is shown in Table IV-15.

Since the differences among the means of sales categories one through four are significant at the .005 level, the null hypothesis is rejected that the means of the variables of the four groups within each sales category are the same. The .06 level of significance for sales category five, however, does not allow rejection of the null hypothesis for that prediction.

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[11]W. J. Dixon, *Biomedical Computer Programs, BMD-05* (Los Angeles: University of California Press, 1970).

TABLE IV-14

OPERATING EXPENSE VARIABLES USED IN REDUCED VARIABLE MDA MODEL
(X indicates operating expenses variables used.)

Operating Expense	Sales Categories				
	1 Up to $100,000	2 $100,000- $150,000	3 $150,000- $200,000	4 $200,000- $250,000	5 $250,000- Up
Shop Labor Sales	X				
Managers' Salaries					
Salesmen's Salaries					
Other Salaries & Wages					
Total Wages & Salaries	X	X	X	X	X
Advertising & Sales Exp.	X	X	X		
Bad Debts		X	X	X	X
Car Expense, Sales	X	X	X	X	X
Car & Truck Expense-Delivery	X				
Depreciation		X	X	X	
Freight Express, Parcel Post & Postage	X		X	X	X
Insurance		X			X
Heat, Light and Water	X	X			X
Rent (or Equivalent)				X	X
Office and Store Supplies		X	X		X
Taxes	X		X	X	
Telephone & Telegraph	X			X	X
Miscellaneous & General Expenses					
Number of Variables Used	9	8	8	8	9

TABLE IV-15

GENERALIZED MAHALANOBIS D^2 STATISTIC MEASURE OF LEVEL OF SIGNIFICANCE OF MEAN DIFFERENCES OF OPERATING VARIABLES BY PROFIT QUARTILES WITHIN SALES CATEGORIES
(For Reduced Variable Model)

Sales Category	D^2 Statistic	d.f.**	Level of Significance*
1	70.06	27	.005
2	77.61	24	.005
3	59.00	24	.005
4	57.43	24	.005
5	39.35	27	.06

*D^2 Statistic applied to contingency table.

**Degrees of freedom.

To measure the ability of the model to predict profitability, its capacity to assign firms to quartiles within sales categories is shown in Table IV-16.

The ability of the reduced variable model compared to the original model to correctly assign firms to correct profitability quartiles by comparing their operations expenditures is shown in Table IV-17. Group assignment of firms was significant at the .005 level in all sales categories, but comparisons of the original model and the reduced variable model were made to determine which had greater value to the management of a particular firm.

The original 18-variable model predicted at least ten percent better in all sales categories than the model reduced to either eight or nine variables, except in sales category three. In the sales category $150,000 to $200,000 annual sales, the model developed from reduced variables produced a five percent better prediction.

Using only eight or nine of the original 18 variables, the model predicted profitability groups for firms correctly 64.6 percent of the time compared to 74.9 percent accuracy for the original model.

It has been demonstrated that:

1. The absolute value of a variable coefficient determines that variable's influence on the profitability of the firm.

TABLE IV-16

PREDICTED QUARTILE MEMBERSHIP BY MDA
REDUCED VARIABLE MODEL

Actual Quartile Membership	Predicted Quartile Membership 1	2	3	4	Total	Correct Assignment Percent
Sales Category 1, up to $100,000 Annual Sales						
1	9	0	1	0	10	90
2	2	7	1	0	10	70
3	0	2	8	0	10	80
4	0	1	1	8	10	80
32 correct out of 40 = 80% correct. t score of 8.10 significant at .005.						
Sales Category 2, $100,000-$150,000 Annual Sales						
1	10	0	2	0	12	83
2	1	6	3	2	12	50
3	1	4	7	0	12	58
4	1	1	2	8	12	67
31 correct out of 48 = 64.5% correct. t score of 6.32 is significant at .005.						
Sales Category 3, $150,000-$200,000 Annual Sales						
1	6	3	1	0	10	60
2	2	5	3	0	10	50
3	2	0	7	1	10	70
4	0	1	3	6	10	60
24 correct out of 40 = 60% correct. t score of 5.12 is significant at .005.						
Sales Category 4, $200,000-$250,000 Annual Sales						
1	5	0	1	1	7	71.5
2	1	5	1	0	7	71.5
3	1	0	5	1	7	71.5
4	1	0	2	3	7	42.9
18 correct out of 28 = 64.3% correct. t score of 5.87 significant at .005.						

TABLE IV-16
(Continued)

Sales Category 5, $250,000 and up Annual Sales

1		10	4	1	1	16	62.5
2		4	7	3	2	16	43.9
3		2	5	4	5	16	25.0
4		2	1	2	11	16	68.8

26 correct out of 48 = 54.2% correct
t score of 4.68 is significant at .005.

TABLE IV-17

CORRECT QUARTILE ASSIGNMENT OF FIRMS
BY SALES CATEGORY
A Comparison of the Reduced Variable Model
to the Original Model

Sales Category	Reduced Variable Model		Original 18 Variable Model
	Number of Firms Correctly Assigned	Percent	Percent
1	32 out of 40	80.0	92.5
2	31 out of 48	64.5	81.2
3	24 out of 40	60.0	55.0
4	18 out of 28	64.3	82.1
5	26 out of 48	54.2	64.0
	Mean =	64.6	Mean = 74.9

2. Because some variables have greater significance than others, a model can be developed in which approximately one-half of the operating expenditure variables can be used to predict within 10.3 percent of the accuracy obtainable with all variables.

These findings allow rejection of the null hypothesis that there are no items of comparative operating data identifiable as being of significantly greater value in determining the firm's degree of profitability than other items of the comparative operating data.

A Validity Sample Check for the Predictor Model

Both the original 18-variable operating expense model and the reduced variable model used the same firms to measure accuracy of predictions (correct assignment of firms to profit quartiles) that were used to construct the models. So that firms would be available to check the validity of the model developed, the data were divided into two parts. The first half of the firms was used in the initial model construction group. The second half was reserved for a validity check of the original model's ability to properly classify firms outside the model. This provided a check on (a) sampling errors in the original sample and (b) possible biases within the multiple discriminant analysis program.

All firms in the validity sample were sorted by sales categories and profitability quartiles such that each member of a group had an operating-profit-to-net-sales ratio within the range of that group in the original model. Discriminant scores[12] were computed for each firm and correct assignment was determined by matching each firm's discriminant score (Z score) to the group parameters determined by the Z scores of firms which were correctly assigned in the original 18 variable model. This method of checking the validity of a multiple discriminant analysis model is suggested by Frank, et al.[13] The detailed tabular results of this model testing are illustrated in Appendix T, and a summary is presented in Table IV-18.

The predictability by percent assignment on the secondary sample is lower, but the model still predicts at a significant level. This differential may be due to any or all of the following:

a. Bias caused by the small samples in groups within sales categories.

b. Additional restrictions imposed by using Z score parameters of only correctly assigned firms within groups of the original model to

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[12] Refer to page 40.

[13] R. E. Frank, W. F. Massey, and G. D. Morrison, "Bias in Multiple Discriminant Analysis," *Journal of Marketing Research*, Vol. 2 (August, 1965), pp. 250-258.

TABLE IV-18

SUMMARY VALIDITY TEST OF ORIGINAL MODEL ON SECONDARY SAMPLE

Sales Category	Percent of Firms Correctly Assigned to Profit Quartiles*	t test level of Significance*
1	46.5	<.005
2	55.4	<.005
3	62.2	<.005
4	50.0	<.005
5	59.3	<.005

*A *priori* probability was 25 percent.

classify secondary sample firms. This could curtail correct assignments of the secondary sample by ten percent with our group sample sizes of approximately ten.

c. Bias created within the computation of the multiple discriminate analysis program. For example, in some instances firms with Z scores compatible to a group could be assigned to some other group because the probability of assignment function results in overlapping Z scores among groups.[14]

The satisfactory level of percentage of correct assignment to groups and the .005 t-test level of significance in testing the original model on the secondary sample allows rejection of the third null hypothesis that comparative operating data models will not predict the profitability of firms other than those from which the model was developed.

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[14]The investigator proposed a set of four hypotheses regarding the group membership of a firm, one of which was to be accepted and the other three rejected. The general form for the likelihood of such a hypothesis might be written (Cooley and Lohnes, page 134): $P(H_j/X_i)$, $1 = 1,2,\ldots,N$ and $j = 1,2,\ldots,g$ which reads: The probability of hypothesis j, given the score vector of firm i. Hypothesis j states that individual i is a member of group j. There would be g (number of groups) such hypotheses for each individual, and the hypothesis (or group) with the highest probability was selected.

Statistical results described in this chapter lead to the following statements:

1. Comparative operating data for highly profitable firms differ significantly from the comparative operating data of less profitable firms.
2. Some operating expense variables have greater significance than others in determining the firm's level of profit.
3. The significance of this difference among operating expense variables can be measured.
4. Predictive models structured from a primary sample of firms can satisfactorily predict profitability for a secondary sample of firms.

CHAPTER V

ANALYSIS OF BALANCE SHEET DATA

Chapter IV analyzed the information obtained from the firm's operating statements. This chapter will apply a similar method of analysis to the data provided by the balance sheets of forty National Automotive Parts Association jobbers. The limited number of balance sheets from jobbers necessitated that they all be used to structure the predictive model and precludes the testing of the predictive model on a secondary sample of firms.

The goals of these analyses are as follows:

1. To determine whether or not the comparative financial data from balance sheets for highly profitable firms differ significantly from the comparative financial data for less profitable firms.
2. To determine if some financial data variables have greater significance than others in determining the firms' level of profit.
3. To measure this significance of financial data variables.

Development of Financial Ratios

Before analysis of data from balance sheets could be carried out, the data needed to be reduced to a common measure so that one firm could correctly be compared to another. In Chapter IV this common measure was easily accomplished by expressing each operating expense as a percent of sales. A single such common denominator was not available for balance sheet data. Instead various financial ratios were used. Historically, financial ratios have been used to detect operating and financial difficulties and to supply a qualitative type of information for assessing the credit worthiness or equity value of a particular firm.[1] The general use of financial ratios has been univariate in nature with emphasis placed on individual signals of impending problems.[2] The multivariate analysis measures a variable's significance while considering the influence and intercorrelation of the variable with all other variables. In this analysis the emphasis

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[1]Edward I. Altman, "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," *The Journal of Finance*, September, 1968, p. 589; Roy A. Faulke, *Practical Financial Statement Analysis*, Fifth Edition (New York: McGraw-Hill, 1961); Robert N. Anthony, *Management Accounting* (Homewood, Illinois: Irwin, 1964).

[2]An exception is Altman's "Financial Ratios," *op. cit.*, p. 589.

is on finding ratios that will predict the profitability of firms and the measurement of each ratio's significance.

What ratios should be used to predict profitability? Anthony[3] divides financial ratios into the following four categories:

1. Tests of profitability
2. Tests of liquidity
3. Tests of Solvency
4. Overall Measures

S. S. Kresge Company[4] divides ratios into the same basic categories as does Anthony except that they call the fourth classification "tests of efficiency" rather than "overall measures" and add "Capitalization Ratios on Capital Structure." Standard and Poor[5] use many ratios to describe the performance of firms. Financial ratios were needed for this model that might have value in predicting profit and that could be computed from the information reported on NAPA balance sheets. The following ratios were selected in five categories:

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[3] Anthony, *op. cit.*, p. 297.

[4] Letter, B. V. Carrico, Jr., Assistant to the Treasurer, S. S. Kresge Company, Detroit, Michigan, December 28, 1970.

[5] Standard & Poor's, *Corporation Records* (New York: Standard & Poor's Corporation, 1970).

1. Tests of Profitability:
   a. Operating Profit/Net Worth
2. Tests of Efficiency:
   a. Operating Profit/Net Sales
   b. Operating Profit/Total Assets
   c. Cost of Goods Sold/Inventory[6]
   d. Sales/Total Assets
3. Tests of Liquidity:
   a. Acid Test, Current Assets minus Inventory/ Total Assets
   b. Current Ratio, Current Assets/Current Liabilities
   c. Current Assets minus Current Liabilities/ Total Assets
   d. Inventory/Net Working Capital
4. Tests of Solvency:
   a. Current Liabilities/Net Worth
   b. Retained Earnings/Total Assets
5. Tests of Capitalization:
   a. Total Debt/Net Worth
   b. Long Term Debt/Total Assets

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[6]Anthony classifies inventory turnover as a test of liquidity. Within this model, it was considered primarily a test of the efficient use of inventory. Normally average inventory is used in this ratio, but only year end inventory information were available.

The first ratio listed above, operating profit/net worth[7] or return on investment, is an all inclusive variable because the only number that encompasses all the relationships of the other ratios is the return-on-investment ratio. An increase in net profit ratio indicates improved performance only if there has been no offsetting decrease in sales volume, increase in investment, or comparable changes. The return-on-investment ratio encompasses all these interrelationships. Yet the return-on-investment ratio is so broad that it does not give clues as to which of the underlying ratios may be responsible for apparent changes in it. Therefore, the model is structured with return-on-investment as the dependent variable and the other ratios are analyzed to determine the extent of their influence on the return-on-investment figure.

The financial statement raw data were prepared in ratio form on computer cards as described in Chapter III. All firms were in sales category V, $250,000 and up annual sales.

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[7]This ratio is a modification of the commonly used return on investment ratio. Usually net profit after tax is used rather than operating profit. The object of this study is to predict operating profit so this form has more value.

Defining the Differences in Financial Ratios According to the Profitability[8] of Firms

To arrange the firms in proper format for multiple discriminant analysis, they were sorted into quartiles of ten firms each. The return-on-investment ratios were as follows:

	Return on Investment
Quartile 1	1.443 to 0.334
Quartile 2	0.319 to 0.262
Quartile 3	0.251 to 0.171
Quartile 4	0.163 to 0.043

Having separated the firms into four levels of profitability, the researcher wished to determine whether there was a significant difference among the financial ratio means for these quartiles. The means of financial ratios for each quartile are shown in Table V-1.

Two methods were used to determine whether a significant difference existed among the means of these four groups of firms of different profit levels. The generalized Mahalanobis D^2 statistic gives a statistical significance measure of group mean differences. If the group means do differ significantly, additional information is provided by the second method--construction of a confusion matrix.[9] The confusion matrix shows the assignment of firms to

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[8] Profitability is measured in terms of return on investment.

[9] William F. Massey, *op. cit.*

TABLE V-1

MEANS OF FINANCIAL RATIOS BY PROFIT QUARTILES
(10 Firms per Group)

SALES CATEGORY $250,000 AND UP PER YEAR

Financial Ratios	Quartile 1 Return on Investment 1.443-0.334	Quartile 2 Return on Investment 0.319-0.262	Quartile 3 Return on Investment 0.251-0.171	Quartile 4 Return on Investment 0.163-0.043
Operating Profit/Net Sales	0.070	0.076	0.051	0.029
Operating Profit/Total Assets	0.203	0.205	0.133	0.058
Sales/Total Assets	2.890	2.721	2.860	3.279
Cost of Goods Sold/Inventory	4.069	3.401	4.055	3.401
Current Assets minus Current Liabilities/Total Assets	0.595	0.700	0.603	0.643
Current Assets minus Inventory /Current Liabilities	1.320	1.848	1.569	2.107
Current Assets/Current Liabilities	3.311	4.210	3.606	4.660
Current Liability/Net Worth	1.002	0.410	0.536	0.579
Inventory/Current Assets Minus Current Liabilities	0.880	0.781	0.865	0.844
Total Debt/Net Worth	2.661	0.524	0.799	0.916
Long Term Debt/Total Assets	0.304	0.055	0.084	0.126
Retained Earnings/Total Assets	0.130	0.376	0.234	0.466

Mahalanobis D^2 Statistic 180.77 with 36 d.f. is significant at .005 which allows the rejection of the null hypothesis that the means of the variables of the four groups are the same.

profit quartiles which were correctly made and those incorrectly made by analysis of the financial ratios of the firms.

The Mahalanobis D^2 statistic for differences in the group means was computed to be 180.77 with 36 degrees of freedom which shows the group means differ at the .005 significance level. See Table V-1. However, more information was needed to determine the specific mean differences. Therefore, weights (discriminant coefficients) were computed which were multiplied times each firm's financial ratios. This provided a standard or (Z) score for each firm by which the firm was assigned to a group. From this classification process, the confusion matrix showed a more exact level of mean differences for the groups.

Table V-2 is derived from the information in Appendix U--The Evaluation of Classification Quartile for Each Firm by Multiple Discriminant Analysis. In Table V-2 scores on the diagonal represent correct group assignments. Scores off the diagonal represent incorrect group assignments. The *a priori* probability that a firm would be assigned to the correct group was 25 percent. The t test was significant at .005. The ability to predict firm assignments to groups was 70 percent for the most profitable quartile. However, the model predicted with greater accuracy for the less profitable quartiles, re: 90 percent for the second

TABLE V-2

PREDICTED PROFIT QUARTILE MEMBERSHIP
BY MULTIPLE DISCRIMINANT ANALYSIS

(12 Financial Ratios)

Actual Quartile Membership	Predicted Quartile Membership					
	1	2	3	4	Total	Correct Assignment Percent
1	7	3	0	0	10	70
2	0	9	1	0	10	90
3	1	1	8	0	10	80
4	0	0	1	9	10	90

33 correct assignments out of 40 = 82.5 percent accuracy.
t test significant at .005.

quartile, 80 percent for the third quartile, and 90 percent for the fourth quartile.[10]

The null hypothesis that financial ratios for highly profitable firms does not differ significantly from the comparative operating data for less profitable firms was rejected.

Defining the Differences in Effect of Individual Financial Ratios on Profit[11]

If a manager can measure the relative influence on profit or return-on-investment of each of the financial ratios, this information could improve his ability to make profit maximizing decisions.

Analysis of the Coefficients of the Financial Ratios

In multiple discriminant analysis, discriminant coefficients are computed by groups for each of the independent variables which in this problem were the twelve financial ratios.[12] These coefficients themselves yield information about the relative importance of each financial

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[10] With reference to the Altman study referred to in Chapter II, page 18, it is interesting to note that his financial ratio model predicted bankruptcy with considerable accuracy and that in this study the financial ratio model predicts poor performance more accurately than high profit performance.

[11] Profit is measured in terms of return on investment.

[12] From a methodological point of view what has been done is to take our twelve dimensional space and collapse the object points onto a single (discriminant) axis. This axis was found by computing a set of weights (coefficients) that maximize the separation between the four groups relative to their within variability.

ratio insofar as discrimination between profitability groups is concerned.[13] [14]

Table V-3 presents the coefficients of the 12 financial ratios for four return-on-investment quartiles. Each coefficient represents the effect of the financial ratio on the probability of classification in the quartile corresponding to the particular discriminant function. The coefficients are more sensitive measures of group return-on-investment characteristics than a similar table of the means of the financial ratios. (See Table V-1) Moreover, the discriminant coefficients take into account correlations among the financial ratios.[15]

A financial ratio coefficient contributes most to the probability of classification in the return on investment group for which its absolute values are largest. Ratios whose coefficients are near zero have little effect on the firm's assignment probability for that group.

Analysis of Profit Predictability Using Only the Most Significant Financial Ratios

To determine how well a few of the more significant financial ratios would predict profitability, a second

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[13] Green and Tull, *op. cit.*, p. 375.

[14] For an illustration on how information can be extracted by analyzing a coefficient, refer to Chapter IV, page 65 on the analysis of the expense variable, rent.

[15] William F. Massey, "Discriminant Analysis of Audience Characteristics," *Journal of Advertising Research*, Vol. 5, No. 1 (March, 1965), pp. 39-48.

TABLE V-3

MULTIPLE DISCRIMINANT COEFFICIENTS FOR 12 FINANCIAL RATIOS
AND FOUR PROFITABILITY QUARTILES

Financial Ratios	Discriminant Coefficients			
	Quartile 1 Return on Investment 1.443-0.334	Quartile 2 Return on Investment 0.319-0.262	Quartile 3 Return on Investment 0.251-0.171	Quartile 4 Return on Investment 0.163-0.043
Operating Profit/Net Sales	-635.69	-555.75	-559.69	-938.34
Operating Profit/Total Assets	388.12	333.61	304.12	424.48
Sales/Total Assets	-99.59	-94.67	-95.90	-116.34
Cost of Goods Sold/Inventory	57.26	55.10	56.51	64.62
Current Assets minus Current Liabilities/Total Assets	414.39	403.14	398.65	421.44
Current Assets minus Inventory /Current Liabilities	-3.06	-4.04	-3.59	-10.68
Current Assets/Current Liabilities	.42	1.53	1.48	8.05
Current Liabilities/Net Worth	6.25	9.87	.07	17.29
Inventory/Net Working Capital	275.59	265.60	273.94	296.38
Total Debt/Net Worth	-12.40	-14.20	-11.05	-18.43
Long Term Debt/Total Assets	124.96	116.47	101.52	119.20
Retained Earnings/Total Assets	11.10	12.69	10.04	16.81

multiple discriminant model with a reduced number of variables was developed. If a high level of correct quartile assignments could be made with fewer variables, this would help to guide management's attentions to areas of decisions most likely to yield results.

To select the proper financial ratios to be used in the reduced-variable model, the following decisions are indicated:

a. How accurate will the prediction be by the reduced number of variables used in the model?

b. Which are the most significant expense variables?

As an attempt to answer these questions, to accomplish (a), a factor analysis[16] was made on all possible variables. The results of this computation are given in Table V-4. The financial ratios in Table V-4 are listed in order of absolute value of coefficients from highest to lowest.

Using the cumulative variance as a guide, seven variables in Table V-4 accounted for .99 of the variance. These identify significant input financial ratios for the reduced-variable, multiple discriminant analysis program to construct a predictive model. It is interesting to note that four of the seven most significant ratios were tests of efficiency; two were tests of liquidity; and one was a measure of capital structure. (See Table V-4)

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[16] W. J. Dixon, *op. cit.*

TABLE V-4

FINANCIAL RATIOS FOR REDUCED VARIABLE MODEL BY CUMULATIVE PERCENTAGE OF VARIANCE ACCOUNTED FOR

Financial Ratios	Number of Variables	Quartile 1 Return on Investment 1.443-0.334	Quartile 2 Return on Investment 0.319-0.262	Quartile 3 Return on Investment 0.251-0.171	Quartile 4 Return on Investment 0.163-0.043
Operating Profit/ Net Sales	1	0.651	0.547	0.603	0.425
Current Assets- Current Liabilities/Total Assets (b)	2	0.807	0.797	0.749	0.638
Operating Profit/ Total Assets (a)	3	0.879	0.894	0.851	0.803
Inventory/Net Working Capital (b)	4	0.944	0.973	0.930	0.883
Long Term Debt/ Total Assets (c)	5	0.978	0.990	0.976	0.948
Sales/Total Assets (a)	6	0.997	0.997	0.991	0.985
Cost of Goods Sold/ Inventory (a)	7	0.999	0.999	0.997	0.996

(a) Test of Efficiency (b) Test of Liquidity (c) Measure of Capital Structure

Like the first model with 12 financial-ratio variables, the purpose of the seven variable model was to determine whether significant differences existed among the group means. If it does, the attention of management could be concentrated on fewer variables. Again, the significance of the difference among group means was determined by the D^2 statistic and by the percentage of correct classification of firms to profitability quartiles.

The D^2 statistic for this analysis program was computed to be 70.06 with 21 degrees of freedom which is significant at the .005 level. This means that a significant difference does exist among the financial ratio data of the groups.

The next step was to further determine the strength of the differences of these financial ratio means by testing ability of the model to assign firms to the correct profit quartiles. Table V-5 shows firm assignments to quartiles by the reduced variable model.

The reduced variable model, using seven financial ratios, compared to 12 in the first model, correctly assigned firms to four groups with 67.5 percent accuracy. The *a priori* probability of assignment is 25.0 percent. The first model using 12 variables assigned firms to groups with 82.5 percent accuracy. This supports the following propositions:

TABLE V-5

PREDICTED QUARTILE MEMBERSHIP BY MDA
REDUCED VARIABLE MODEL
(Seven Financial Ratios)

Actual Quartile Membership by Return on Investment	1	2	3	4	Total	Correct Assignment Percent
1	6	1	2	1	10	60
2	1	7	2	0	10	70
3	2	2	6	0	10	60
4	0	0	2	8	10	80

Mean D^2 of 60.06 with 21 d.f. was significant at .005.
27 correct out of 40 = 67.5% correct assignment.
t score of 6.2 shows correct assignments significant at .005.

1. The absolute value of a coefficient determines the financial ratio's influence on the profitability of the firm.
2. Because some variables have greater significance than others, a model can be developed from seven financial ratios which can be used to assign firms to groups within 15 percent of the accuracy of the 12 financial ratio model.

This information rejects the null hypothesis that there are no items of comparative operating data that can be identified as having significantly greater value than others in determining the firm's degree of profitability.

These analyses of balance sheet data support the following statements:

1. Financial data for highly profitable firms differ significantly from the comparative operating data of less profitable firms.
2. Some financial data variables have greater significance than others in determining the firm's level of profit.
3. And this significance can be measured.

CHAPTER VI

THE NEED FOR AND SIGNIFICANCE OF COMPARATIVE OPERATING DATA IN PROFIT MAXIMIZING DECISIONS

Determination of Findings

Chapter I established the need for standards to guide people in making decisions. The standards may be goals to move toward or away from, whichever one wishes to do. In industries, comparative data provide standards which are generally used. The extent of this use was illustrated by the United States Chamber of Commerce.

> Without appropriate statistical studies as a guide, many business enterprises would make about as much progress as a blindfolded burro in a revolving door.[1]

The objective of this study has been to extract more information from comparative data. This could aid in obtaining greater profits rather than to have average information which tends to guide one to average profits.

This need for maximizing information for management is further illustrated in a review of current literature

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[1]*Modern Day Trade and Professional Associations* (Washington, D.C.: Chamber of Commerce of the United States, 1964.

where emphasis is on "best" procedures.[2] Peter D. Bennett's survey[3] demonstrated the high level of interest of business firms in better and more information to aid marketing decisions. The survey of trade associations (Chapter II) showed that industries have a very keen interest in comparative operating data. Trade associations consider the collection, processing, and redistribution of information one of their prime functions. The major merchandising corporations surveyed, all process, analyze, and use comparative data. The literature supports the idea that our state-of-the-art is such that we should now be able to utilize more information. For example, EDP (Electronic Data Processing) has generally been used for routine, repetitive tasks. Kaplan[4] states, "The next level of sophistication in EDP usage for business is in simulating complex business systems and in employing mathematical formulations (models) for analyzing business alternatives (operations research)." Predictive models have been developed and are illustrated in the writings of Cooley and Lohnes,[5] Frank, Massey and Morrison,[6] Anderson,[7] Rao,[8] and Schlaifer.[9]

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[2]Kotler, *op. cit.* [3]Bennett, *op. cit.*

[4]Kaplan, *op. cit.* [5]Cooley and Lohnes, *op. cit.*

[6]Frank, Massey and Morrison, *op. cit.*

[7]Anderson, *op. cit.* [8]Rao, *op. cit.*

[9]Schlaifer, *op. cit.*

Averaged comparative data, as has been generally used by industries, has limited value to the profit maximizer. The profit maximizer needs the following: (1) his position defined in the industry, (2) goals for higher profit levels indicated, (3) information on what steps are necessary in his operation to reach the new goals, (4) the order of significance or priorities of action to reach the goals, and (5) a measure of his progress toward these higher profit goals.

To construct predictive models which would accomplish these ends, the following propositions were tested:

a. Comparative operating data for highly profitable firms differ significantly from comparative operating data for less profitable firms.
b. Some items of comparative operating data can be identified as being of significantly greater value in determining the firm's degree of profitability than other items of comparative operating data.
c. Comparative operating data models can predict the profitability of firms other than those firms from which the model was made.

All these propositions were supported in Chapter IV using operating expenses from National Automotive Parts Association jobber's operating statements and Chapter V using financial ratios from National Automotive Parts Association jobber balance sheets.

In the process of supporting these propositions through multivariate techniques, an information model was structured for analyzing the profit maximizing needs of a firm. The model is best illustrated by applying it to the needs of specific firms.

Application of the Profit Maximizing Model to Firms

Two examples of application of the model illustrate its use. The first demonstrates the operating-expense model approach to profit maximizing. The second demonstrates the financial-ratio approach to profit maximizing.

1. Operating-Expense Model--Taking the most profitable firm from Quartile 3 in Sales Category I, Firm number 30-05, we have a firmadjacent to the median operating profit to sales ratio of 5.55 percent. Assuming the manager of Firm 30-05 would like to attain greater profits, he could make comparisons with operations of the most profitable Quartile. The firms in Quartile 1 have operating profit/sales ratios of 10.35 percent and up. As a first step, the manager would compare his operating expense data with the mean of operating expenses for Quartile 1 firms, the most profitable group. This information is shown in Columns 1 and 2 of Table VI-1.

In order for the manager of firm 30-05 to concentrate his effort where potential results are greatest he would do three things:

a. He would eliminate operating expenses with the smallest difference between firm 30-05 and the

TABLE VI-1

OPERATING EXPENSE COMPARISON OF A SINGLE FIRM
TO A PROFITABLE QUARTILE MEAN
(Data expressed as a percent of sales.)

Operating Expenses*	Firm 30-05 (1)	Mean Quartile 1 (2)	Col. 1 Minus Col. 2 (3)	Coefficients for Quartile 1 (4)
Total Wages & Salaries	16.61	13.88	2.73	34.64
Advertising & Sales Expense	.61	.48	.13	11.73
Bad Debts	.66	.26	.40	4.76
Car Expense-Sales	-0-	-0-	-0-	12.41
Car and Truck Expense-Delivery	1.75	.80	.95	8.37
Depreciation	.67	.29	.38	.46*
Freight, Express, Parcel Post and Postage	.80	.72	.08*	8.35
Insurance	.93	.55	.38	-1.26*
Heat, Light & Water	.55	.47	.08*	10.24
Rent (or Equivalent)	1.69	1.42	.27*	-1.54*
Office & Store Supplies and Expense	.78	.71	.07*	5.02
Taxes	.54	.87	-.33*	10.78
Telephone & Telegraph	.94	.67	.27	15.46
Miscellaneous & General Expense	.06	1.87	-1.81*	3.76

*Indicates operating expenses to be omitted from reduced variable model.

mean of Quartile 1 firms. See items marked with an asterisk in Column 3 of Table VI-1.

b. He would eliminate operating expenses with negative values in Column 3, since negative value indicates that he is performing as well or better than the firms in Quartile 1.

c. He would eliminate operating expenses with very small coefficients[10] in Column 4, Table VI-1 (Absolute Values).

The significant operating expense variables remaining in the model are those with the greatest probability of producing results for management in increasing the profitability of firm 30-05. See Table VI-2 for the reduced variable model. The reduction in the original number of variables has done three things for the manager. These are as follows:

a. It has reduced his problem to more manageable proportions.

b. It has set specific goals for action needed.

c. It has given him a measure of the importance as well as the possibility of making changes in each expense variable to qualify the firm for increased profit.

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[10]The meaning of this coefficient to the firm manager is that its magnitude tells how much effect this expense variable has on profit. Its size also tells the manager the extent to which data in Quartile 1 varied thereby influencing profitability. It includes the measure of the change in effect by all other operation expenditures when this expenditure is changed. Statistically, the coefficient is a measure of the among-group and within-group variance.

TABLE VI-2

PROFIT MAXIMIZING REDUCED VARIABLE MODEL FOR FIRM 30-05

Operating Expenses	Goal*	Coefficient
Total Wages & Salaries	-2.73	34.6
Advertising & Sales Expense	+ .13	11.7
Bad Debts	- .40	4.7
Car & Truck Expense-Delivery	-. 95	8.4
Telephone & Telegraph	- .27	15.5
	Total = -3.95	

*Data expressed as percentage of sales.

Additionally, this analytical model may be used to define the position of the firm 30-05 in the industry, establish a goal for planned progress, and measure the extent of progress at desired intervals. For example, in Table VI-3, Firm 30-05 is approximately average with a Z score of 160.37. To become as profitable as firms in Quartile 1, this Z score must be reduced to 105.88--the established goal. At the end of any accounting period, a new Z score for firm 30-05 can be computed to measure the firm's progress toward the established goal.

Note that the model is concerned with proper level of expenditures, not just expense reduction. Table VI-2 shows that firm 30-05 will need to increase advertising and sales expenses by .13 percent of sales to achieve profit goals. The coefficient weight is reasonably large, 11.7, which indicates that advertising is important in its total effects even though the proportion of expenditure is small.

This analytical model has many other uses. For example, if a firm is not properly assigned by its Z score to the group representing the firm's profit margin, the model will define for management the irregularities between the firm's operating data and the quartile's operating data.

TABLE VI-3

Z SCORE* MEASURE OF FIRM 30-05

Sales Category I	Mean Z Scores	Firm 30-05 Z Scores
Group 1	105.88	(105.88 Goal)
Group 2	149.44	
		160.37
Group 3	175.89	
Group 4	220.33	

*Refer to page 38 for Z score formula.

To illustrate, firm 01-61 in Sales Category II had an operating profit/sales ratio compatible to Quartile 2, but the model's Z score for 01-61 shows that this firm has operating expenses comparable to firms in Quartile 4, the least profitable quartile of firms in this sales category. To guide management's decisions, the analytical model provides the information in Table VI-4. It is interesting to note that advertising for 01-61 was .33 percent of sales compared to the mean of Group 2 which was .48 percent of sales. Firm 01-61 should examine its operating expenditures because the model indicates that this firm is spending 31 percent less for advertising than other firms in Quartile 2, and spending considerably more on wages, bad debts, and freight. The coefficient weighted product in Table VI-4 is an indication of the level of importance of each expense variable to management. Without this systematic analysis and weighting system, management could easily overlook advertising. It is a small expenditure item, but it is the second most significant operation expenditure. The model indicates a strong probability that profit will increase with some increase in advertising expenditures, the basic assumption being that increased advertising would produce results comparable to similar firms. Management's priorities for opportunities to increase profits by reducing operating expenses are (1) bad debts, (2) wages, and (3) freight, in that order.

TABLE VI-4

COMPARISON OF QUARTILE 2 WITH FIRM 01-61

Most Significant Operating Expenses	1 01-61* Minus Group 2	2 Coefficient	Coefficient Weighted Product 1 x 2
Total Wages	+2.16	1.16	2.50
Advertising & Sales Expense	- .15	10.59	-1.59
Bad Debts	+1.44	9.70	13.968
Freight	+ .70	.68	.48

*Information is expressed as a percentage of sales.

2. Financial Ratio Model--As with the operation expenditures model, a firm may use the financial ratio model to further structure its efforts to increase profitability.

Firm 12-04 is the top firm of Quartile 3 in Sales Category 5. It has a 25.1 percent return on investment which is approximately average for firms in Sales Category 5. To make this firm more profitable, management could make comparisons with the operation expenditures of Quartile 1 which has returns on investment of 33.4 percent and up. See Table VI-5.

The manager of firm 12-04, to concentrate his efforts where they can be most productive, should eliminate the financial ratios with a combination of small values in Column 3 and small coefficients, Column 4, in Table VI-5. These ratios are indicated by an asterisk. The ratios which remain are those most likely to produce results for management in their efforts to increase return on investment for firm 12-04. The better defined reduced variable problem is shown in Table VI-6.

This reduction in the number of ratios has reduced the manager's problem to manageable proportions and indicates the specific changes required to attain planned goals. The coefficients of significance indicate the importance of ratios as well as the possibility of making the changes. The absolute size of coefficients aids in establishing the priority of actions by the management. An incremental

TABLE VI-5

FINANCIAL RATIO COMPARISONS

Column Number	1	2	3	4
Financial Ratios	Firm 12-04	Mean Quartile 1	Difference between Col. 1 and Col. 2	Discriminant Coefficients Group 1
Operating Profit/Net Sales	0.046	0.070	+.024	-635
Operating Profit/Total Assets	0.154	0.203	+.049	388
Sales/Total Assets	3.368	2.890	-.478	-99
Cost of Goods Sold/Average Inventory	4.307	4.069	-.238	57
Current Assets Minus Current Liabilities/Total Assets	0.466	0.595	+.129	411
Current Assets Minus Inventory* /Current Liabilities	0.830	1.320	-.490	-3
Current Assets/Current* Liabilities	2.209	3.311	-1.102	0.4
Current Liabilities/Net Worth*	0.627	1.002	-.375	6
Inventory/Net Working Capital	1.140	0.880	-.260	275
Total Debt/Net Worth	0.627	2.661	+2.034	-12
Long Term Debt/Total Assets	0.0	0.304	+.304	124
Retained Earnings/Total Assets*	0.0	0.130	-.130	11

*Ratios least likely to be of significance to management.

TABLE VI-6

REDUCED VARIABLE MODEL FOR FIRM 12-04
TO ATTAIN RETURN ON INVESTMENT
EQUAL TO FIRMS IN QUARTILE 1

Financial Ratios	Required*	Coefficients of Significance
Operating Profit/Net Sales	+.024	-635
Operating Profit/Total Assets	+.049	388
Sales/Total Assets	-.478	-99
Cost of Goods Sold/Inventory	-.238	57
Current Assets minus Current Liabilities/Total Assets	+.129	411
Inventory/Net Working Capital	-.260	275
Total Debt/Net Worth	+2.034	-12
Long Term Debt/Total Assets	+.304	124

*From Column 3, Table VI-5.

variable analysis can be developed by the model as shown in Table VI-7. The incremental Z score of 37.2 indicates that the use of debt financing in Quartile 1 is a very significant contributor to a high return on investment, and likewise the 14.3 score for Group 4 shows the risk of using debt financing. Debt financing has less significance in Groups 2 and 3.

A similar analysis of operating profit to net sales ratio illustrates that the second most profitable group has a mean operating profit of 7.6 percent, but that for firms in Quartile 1 the operating profit is 7.0 percent. This indicates that sufficiently more sales can be obtained at 7.0 percent than at 7.6 percent margin such that the rate of return on investment is increased.

These analytical models provide profit maximizing information to management which can be used to:

a. Define the firm's relative position in the industry.
b. Establish specific management goals to attain higher profit levels.
c. Reduce the number of problem variables to more manageable proportions.
d. Indicate the steps necessary in the firm's operation to reach profit goals.
e. Denote the significance and priorities of the steps to reach profit goals.

TABLE VI-7

THE LONG TERM DEBT TO TOTAL ASSETS RATIO ANALYSIS

Quartile	Quartile Means	Quartile Coefficients	Incremental Z Score
1	.30	124	37.2
2	.05	116	5.8
3	.08	101	8.1
4	.12	119	14.3

f. Provide a standard numerical value that indicates management's progress toward desired goals at each accounting period.

Chapter One showed that comparative data used by industries are usually in the form of operating statements, balance sheets, and the data that are significant and unique to the specific industry. The applications made in the study were with the first two forms of data. The information value from the model can be extended by applying it to other data significant to a specific industry.

Additional Research Interests

Observing the applications of the model illustrated above, many areas of interest develop.

The manufacturers and regional distribution corporations in the National Automotive Parts Association may be concerned as much with jobbers attaining high level sales goals as profit goals. The model needs to be applied to the comparative operating data to provide management information for maximizing sales.

Gross margin is a significant operating variable, and a model should be structured to show gross margin relationships and responsiveness to operating expenditures and operating profit.

The accuracy of the model is dependent upon standardization and accuracy of accounting procedures. Studies

to reduce accounting errors and/or measure and compensate for them within the model would improve its predictability.

Comparative data reflect at least indirectly the influence of pressures both internal and external to the firms represented, because the firm must operate within its environment. However, the extent to which pertinent data on external variables can be more directly measured and introduced into the model may increase its value to management. Some of these external variables which might be a source of productive study are as follows:

a. Economic and geographic conditions in the firm's trade area.

b. Sociographic variables such as size of family, habits of people, and the like.

c. Psychographic variables to measure how people would respond to management's decisions.

Some of the studies suggested may be reasonably attainable. Some will be very difficult. Each addition of significant measurable variables increases the probability of accurate model predictions.

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APPENDIXES

APPENDIX A

THE NATIONAL AUTOMOTIVE PARTS ASSOCIATION (NAPA)

The National Automotive Parts Association (NAPA)

The National Automotive Parts Association is a major participant in the automotive after market. The NAPA system is supported by resources totaling more than a billion dollars. Each participating firm is financially and legally independent of the others. Participation is on a voluntary basis. NAPA is composed of the following groups:

A. A group of separate warehouse corporations who collectively operate 56 NAPA Distribution Centers in major cities throughout the United States.

B. A production establishment composed of 35 independent manufacturers who distribute exclusively NAPA products; 50 manufacturers whose lines are distributed by NAPA Distribution Centers but not exclusively; (i.e., the Balkamp Company owned and operated by NAPA distribution centers which procures, processes, and distributes through the NAPA channels 10,000 line items from 350 manufacturers.

C. A total of 4,215 independent associated jobbers who sell the NAPA merchandise to car dealers, independent garages, service stations, fleets, and do-it-yourself customers. (These jobbers are distributed throughout the United States in both urban and rural areas. Sixteen are in Hawaii, five in the Bahamas, and sixteen in Mexico. These jobbers contract to distribute the

NAPA merchandise in their area in exchange for the services supplied by NAPA. This is a working contract with no monetary exchange for the franchise.)

D. The NAPA association headquarters in Chicago, which coordinates and assists the functions of the board of directors, 16 operating committees, and the manufacturer's council. It also represents NAPA before automotive, industrial, and governmental groups, provides full-time sales training programs for jobber salesmen, conducts studies of new and existing price structures, provides inventory control systems, carries on marketing research, and performs other similar activities.

APPENDIX B

FORM USED FOR SURVEY OF INDUSTRIES ABOUT COMPARATIVE OPERATING DATA

1. NAME OF ORGANIZATION _____.

2. PERSON TO WHOM BRIEF OF THIS RESEARCH SHOULD BE MAILED:

   NAME _____

   ADDRESS _____

   _____

3. Number of firms from which comparative data is collected _____.

4. Number of firms to which the comparative data is redistributed after it is analyzed _____.

5. Is comparative data collected on standardized forms? Yes_____ No_____.

6. Please write below how collected data is processed for redistribution to firm managers. (Such as: averaged, sorted by size, sorted by profitability, information on any techniques used to maximize information from data to improve management.)

7. Additional comments you may feel to be significant in this area of research.

8. If restriction of organizational identity is required, please so indicate and your desires will be followed.

APPENDIX C

NATIONAL HOME FURNISHINGS ASSOCIATION
1969 OPERATING RESULTS
TOP PROFIT STORES COMPARED
TO ALL STORES

NATIONAL HOME FURNISHINGS ASSOCIATION
1969 OPERATING RESULTS
TOP PROFIT STORES COMPARED
TO ALL STORES

	Medium-Size Stores ($250,000-$500,000)		Medium-to-Large Stores ($500,000-$1 million)		Large Stores (Over $1 million)	
	All Stores	Top ¼ Profit Stores	All Stores	Top ¼ Profit Stores	All Stores	Top ¼ Profit Stores
Net profit before income tax	5.86%	11.06%	4.21%	10.07%	5.43%	12.39%
Net profit from operations and credit service	7.33	11.07	4.70	10.07	6.99	13.56
Total operation expenses	36.41	34.57	40.93	34.52	39.76	38.37
Sales increase (1969 over 1968)	5.22	6.01	2.50	2.50	4.41	2.50

Source: National Home Furnishings Association Special Report, July, 1970.

APPENDIX D

NATIONAL RETAIL HARDWARE ASSOCIATION
COMPARISON BETWEEN 1/3 STORES WITH THE HIGHEST TOTAL EARNINGS AND THE 2/3 MAKING UP THE BALANCE

NATIONAL RETAIL HARDWARE ASSOCIATION
COMPARISON BETWEEN 1/3 STORES WITH
THE HIGHEST TOTAL EARNINGS
AND THE 2/3 MAKING UP THE
BALANCE

	1969 Profit Makers	Remaining 2/3
Stores	259	523
Stores Offering Installment Sales	27%	21%
Current Year's Sales vs. Previous Year	107.90%	104.81%
Average Sale per Customer	$ 3.70	$ 3.92
Total Sales Less Returns	100.00%	100.00%
Cost of Goods Sold	65.85	68.30
Margin	34.15%	31.70%
PAID OUT IN SALARIES		
To Owners and Managers	6.90	8.00
To Salespeople, Office & Other	9.90	11.30
TOTAL PAID OUT IN SALARIES	16.80	19.30
OTHER COSTS OF DOING BUSINESS		
Office Supplies & Postage	0.45	0.45
Advertising	1.50	1.50
Donations	0.05	0.05
Telephone & Telegraph	0.30	0.35
Losses on Notes & Accounts	0.15	0.20
Delivery Expense (Other than Wages)	0.40	0.60
Depreciation-Delivery Equipment	0.20	0.20
Depreciation-Furn., Fix., & Tools	0.30	0.40
Rent	2.40	2.85
Repairs to Building	0.10	0.15
Heat, Light, Water, Power	0.85	0.85
Insurance*	0.90	1.10
Taxes* (Excluding Fed. Inc. Tax)	1.15	1.40
Interest on Borrowed Money*	0.05	0.30
Unclassified--Incl. Store Supplies	1.20	1.45
TOTAL EXPENSE (Not incl. interest on investment)	26.80	31.15
NET PROFIT	+7.35	+0.55
Cash Discount & Other Earnings	1.70	1.50
TOTAL EARNINGS (before Fed. Inc. Tax)	+9.05	+2.05
PROFIT ON INVESTMENT (Not incl. R.E.)	+20.95	+5.85

*Not including amounts paid in connection with real estate ownership.

Source: Management Report, National Retail Hardware Association, Indianapolis, Indiana.

	Profit Makers	2/3
ACTIVE OWNER'S RETURN ON INVESTMENT (Not incl. R.E.).....	+36.90	+28.60
Salary per year per Owner or Manager	$7,800	$7,895
Salary per year per Salesperson.....	4,515	4,730
Salary per year per Office Employee.	4,015	4,255
Salary per year per Other Employee..	3,740	4,220
Salary per year per Employee (not owners or managers).....	4,500	4,635
Sales per year per person employed..	34,165	30,980
Average Selling Area Size in Square Feet.....	3,500	3,500
Sales per Square Feet.....	$45.77	$46,22
Merchandise Inventory per $10,000 of Sales.....	2,690*	2,830*
Average Stock Turn Times.....	2.45*	2.45*
Credit Sales.....	35%	40%
Average Accounts Receivable Collection	69.5 Days	86.1 days
Average Capital Turn Times.....	2.35	2.95
Current Asset Ratio.....	10.68	5.98
Total Debt to Tangible Net Worth....	14.98%	28.25%
Rent Cost per Square Foot.....	0.849	
Sales to Inventory Ratio.....	3.81	3.61

*[sic]

APPENDIX E

QUESTIONNAIRE FORM USED FOR PERSONAL INTERVIEW OF AUTOMOTIVE PARTS JOBBER MANAGERS TO DETERMINE THE EXTENT TO WHICH THEY USE COMPARATIVE OPERATING DATA

FIRM:_____ DATE:_____

PERSON INTERVIEWED:_____

TITLE:_____

Are you familiar with the annual consolidated NAPA Jobber Operating statements?

Do you compare your annual operating statement with these operating statements for firms with sales approximately equal to your sales?

What value has this comparison of operating statements had for you?

Have you used this information on jobber operating costs to make decisions on how to operate your business? How?

Which items on the operating statement were you most interested in comparing and therefore seemed to be of the most value to you?

APPENDIX F

SUMMARY OF SURVEY OF USE OF COMPARATIVE OPERATING DATA BY JOBBER MANAGERS

SUMMARY OF SURVEY OF USE OF COMPARATIVE OPERATING DATA
BY JOBBER MANAGERS

Jobber Manager Number	Are you Familiar With NAPA Comparative Statements?	Do You Compare Your Firm's Data With NAPA Data?	Value Received From Comparison	Operating Statement Items Most Frequently Compared
1	Yes	No		
2	Yes	Yes	Limited Value	Labor, Rent, Utilities
3	Yes	Yes	(Very Limited Value)	Labor, Rent
4	Yes	Yes	Limited Value	Gross Profit, Rent, Labor
5	Yes	Yes	Real Value	Rent, Labor, Stock Turnover
6	Yes	Yes	Limited Value	Gross Profit, Labor
7	Yes	Yes	Real Value	Advertising, Rent, Bad Debts, Labor
8	Yes	Yes	Limited Value	Labor
9	Yes	No		

APPENDIX G

LETTER OF INSTRUCTIONS TO NAPA JOBBERS ON HOW TO COMPLETE COMPARATIVE DATA FORMS



NATIONAL AUTOMOTIVE PARTS ASSOCIATION
29 East Madison Street
Chicago, Illinois 60602

NAPA JOBBER FINANCIAL REPORT FORM
For the Year 1969
(or Fiscal Year Ending in 1969)

Instructions:

Please insert the figures from your profit and loss statement that correspond to the items listed in this form and return just as soon as possible to your NAPA Warehouse.

Wherever your statement breaks cost items down into more detail, combine the cost figures of the detailed items and insert them in the appropriate listing. For example, if bonuses and commissions are paid on sales and listed separately, they should be combined under salaries.

Shop labor sales should be separated, if possible, as well as the related direct shop expenses and entered on the proper lines.

Reasonable estimates are permissible on any breakdown of the individual items provided the amounts are marked "Estimate." If you have no expense for the items listed, you should so indicate by inserting the word "None" or "O" on that line.

A well prepared report by you will product excellent results when consolidated with those received from other NAPA jobbers and the reported results will prove to be real valuable to you in making comparisons with others.

NATIONAL AUTOMOTIVE PARTS ASSOCIATION

APPENDIX H

REPORTING FORMS FOR COMPARATIVE OPERATING DATA USED BY NAPA

CALENDAR YEAR 1969
OR FISCAL YEAR ENDED IN 1969
(Indicate Beginning and End of Year _____)

FINANCIAL OPERATING STATEMENT

INCOME

1. NET SALES--MERCHANDISE
Include sales of parts and merchandise less sales credits issued for adjustments and returned material (including cores)..... $_____

2. SHOP LABOR SALES
Include labor sales less labor sales credits..... $_____

3. TOTAL NET SALES
(Enter total of lines 1 and 2)..... $_____

4. COST OF GOODS SOLD
Include cost of parts and merchandise sold less credits received for returned material and rebates..... $_____

5. COST OF SHOP SALES
Include shop salaries, wages and bonuses, shop supplies, depreciation on shop equipment, shop tools, electric power and gas and any other direct expense..... $_____

6. Number of Shopmen_____

7. TOTAL COST OF SALES
(Enter total of lines 4 and 5)..... $_____

8. GROSS PROFIT
(Enter difference between lines 3 and 7)..... $_____

EXPENSES

9. MANAGERS' SALARIES (Or Owners' Withdrawals)
If sold proprietorship or partnership, enter amounts drawn by owner or managing partners. If corporation, enter amount paid to executive manager..... $_____

10. Number of Managers_____

11. SALESMEN'S SALARIES, WAGES and COMMISSIONS
Include all payments to outside salesmen..... $_____

12. Number of Outside Salesmen_____

13. ALL OTHER SALARIES AND WAGES
Include all payments to store, stock, delivery and office employees (but exclude those related to the shop and entered in line 5)..... $_____

14. Number of all other Employees_____

15. TOTAL WAGES, SALARIES and COMMISSIONS..... $_____

16. Total Number of Employees_____

17. ADVERTISING AND SALES EXPENSES
Include advertising, clinic and sales meeting expenses..... $_____

18. BAD DEBTS
Include uncollectible accounts charged off or addition to reserve for bad debts less any recoveries..... $_____

19. CAR EXPENSE--Sales
Include operating, maintenance and repair costs and depreciation on all autos used for sales work including any allowances to salesmen for use of their cars..... $_____

20. CAR AND TRUCK EXPENSE--Delivery
Include operating, maintenance and repair costs and depreciation on all vehicles used for delivery (except costs on vehicles devoted to sales work and entered on line 19 above)..... $_____

21. DEPRECIATION
Include depreciation on bins, fixtures, and office furniture (but exclude depreciation entered on lines 5, 19 and 20 above and line 25 below)..... $_____

22. FREIGHT, EXPRESS, PARCEL POST and POSTAGE
a. Incoming (include all costs of incoming freight, parcel post and postage)..... $_____
b. Outbound (include all costs of outbound freight, parcel post and postage)..... $_____
c. Freight Allowance (include total amount of allowance earned).. $_____
d. Total Freight (Subtract c from a and b above)..... $_____

23. INSURANCE
Include all fire and casualty, public liability, workmen's compensation and other insurance premiums (except life insurance premiums on officers or partners lives)..... $_____

24. HEAT, LIGHT and WATER

Include electric and gas (except prorata portion allocated to the shop) heat and water expenses..... $_____

25. RENT (or Equivalent)
Include building rental or if owned outright the equivalent of all costs of repairs, maintenance, real estate taxes, and depreciation on building and improvements..... $_____

26. OFFICE and STORE SUPPLIES and EXPENSE
Include stationery, printing, paper bags and boxes, cartons and miscellaneous items used in the store and office..... $_____

27. TAXES
Include all taxes paid to local, state and federal government tax authorities (excluding income taxes)..... $_____

28. TELEPHONE AND TELEGRAPH
Include all T & T costs including those charged to customers..... $_____

29. MISCELLANEOUS or GENERAL EXPENSES
Including handling or service charges; repairs and maintenance of store and office equipment and fixtures; legal, accounting and collection expenses; travel and entertainment expenses; dues, subscriptions and donations and other general expenses..... $_____

30. TOTAL EXPENSES
(Enter totals of lines 15 to 29 inclusive)..... $_____

31. OPERATING INCOME
(Enter difference between line 8 and line 30)..... $_____

OTHER INCOME and EXPENSES

32. OTHER INCOME
Include discounts earned, interest earned, gain on sales of fixed assets, scrap sales, etc..... $_____

33. OTHER EXPENSES
Include discounts allowed, interest paid, loss on sales of fixed assets, etc..... $_____

34. NET PROFIT BEFORE INCOME TAXES
(Enter total of lines 31 and 32 and subtract line 33)..... $_____

35. If this is a consolidated report of branch jobbing operations, enter here the total number included in the above report_____.

BALANCE SHEET

36. A copy of your balance sheet as of the close of your fiscal year ending in 1969 would be appreciated for the purpose of determining various financial ratios including the rate of inventory turnover. Indicate if balance sheet is submitted:
Yes_____ No_____

If a Balance Sheet is not submitted, please provide the following:

a. Average Inventory_____

b. Net Worth or Investment at beginning of year_____

37. Name of warehouse serving you:_____

38. To compile this information geographically, please state your location below (names are not required)

City_____

County and State_____

APPENDIX I

PART 1-MULTIPLE DISCRIMINANT ANALYSIS PROGRAM BMD05M AS ADAPTED FOR THIS STUDY

PART 2-AN EXPLANATION WHY FACTOR ANALYSIS WAS NOT USED TO REDUCE THE NUMBER OF VARIABLES

PART ONE

MULTIPLE DISCRIMINANT ANALYSIS PROGRAM BMD05M[14]

1. GENERAL DESCRIPTION

a. This program directs the computation of a set of linear functions for the purpose of classifying an individual into one of several groups. The input data consists of a set of observations for each of the classification groups; each observation consists of the values of a set of variables, and each observation contains a value for each of the variables.

The group assignment procedure followed is derived from a model of a multivariate normal distribution of observations within groups such that the covariance matrix is the same for all groups. An individual is classified into the group for which the estimated probability density is largest. The equivalent computational procedure followed evaluates the computed linear function corresponding to each of the groups and assigns an individual to the group for which the value is largest.

The hypothesis that group means are the same is tested.

b. Output for this program includes:

(1) Mean scores
(2) Matrix of cross-products of deviation from means
(3) Dispersion matrix
(4) Inverse of dispersion matrix
(5) D-square statistic

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[14]Adapted from W. J. Dixon, *Biomedical Computer Programs* (Los Angeles: University of California Press, 1970), p. 198.

(6) Coefficients and constants
(7) Evaluation of classification function for each case
(8) Classification

c. Limitations per problem:

(1) g, number of groups ($2 \leq g \leq 5$)
(2) p, number of original variables ($g \leq p \leq 10$)
(3) n_i, sample size or number of cases in any one group ($n_i \leq 175$)
(4) t, number of Transgeneration Cards ($0 \leq t \leq 99$)
(5) q, number of variables added to the original set after transgeneration ($-9 \leq q \leq 25$) $g \leq (p+q) \leq 25$.

d. This program allows transgeneration. Transgeneration cards were used to increase the number of variables in the program to eighteen.

2. DATA INPUT

Data are symbolized by x_{ijk}, where i refers to group, j refers to the firm, and k refers to variable.

The sample size may be different from one group to another, but the number of variables must be the same for all groups.

The form of the input data is illustrated in the following example:

		Variables			
	Firm	1	2	3	etc.
Group 1	1	$x_{1,1,1}$	$x_{1,1,2}$	$x_{1,1,3}$	...
	2	$x_{1,2,1}$	$x_{1,2,2}$	$x_{1,2,3}$	...
	etc.	...	...	...	...
Group 2	1	$x_{2,1,1}$	$x_{2,1,2}$	$x_{2,1,3}$	...
	2	$x_{2,2,1}$	$x_{2,2,2}$	$x_{2,2,3}$	...
	etc.	...	...	...	...

.
.
etc.

3. COMPUTATIONAL PROCEDURE[15] [16]

The data are to be prepared in the form

$$x_{ijk} \qquad \begin{matrix} i = 1,2,\ldots,g & \text{group} \\ j = 1,2,\ldots,n_i & \text{case or jobber} \\ k = 1,2,\ldots,p+q & \text{variable} \end{matrix}$$

where g = number of groups
n_i = sample size in the ith group
$p+q = m$ = number of variables.

Step 1. Transgenerations are performed by use of the transgeneration cards. Let m = number of variables after transgeneration.

Step 2. The means of variables considered within each group are computed. They are denoted by:

$$(x_{i.1}, x_{i.2}, \ldots, x_{i.m}), \quad i = 1,2,3,4.$$

Step 3. The matrix S_i, the sum of products of deviation from mean, is computed for each group.

$$S_i = s^i_{jk}) \qquad \begin{matrix} j = 1,2,\ldots,m \\ k = 1,2,\ldots,m \end{matrix}$$

$$\text{where } s^i_{jk} = \sum_{\ell=1}^{n_i} (s_{i\ell j} - s_{i.j})\,(s_{i\ell k} - s_{i.k})$$

Step 4. The pooled dispersion matrix D, based on the matrices S_i, $i = 1,2,\ldots,g$, is computed.

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[15] W. J. Dixon, *Biomedical Computer Programs* (Los Angeles, California: University of California Press, 1970), p. 200.

[16] T. W. Anderson, *Introduction to Multivariate Statistical Analysis* (New York: John Wiley & Sons, Inc., 1958), Section 6.7ff.

$$D = \frac{\sum_{i=1}^{g} S_i}{\sum_{i=1}^{g} n_i - g}$$

Step 5. The pooled dispersion matrix D is inverted using an inversion routine prepared by Rocketdyne, a division of North American Aviation.

The matrix DD^{-1} is computed as a check on the accuracy of the inverse.

Step 6. Common means:

$$x_{..j} = \left(\sum_{\ell=1}^{g} n_\ell x_{\ell.j}\right) / \left(\sum_{\ell=1}^{g} n_\ell\right)$$

where j = 1, 2,...,m

Generalized Mahalanobis D^2 Statistic, V:

$$V = \sum_{a=1}^{p} \sum_{b=1}^{q} (D_{ab}^{-1}) \sum_{\ell=1}^{g} n_\ell (x_{\ell.a} - x_{..a})(X_{\ell.b} - x_{..b})$$

V can be used as chi-square (under assumption of normality) with m (g-1) degrees of freedom to test the hypothesis that the mean values are the same in all the g groups for these m variables.

Step 7. The i^{*th} coefficients and constant are computed in discriminating function, i* = 1,2,...,g.

Let $(d_{j1}, d_{j2}, \ldots, d_{jm})$ by the jth row of D^{-1}.

Then coefficients, $C_{ji*} = \sum_{=1}^{m} d_{j\ell} x_{i.\ell}$

constant, $C_{0i*} = = \frac{1}{2} \sum_{\ell=1}^{m} \sum_{r=1}^{m} d_{\ell r}\, x_{i.\ell} x_{i.r}$

the i^{*th} discriminating function is given by

$$f_{i*}(z_1, z_2, \ldots, z_m) = \sum_{\ell=1}^{m} z_\ell c_{\ell i*} + c_{0i*}$$

Step 8. For each group i, the following table is prepared giving each i* discriminating function evaluated for each data point.

i* / j	1 2 . . . g	Largest "Probability"	Function No. for Largest "Probability"
1 2 . . . n_i	For each j $P_i = \frac{e^{(f_{i*}-\max f_{i*})}}{\Sigma e^{(f_{i*}-\max f_{i*})}}$		

The table is prepared as follows : the value of each of the g discriminating functions is computed for the first observation $(x_{i11}, x_{i12}, \ldots, s_{ilm})$ of the ith group. The g values obtained are located in Columns 1 through g of the first row. The largest number of this set of values is printed in the column headed "Largest Probability." Finally, the number of the function that gave the largest value is indicated in the last column. The second row of the table is obtaine using the second case of the ith group. The process continues until all n_i rows are completed.

If the experimental groups are widely separated, then in the ith table the last column will contain mostly the value i.

Step 9. To summarize the tables computed in Step 8, the classification matrix B is computed.

$$B = (b_{ij}) \quad i = 1,2,\ldots,g; \; j = 1,2,\ldots,g$$

The first row of the matrix B tabulates the largest function numbers appearing in the last column of the first table, namely for the group 1 computed in Step 8. The second row shows the tabulation of the second table and so on to the last table. Diagonal values show assignment to correct classification. Off diagonal values show errors in classification assignment.

PART TWO

AN EXPLANATION WHY FACTOR ANALYSIS WAS NOT USED TO REDUCE THE NUMBER OF VARIABLES

Ideally, it would be desirable to use the rotated factor matrix (varimax) to reduce the number of variables to be used as input for the multiple discriminant analysis program, but this procedure was ruled out for the following reasons:

1. The statistical error in coefficients in the factor analysis program when combined with the statistical error in the multiple discriminant analysis coefficients would compound total error introduced into the model.
2. To combine variables as grouped by factor analysis requires assignment of new names to the combined factors. This reduces the value of the data to management as exemplified by the Federal Trade Commission surveys of industries of 1941 in which the data were so general in nature that they had little value for problem solving. The goal of this study was to locate those specific variables with greatest significance to management.

3. By staying with the multiple discriminant analysis program, the input can remain in raw data form which simplifies interpretation. It also makes it possible to use the discriminant values in the model for direct application to operating data of any individual firm in determining those variables of greatest significance in maximizing the firm's profit.

APPENDIX J

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM BY MULTIPLE DISCRIMINANT ANALYSIS ON OPERATING STATEMENT DATA

Sales Category I

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM
BY MULTIPLE DISCRIMINANT ANALYSIS ON
OPERATING STATEMENT DATA

(Sales Category I)

Firm	Probability Associated With Largest Discriminant Group	Largest Group No.
	GROUP 1	
1	0.83837	1
2	0.99741	1
3	0.94113	1
4	1.00000	1
5	0.99869	1
6	0.98700	1
7	0.95408	1
8	0.99685	1
9	0.99165	1
10	0.98405	1
	GROUP 2	
1	0.67246	3
2	0.74834	2
3	0.92753	2
4	0.89828	1
5	0.64643	1
6	0.98256	2
7	0.98268	2
8	0.96499	2
9	0.99995	2
10	0.88651	2
	GROUP 3	
1	0.96565	3
2	0.86236	3
3	0.98088	3
4	0.52609	3
5	0.58793	3
6	0.96057	3
7	0.47070	3
8	0.86355	3
9	0.99461	3
10	0.87876	3

(Continued)

	GROUP 4	
1	0.67359	4
2	0.99701	4
3	0.80903	4
4	0.64486	4
5	0.99940	4
6	0.99515	4
7	0.99757	4
8	0.99996	4
9	0.99735	4
10	0.99867	4

APPENDIX K

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM BY MULTIPLE DISCRIMINANT ANALYSIS ON OPERATING STATEMENT DATA

Sales Category II

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM
BY MULTIPLE DISCRIMINANT ANALYSIS
ON OPERATING STATEMENT DATA

Sales Category II

Firm	Probability Associated With Largest Discriminant Group	Largest Group No.
	GROUP 1	
1	0.87215	1
2	0.98011	1
3	0.79567	1
4	0.91006	1
5	0.90151	1
6	0.99799	1
7	0.96554	1
8	0.39059	1
9	0.96369	1
10	0.52873	2
11	0.57308	1
12	0.96651	1
	GROUP 2	
1	0.63899	4
2	0.69458	2
3	0.83702	2
4	0.76384	3
5	0.42490	2
6	0.89748	2
7	0.89274	2
8	0.54018	1
9	0.66587	2
10	0.66962	2
11	0.72270	2
12	0.87788	2

	GROUP 3	
1	0.98650	3
2	0.63968	3
3	0.87057	3
4	0.73432	3
5	0.46428	2
6	0.81765	3
7	0.37748	2
8	0.94648	3
9	0.91557	3
10	0.98419	3
11	0.80808	3
12	0.95397	3

	GROUP 4	
1	0.90617	4
2	0.70043	3
3	0.47179	3
4	0.97062	4
5	0.50287	4
6	0.38405	4
7	0.95348	4
8	0.99339	4
9	0.66335	1
10	0.97871	4
11	0.75205	4
12	0.97001	4

APPENDIX L

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM BY MULTIPLE DISCRIMINANT ANALYSIS ON OPERATING STATEMENT DATA

Sales Category III

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM
BY MULTIPLE DISCRIMINANT ANALYSIS
ON OPERATING STATEMENT DATA

Firm	Probability Associated With Largest Discriminant Group	Group No.
	Sales Category III	
1	1.00000	1
2	1.00000	1
3	0.99998	1
4	1.00000	1
5	1.00000	1
6	1.00000	1
7	1.00000	1
8	0.99997	1
9	0.99943	1
10	1.00000	1
	GROUP 2	
1	1.00000	1
2	0.99999	1
3	1.00000	1
4	0.99975	4
5	1.00000	1
6	0.80271	4
7	0.98326	1
8	1.00000	4
9	0.99931	4
10	0.99906	1

(Continued)

	GROUP 3	
1	0.98109	1
2	1.00000	1
3	0.62441	3
4	0.62441	1
5	0.97625	3
6	0.99974	1
7	0.93793	1
8	0.94482	1
9	0.68077	3
10	0.94687	1
	GROUP 4	
1	1.00000	4
2	1.00000	4
3	0.99466	4
4	0.98810	1
5	1.00000	4
6	1.00000	4
7	1.00000	4
8	1.00000	4
9	1.00000	4
10	1.00000	4

APPENDIX M

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM BY MULTIPLE DISCRIMINANT ANALYSIS ON OPERATING STATEMENT DATA

Sales Category IV

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM
BY MULTIPLE DISCRIMINANT ANALYSIS
ON OPERATING STATEMENT DATA

Sales Category IV

Firm	Probability Associated With Largest Discriminant Group	Largest Group No.
	GROUP 1	
1	0.97644	1
2	0.99844	1
3	0.63252	3
4	0.96110	1
5	0.79039	4
6	0.86901	1
7	0.98998	1
	GROUP 2	
1	0.89944	1
2	0.99592	2
3	0.99538	2
4	0.98808	2
5	0.99997	2
6	0.44673	1
7	0.99946	2
	GROUP 3	
1	0.96600	3
2	1.00000	3
3	0.99982	3
4	0.99593	3
5	0.98072	3
6	0.99993	3
7	0.99999	3
	GROUP 4	
1	0.99860	4
2	0.99079	4
3	0.99878	4
4	0.88321	4
5	0.92587	4
6	0.99964	4
7	0.55242	4

APPENDIX N

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM BY MULTIPLE DISCRIMINANT ANALYSIS ON OPERATING STATEMENT DATA

Sales Category V

EVALUATION OF CLASSIFICATION GROUP FOR EACH FIRM
BY MULTIPLE DISCRIMINANT ANALYSIS
ON OPERATING STATEMENT DATA

Firm	Probability Associated With Largest Discriminant Group	Largest Group No.
	Sales Category V	
1	0.52753	1
2	0.94431	1
3	0.63811	1
4	0.98953	1
5	0.80402	1
6	0.97534	1
7	0.31731	4
8	0.92252	1
9	0.95592	1
10	0.44722	1
11	0.84083	4
12	0.54192	2
13	0.93800	1
14	0.97827	1
15	0.50405	1
16	0.95690	1
	GROUP 2	
1	0.56754	2
2	0.59702	2
3	0.55750	2
4	0.43222	2
5	0.86347	2
6	0.49909	3
7	0.58808	2
8	0.43350	3
9	0.58524	2
10	0.72590	1
11	0.88406	2
12	0.62302	3
13	0.54421	4
14	0.29178	1
15	0.38108	1
16	0.74940	2

(Continued)

	GROUP 3	
1	0.60612	4
2	0.53298	4
3	0.51825	3
4	0.34802	1
5	0.72195	1
6	0.55101	2
7	0.66888	3
8	0.68682	3
9	0.37788	4
10	0.41324	1
11	0.97745	1
12	0.43178	1
13	0.94742	3
14	0.48160	3
15	0.71646	4
16	0.59972	4

	GROUP 4	
1	0.58791	2
2	0.70717	4
3	0.99965	4
4	0.58939	4
5	0.47403	4
6	0.66208	4
7	0.79605	4
8	0.99110	4
9	0.91623	4
10	0.81104	4
11	0.87016	4
12	0.86750	4
13	0.98002	4
14	0.89753	4
15	0.99642	4
16	0.70309	4

APPENDIX O

MULTIPLE DISCIMINANT COEFFICIENTS, SALES CATEGORY I, UP TO $100,000 ANNUAL SALES

MULTIPLE DISCRIMINANT COEFFICIENTS,
SALES CATEGORY I, UP TO $100,000 ANNUAL SALES

Operating Expense Variables	QUARTILE DISCRIMINANT COEFFICIENTS			
	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Shop Labor Sales	-13.56	-17.03	-16.32	-20.03
Managers' Salaries	-30.26	-18.12	-135.07	-54.03
Salesmen's Salaries	-31.73	-19.05	-136.84	-55.13
Other Salaries & Wages	-30.86	-19.03	-135.84	-55.15
Total Wages & Salaries	34.63	23.02	140.53	60.05
Advertising & Sales Expense	11.73	10.30	13.34	18.28
Bad Debts	4.77	4.73	5.90	8.58
Car Expense-Sales	12.41	11.55	15.92	17.61
Car & Truck Expense-Delivery	8.38	10.04	11.00	12.49
Depreciation	.46	-3.60	-1.72	-1.75
Freight, Express, Parcel Post and Postage	8.36	10.17	11.22	12.34
Insurance	-6.27	1.90	-2.76	-3.17
Heat, Light & Water	10.25	15.79	16.47	17.80
Rent (or Equivalent)	-1.55	1.41	-1.41	-1.20
Office & Store Supplies and Expenses	5.03	4.15	6.91	4.12
Taxes	10.78	14.69	14.32	18.64
Telephone and Telegraph	15.46	18.97	21.96	24.83
Miscellaneous and General Expenses	3.76	2.36	3.73	4.34

APPENDIX P

MULTIPLE DISCRIMINANT COEFFICIENTS, SALES CATEGORY II, $100,000 to $150,000 ANNUAL SALES

MULTIPLE DISCRIMINANT COEFFICIENTS,
SALES CATEGORY II, $100,000 to $150,000 ANNUAL SALES

Operating Expense Variables	QUARTILE DISCRIMINANT COEFFICIENTS			
	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Shop Labor Sales	1.54	1.63	1.33	1.55
Managers' Salaries	3.03	2.74	3.09	3.41
Salesmen's Salaries	1.41	1.83	1.38	1.95
Other Salaries & Wages	2.91	2.77	2.87	3.29
Total Wages & Salaries	0.35	1.17	0.86	1.10
Advertising & Sales Expense	12.64	10.59	8.05	13.25
Bad Debts	7.45	9.71	6.78	11.31
Car Expense-Sales	2.43	3.28	5.59	4.66
Car & Truck Expense-Delivery	2.03	2.06	4.47	2.88
Depreciation	5.09	4.02	5.15	6.51
Freight, Express, Parcel Post and Postage	0.95	0.68	0.64	0.47
Insurance	6.69	11.77	5.38	10.45
Heat, Light & Water	10.72	12.00	11.89	12.86
Rent (or Equivalent)	2.73	2.21	2.38	2.77
Office & Store Expense and Supplies	5.17	3.73	6.19	6.44
Taxes	-0.66	-0.59	-0.81	-1.35
Telephone and Telegraph	0.39	2.52	3.23	1.80
Miscellaneous and General Expenses	0.64	0.62	1.31	0.96

APPENDIX Q

MULTIPLE DISCRIMINANT COEFFICIENTS, SALES CATEGORY III, $150,000 to $200,000 ANNUAL SALES

MULTIPLE DISCRIMINANT COEFFICIENTS,
SALES CATEGORY III, $150,000 to $200,000 ANNUAL SALES

Operating Expense Variables	QUARTILE DISCRIMINANT COEFFICIENTS Quartile 1	Quartile 2	Quartile 3	Quartile 4
Shop Labor Sales	-0.45	-2.37	-0.17	-2.59
Managers' Salaries	-10,041.91	-11,942.90	-10,271.08	-16,421.43
Salesmen's Salaries	-10,047.89	-11,950.72	-10,276.99	-16,432.53
Other Salaries & Wages	-10,044.65	-11,949.43	-10,276.01	-16,428.93
Total Wages & Salaries	10,056.49	11,959.01	10,287.47	16,443.62
Advertising & Sales Expense	72.49	85.92	81.40	104.51
Bad Debts	29.02	38.92	31.53	49.05
Car Expense, Sales	63.63	76.00	52.29	102.23
Car & Truck Expense, Delivery	14.53	14.26	16.66	18.20
Depreciation	67.51	73.95	69.54	101.69
Freight, Express, Parcel Post and Postage	36.09	38.45	38.84	48.51
Insurance	-20.09	-20.59	-27.42	-23.61
Heat, Light & Water	2.37	-0.42	6.56	-0.46
Rent (or Equivalent)	31.63	34.49	36.52	44.80
Office & Store Expense and Supplies	43.44	46.81	46.54	63.14
Taxes	59.34	65.25	65.72	85.26
Telephone & Telegraph	-6.07	-15.63	-8.53	-14.76
Miscellaneous & General Expenses	10.93	13.68	14.95	18.10

APPENDIX R

MULTIPLE DISCRIMINANT COEFFICIENTS, SALES CATEGORY IV, $200,000 to $250,000 ANNUAL SALES

MULTIPLE DISCRIMINANT COEFFICIENTS,
SALES CATEGORY IV, $200,000 to $250,000 ANNUAL SALES

Operating Expense Variables	QUARTILE DISCRIMINANT COEFFICIENTS			
	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Shop Labor Sales	5.08	5.88	3.95	4.82
Managers' Salaries	34.52	46.67	51.65	107.79
Salesmen's Salaries	31.74	42.62	49.59	100.72
Office Salaries and Wages	34.67	46.51	52.11	102.65
Total Wages & Salaries	-27.68	-38.53	-45.45	-95.43
Advertising & Sales Expense	7.57	5.05	10.85	5.81
Bad Debts	34.14	33.76	17.77	31.73
Car Expense-Sales	70.41	92.08	63.77	65.30
Car & Truck Expense-Delivery	-7.28	-7.20	0.60	-6.02
Depreciation	-35.31	-42.66	-23.87	-33.79
Freight, Express, Parcel Post & Postage	47.14	55.91	34.72	46.76
Insurance	12.84	13.17	0.30	16.19
Heat, Light & Water	-2.24	-5.14	-5.71	-8.98
Rent (or Equivalent)	23.43	29.08	17.05	22.22
Office and Store Expense and Supplies	4.16	8.26	1.15	4.08
Taxes	16.52	16.98	9.02	14.57
Telephone & Telegraph	-46.47	-60.95	-27.90	-46.87
Miscellaneous and General Expense	-2.17	-0.46	2.33	-0.67

APPENDIX S

MULTIPLE DISCRIMINANT COEFFICIENTS, SALES CATEGORY V, $250,000 AND UP ANNUAL SALES

MULTIPLE DISCRIMINANT COEFFICIENTS,
SALES CATEGORY V, $250,000 AND UP ANNUAL SALES

Operating Expense Variables	QUARTILE DISCRIMINANT COEFFICIENTS			
	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Shop Labor Sales	-0.19	-0.07	-0.33	0.03
Managers' Salaries	-67.81	-47.06	-82.22	-43.99
Salesmen's Salaries	-66.17	-45.34	-80.29	-42.05
Office Salaries & Wages	-66.07	-45.41	-80.31	-42.03
Total Wages & Salaries	70.60	50.05	85.11	47.30
Advertising & Sales Expense	2.29	3.99	1.85	2.42
Car Expense-Sales	4.60	7.08	5.50	7.36
Car & Truck Expense-Delivery	2.86	2.53	3.91	3.19
Depreciation	-1.96	-1.43	-2.36	-2.44
Freight, Express, Parcel Post and Postage	17.23	15.63	16.46	18.48
Insurance	15.63	15.08	16.80	17.59
Heat, Light & Water	10.40	12.36	12.59	11.31
Rent (or Equivalent)	6.84	6.33	6.65	7.74
Office & Store Expenses and Supplies	4.21	9.66	8.98	8.63
Taxes	4.17	4.02	4.01	3.38
Telephone & Telegraph	24.56	20.12	20.49	24.26
Miscellaneous and General Expenses	3.18	3.76	3.81	5.49

APPENDIX T

VALIDITY TEST OF ORIGINAL MODEL ON SECONDARY SAMPLE
Validity Test
1st Run, 18 Variables

VALIDITY TEST OF ORIGINAL MODEL ON SECONDARY SAMPLE
Validity Test
1st Run, 18 Variables

Sales	Group Parameters by Initial Z Scores for Model Building for Firms Properly Assigned[c]	Z Score Parameters on Validity Groups	Number of Firms			Correct Assignment Percent	Level of Significance t Test
			Properly Assigned	Improperly Assigned	Total		
Category I							
Group 1	76.15 to 121.35	90.16 to 216.10	3	4	7	43	
Group 2	135.10 to 161.28	83.87 to 214.16	9	11	20	45	
Group 3	160.37 to 197.86	140.04 to 254.40	5	5	10	50	
Group 4	208.74 to 243.80	161.46 to 271.81	3	3	6	50	
Total			20	23	43		
Percent			46.5	53.5	100.0		.005
Category II							
Group 1	70.08 to 98.16	62.95 to 101.30[a]	9	1	10	90	
Group 2	95.92 to 122.69	70.54 to 124.81	3	12	15	20	
Group 3	85.13 to 111.48	77.76 to 117.84	10	7	17	59	
Group 4	114.62 to 150.81	114.92 to 129.13	4	1	5	80	
Total			26	21	47		
Percent			55.4	44.6	100.0		.005
Category III							
Group 1	327.96 to 483.36[b]	301.78 to 496.13[a]	7	1	8	88	
Group 2	388.13 to 570.54[b]	404.19 to 606.33	4	3	7	57	
Group 3	408.92 to 546.59	453.59 to 652.34	6	4	10	60	
Group 4	807.05 to 10008.68	588.24 to 1011.82[d]	11	9	20	50	
Total			28	17	45		
Percent			62.2	47.8	100.0		.005

(Continued)

Sales	Group Parameters by Initial Z Scores for Model Building for Firms Properly Assigned[c]	Z Score Parameters on Validity Groups	Number of Firms: Properly Assigned	Number of Firms: Improperly Assigned	Number of Firms: Total	Correct Assignment Percent	Level of Significance t Test
Category IV							
Group 1	186.03 to 224.46	180.85 to 335.41[a]	5	3	8	63	
Group 2	240.43 to 297.33	164.84 to 294.71	3	5	8	47	
Group 3	152.52 to 171.52	105.73 to 255.19[d]	3	8	11	27	
Group 4	183.00 to 231.67	184.43 to 285.24[d]	5	0	5	100	
Total			16	16	32		
Percent			50.0	50.0	100.0		.005
Category V							
Group 1	112.86 to 153.76	108.12 to 169.67	13	3	16	81	
Group 2	138.99 to 156.81	117.86 to 158.57	6	10	16	38	
Group 3	139.07 to 155.10	97.63 to 201.78	7	9	16	44	
Group 4	160.87 to 211.98	123.80 to 208.27	12	4	16	75	
Total			38	26	64		
Percent			59.3	40.7	100.0		.005

[a]Firms below initial Z score for this group are considered properly assigned as they still remain in Group 1.

[b]This group had zero percent correct assignment; however, the Z scores should be as applicable as in other groups. Since there is no standard for establishing parameters, an arbitrary 60 percent of the central scores is used. This is more conservative than the model parameters used for other groups.

[c]As Z scores exceed these group parameters, assignment tends to be made to other groups.

[d]Firms above initial Z score for this group are considered properly assigned as they still remain in Group 4.

APPENDIX U

EVALUATION OF CLASSIFICATION FOR EACH FIRM BY MULTIPLE DISCRIMINANT ANALYSIS ON FINANCIAL RATIO DATA

EVALUATION OF CLASSIFICATION FOR EACH FIRM
BY MULTIPLE DISCRIMINANT ANALYSIS ON
FINANCIAL RATIO DATA

Firm	Probability Associated With Largest Discriminant Group	Largest Group No.
	GROUP 1	
1	0.99133	1
2	0.99806	1
3	1.00000	1
4	0.99945	1
5	0.99973	1
6	0.91824	1
7	0.99952	1
8	0.99912	1
9	0.62475	2
10	0.67198	1
	GROUP 2	
1	0.35804	4
2	0.51041	3
3	0.90152	2
4	0.56259	2
5	0.81000	2
6	0.91448	2
7	0.82774	2
8	0.78160	2
9	0.71089	2
10	0.98057	2
	GROUP 3	
1	0.72818	3
2	0.67705	3
3	0.90334	3
4	0.93079	3
5	0.67570	3
6	0.77426	3
7	0.81593	3
8	0.46731	2
9	0.90646	3
10	0.90349	3

(Continued)

	GROUP 4	
1	0.84918	4
2	0.62896	4
3	0.86580	3
4	0.72352	3
5	0.95704	4
6	0.63306	3
7	0.85148	4
8	0.99930	4
9	0.99847	4
10	0.99953	4