PREDICTION OF LIQUIDATION OR REORGANIZATION FOR FIRMS FILING UNDER CHAPTER X OF THE BANKRUPTCY ACT OF 1898

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CHAPTER I

INTRODUCTION

> Because bankruptcy law affects the decision to resort to bankruptcy, the optimal corporate bankruptcy system must fulfill two requirements: (1) it must generate the optimal number of bankruptcies, and (2) it must do so at minimal cost (Meckling, 22, p. 31).

The research reported in this dissertation relates to the second requirement above for optimal bankruptcy systems, i.e., cost minimization. The objective of the research was to develop a model for predicting the outcome of those bankruptcy proceedings in which the possible outcomes include corporate reorganization or corporate liquidation and dissolution. To the extent that prediction of liquidation or reorganization is possible, certain costs of bankruptcy are avoidable. Avoidance of these costs would contribute to cost minimization and therefore is beneficial to equityholders of the firm.

Background

Chapter X of the Bankruptcy Act of 1898 deals with corporate reorganizations. Corporations which enter Chapter X of the 1898 Act, hereafter Chapter X, face two prospects. First, they may be reorganized and become a viable business. Second, they may be liquidated.

The bankruptcy court is charged with the responsibility of determining whether reorganization or liquidation is in the best interest of the corporation's equityholders. Reorganization will be beneficial if the equityholders will receive more via reorganization than via liquidation.

The process of determining whether liquidation or reorganization is preferable and the resulting administration of the decision can be a long and expensive procedure. The costs of this process are called determination costs, and, conceivably, are avoidable if an accurate predictive model of the sort referenced above is available. The avoidable costs include, in part at least, a portion of accountants' and lawyers' fees, other professional fees, and trustees' fees. Of course, costs incurred subsequent to the court's decision are not avoidable.

Literature Review

The study of financial failure of the firm has a rather lengthy history. Previous studies have defined failure in various ways, including whether a firm would enter bankruptcy proceedings. However, no study to date has specifically investigated the question intimated above. What happens to a firm after entering bankruptcy proceedings? The following literature review is included to provide the background for the use of ratios and both univariate and multivariate techniques for prediction in

financial failure situations. In addition, the review provides insight into possible methodological problems of the present research and their potential resolution.

The financial literature has contained examples of the use of performance indicator analysis to predict failure for approximately 50 years. Performance indicators are generally financial ratios. Financial ratios are simply quotients of two numbers obtained from financial statements or other financial sources. The logic underlying the use of financial ratios is that a firm is a pool of cash. The objective of the firm is to manage its cash flows effectively. Bankruptcy ensues when the cash pool is drained and the firm has no means of generating cash to resupply the pool (Sharma and Mahajan, 32). Financial ratios are a conventional means of quantifying and analyzing financial statement relationships. Therefore, financial ratio analysis should provide signals concerning an enterprise's possible reorganization or liquidation.

Winakor and Smith (40) concluded that the ratio or net working capital to total assets could be used up to 10 years prior to failure to predict failure. Fitzpatrick (12) used trends of ratios and found his best predictors to be net profit to net worth and net worth to total debt up to five years before failure. Both of these studies had severe statistical limitations which were somewhat overcome by Merwin (23). He found that

three ratios could be used up to five years prior to failure to predict failure. These three were net working capital to total assets, net worth to total debt, and the current ratio.

Beaver (7) used univariate statistical methods to study the underlying predictive ability of financial statements. Using a paired design, he found that the cash flow to total debt ratio could be used as a predictor up to five years before failure of the firm. Altman (2) used multiple discriminant analysis (MDA) to assess the quality of ratio analysis as an analytical technique. The prediction of corporate bankruptcy was used as an illustrative case. MDA allows for the use of several ratios simultaneously to predict bankruptcy. The previous studies were univariate and did not allow for conflicting signals from different ratios. Tamari (35) used multiple ratios with arbitrary weightings.

Altman (2) chose samples of firms which filed under Chapter X of the Bankruptcy Act of 1898 and paired these with non-failed firms. He built his MDA model using data one year prior to bankruptcy and then applied the model to the original data as well as to data two years prior to bankruptcy. Altman found he was able to predict failure up to two years prior to bankruptcy. Altman's model was accurate on several secondary samples introduced and lends credence to the proposition that

multivariate analysis of ratios' predictive ability may be better than univariate analysis.

Deakin (9) re-examined the Beaver data, with a somewhat narrower definition of failure, but using the MDA technique. He found that failure could be predicted up to three years prior to its occurrence using different models for each year. Wilcox (39) used a single ratio model based on the dynamic variability of cash flows and found prediction was possible up to five years prior to failure. Blum (8) used MDA to test the hypothesis that failure could be predicted in companies to which the Failing Company Doctrine (a defense in antitrust cases) is applicable. He was able to predict reasonably well up to five years before failure. This Failing Company Model used 12 variables, including trend breaks, slopes, and standard deviations for net income and the ratio of quick assets to inventory.

Blum (8) used Beaver's cash flow to total debt ratio as a naive model which predicted very well for Blum's sample of firms. In fact, the accuracy of Beaver's univariate and the MDA approach were similar. Edmister (10) used stepwise MDA and found MDA to be a superior predictor when compared to univariate analysis. He was successful in predicting small business failure up to three years prior to failure. However, Hoeven (18) found that percentage change of trend variables to be better predictors of small business default than MDA.

The debate on Altman's (2) MDA has been ongoing. Joy and Tollefson (20) critized the level of sophistication of MDA in finance literature in general, and Altman in particular. Joy and Tollefson's criticism included the lack of ex ante validation, criteria governing the selection of variables, and failure to compare the model with naive models. Moyer (25) applied the Altman model to later data and concluded the model was sensitive to time span or firm size since the predictability of the model was diminished. Moyer re-estimated the model using Altman's variables as well as a stepwise procedure. He found the Altman model may have contained superfluous variables. His re-estimated reduced model was successful in predicting bankruptcy up to three years prior to failure. Individual functions were estimated for each of the three years using the first three variables of Altman's earlier model. Altman (5) questioned Moyer's results in regard to definition and design. Moyer (26) defended his work as appropriate. The thrust of this series was that MDA is a viable technique for failure prediction. In addition, the re-examination revealed methodological areas which should be improved. The problematic methodological areas are the lack of ex ante validation, criteria governing the selection of variables, the failure to compare the model with naive models, and sensitivity of models to time span or firm size. These issues will be addressed in a subsequent chapter.

In summary, previous research has used ratios to try to discriminate between firms which would fail in various ways, including whether a firm would enter bankruptcy proceedings. The research reported in this dissertation was concerned with whether firms which entered bankruptcy were subsequently liquidated or reorganized.

Definition of Population and Variables

The population consists of 43 firms whose Chapter X proceeding involved the SEC and were closed during the period of July 1, 1959, to June 30, 1974. These firms were studied rather than others because of the relative availability of data needed to compute the financial ratios used in the modeling process. These were the latest available when the project commenced. The data were collected from the SEC, the Administrative Office of the U.S. Courts, and the latest available audited financial statements of the firms prior to their Chapter X filing date. Thirty-nine financial statements ratios were selected (see Appendix A). These ratios included indexes of liquidity, profitability, and leverage plus others found significant in previous studies.

Methodology

The research effort used multiple discriminant analysis models to classify the population, as defined above, as either liquidated or reorganized. The results

of this classification were compared to a proportional chance model based on the actual disposition of the firms. If the MDA model was better than the proportional chance model, the methodology called for the use of the MDA model to predict the ultimate disposition of firms which filed in later time periods.

Limitations of the Study

No research effort is without limitations. One major limitation of this research was that classification schemes generally will not result in 100 percent accuracy. Therefore, the consequences of potential misclassifications should be evaluated by the users. The study was limited due to the restricted data base. Generalizations of the results to other population are inappropriate unless the user deems the other population(s) to have similar statistical properties.

Organization of the Study

Chapter I contains an introduction to the research problem and a review of the literature concerning business failure prediction. Chapter II contains a discussion of methodology used in this research. The results of the research are included in Chapter III. Chapter IV is a summary and criticism of the research.

CHAPTER II

METHODOLOGY

Chapter II contains the specifications and the justification of the methodology for this research. The methodology involved: 1) identifying a reasonable predictive model, 2) using the model to predict, and 3) analyzing the prediction in terms of errors.

Model Identification

Financial ratio analysis has been applied to detect company operating and financial difficulties since the 1930's. Winakor and Smith (40), in a 1935 study as well as several later studies including Merwin (23) and Beaver (7), concluded that failing firms exhibit significantly different ratio measurements than continuing firms. The use of ratio analysis in the previous studies implies the potential of ratios as predictors of failure. Ratios measuring profitability, liquidity, and solvency have generally been the most significant indicators. The previously cited studies unfortunately did not find the same ratios to be the best predictors. Each previous study did establish a generalization regarding the performance of a chosen variable for which there was no

particular criterion, other than judgment, for inclusion. Studies prior to 1968 were generally univariate in nature with emphasis placed on individual signals.

Ratio analysis in the univariate form is potentially confusing and susceptible to faulty interpretation due to lack of completeness. The potential ambiguity of different measures is easily demonstrated. To illustrate, consider a firm with a poor profitability record but above average liquidity. At least in the short run, the firm would not be a candidate for failure since it should be able to meet maturing obligations. The use of isolated financial statement data is the inherent shortcoming of univariate analysis. A methodology which overcomes this shortcoming and combines ratios to define a predictive model has the potential for greater predictive accuracy (2).

The use of Multiple Discriminant Analysis (MDA) to predict group membership is well documented in the literature (2, 5, 8, 9, 10, 25, 26, 28). MDA is a statistical technique which will classify an observation into a known group dependent upon the observation's individual characteristics. MDA is generally used to classify observations where the dependent variable is qualitative, e.g., male or female, liquidated or reorganized. As a prerequisite for the use of MDA, it is therefore necessary to establish definitive mutually exclusive group

classifications with the number of groups being two or more.

After establishing the groups, data are collected for the objects in the group. This research used corporations which filed under Chapter X as the objects and financial statement ratios as the characteristics. MDA quantifies a linear combination of these financial ratios which classifies the firms into one of the established groups. If an object (firm) has characteristics (financial ratios) which can be identified for all objects (firms), MDA establishes a set of discriminant coefficients. The application of these coefficients to the actual values of the characteristics provides a basis for classifying the firm into one of the established groups. MDA considers the entire group of characteristics as well as the interaction therein in assigning group membership.

MDA reduces the dimensionality from the number of independent variables (financial ratios) to G-1 dimension(s), where G is the number of groups. For example, this research was concerned with two groups and the analysis was therefore in one dimension (2). The discriminant function was of the form:

$$Z_j = a + b_1X_{1j} + b_2S_{2j} + \ldots + b_NX_N$$

where Z_j = the jth individual's discriminant score (j = 1 - 43),

a = constant,

b_i = the discriminant coefficient for the ith variable (i = 1 - 39), and

X_{ij} = the jth individuals' value of the ith individual variable.

Classification is accomplished by computing a cut off point for the Z scores. This cut off, or critical score (Z crit), is generally the midpoint between the group centroids since MDA maximizes the distance between centroids. The classification procedure is:

If $Z_j < Z_{crit}$ classify individual J as belonging to the group with the smallest mean.

If $Z_j > Z_{crit}$ classify individual J as belonging to the group with the largest mean.

The assumptions underlying MDA are that each of the X_i variables has a multivariate normal distribution for all groups; the X_i variables are assumed to have different means but common variance-covariance matrices for all groups (13).

The assumption of common variance-covariances matrices may be tested with Box's M statistic. Box's M is a multivariate analog of Bartlett's test for homogeneity of variance (41), which is perhaps the most widely used test. Box's M was transformed so that statistical significance was determined from an F table. Rejection of the hypothesis of equal variance-covariance matrices indicates using the individual variance-covariance matrix for each group rather than the pooled variance-covariance matrix in the

MDA (41). The consequence of having grossly different variance-covariance matrices is the tendency to classify objects into the group with the greatest overall variance if linear MDA is used (27). Accordingly, this research used the individual variance-covariance matrices in the linear MDA rather than the pooled variance-covariance matrix when the hypothesis of equal variance-covariance matrices was rejected or could not be calculated. Strictly speaking, unequal variance-covariance matrices also indicate that a linear discriminant function is not appropriate. However, since a computer accessible non-linear MDA package was unavailable and in practice linear MDA is very robust with respect to its basic assumptions (27), linear MDA was used even when not strictly proper.

If the means of the two groups are equal, the use of discriminant analysis is fruitless. MDA is based on the premise that the means, or group centroids, are different. As an additional pretest to the MDA, a Hotelling's T^2 was computed on the mean vectors of ratios for the two groups to determine if the MDA was appropriate. The Hotelling T^2 was transformed so that statistical significance were determined from an F table. If the T^2 was not significant, then MDA is not appropriate.

The utilization of a comprehensive set of financial ratios implied an intercorrelation problem. To deal with this problem, stepwise linear MDA rather than direct MDA was chosen. Stepwise linear MDA allows for the entrance

of a variable only if it significantly contributes to the predictive accuracy of the model. Therefore, a variable with a high degree of correlation to those already included in the model is chosen only if that variable has other significant information content.

The specific stepwise linear MDA package chosen is contained in SPSS (27). The process began by choosing the single variable which had the highest value on a predetermined selection criterion. The selection criterion used in this research was Wilks' Λ, a criterion which maximizes intergroup differences and minimizes intragroup differences. This process continues for all possible pairs, triplets, etc. until all variables are entered or no remaining variables can provide a specified level of improvement.

Some chosen variables may lose their discriminating power as other variables are chosen. The loss occurs because the same information is now available from some combination of entered variables. The potential redundancy was tested at the beginning of each iteration (26).

Definition of Population and Methodology

The population consists of 43 firms, as explained in Chapter I. The filings were arranged chronologically, based on year of filing. Starting with the earliest filing years required to develop a successful model, filings

are randomly divided into a calibration group, n_1, and validation group, n_2 (Figure 1).

The 20 filing for the years 1959 through 1969 were chosen as the first group to divide into the calibration and validation groups. All randomizations, for the initial and subsequent groups, were accomplished by the "blind stab" method using a random number table. The results of this randomization process are given in Appendix C.

This calibration group was used to develop tentative model LDFA1. LDFA1 was used to classify the filings from the validation group detailed in Appendix C. Classification better than a proportional chance model, based on prior probabilities of group membership, constituted successful validation. A proportional chance model is defined as a model which classifies all cases into the larger group. For example, if 60 percent of the cases in the calibration group were liquidated and 40 percent were reorganized, a proportional chance model classifies all cases in the validation group as liquidated.

Assuming successful validation for a time span, as defined in Appendix C, the methodology calls for the calibration and validation group for that time span to be combined, $n_1 + n_2$, to develop a predictive model for those firms filing in the next year. For example, all 20 firms which filed in the 1959-1969 time span would be used to compute the first predictive model LDFA. The

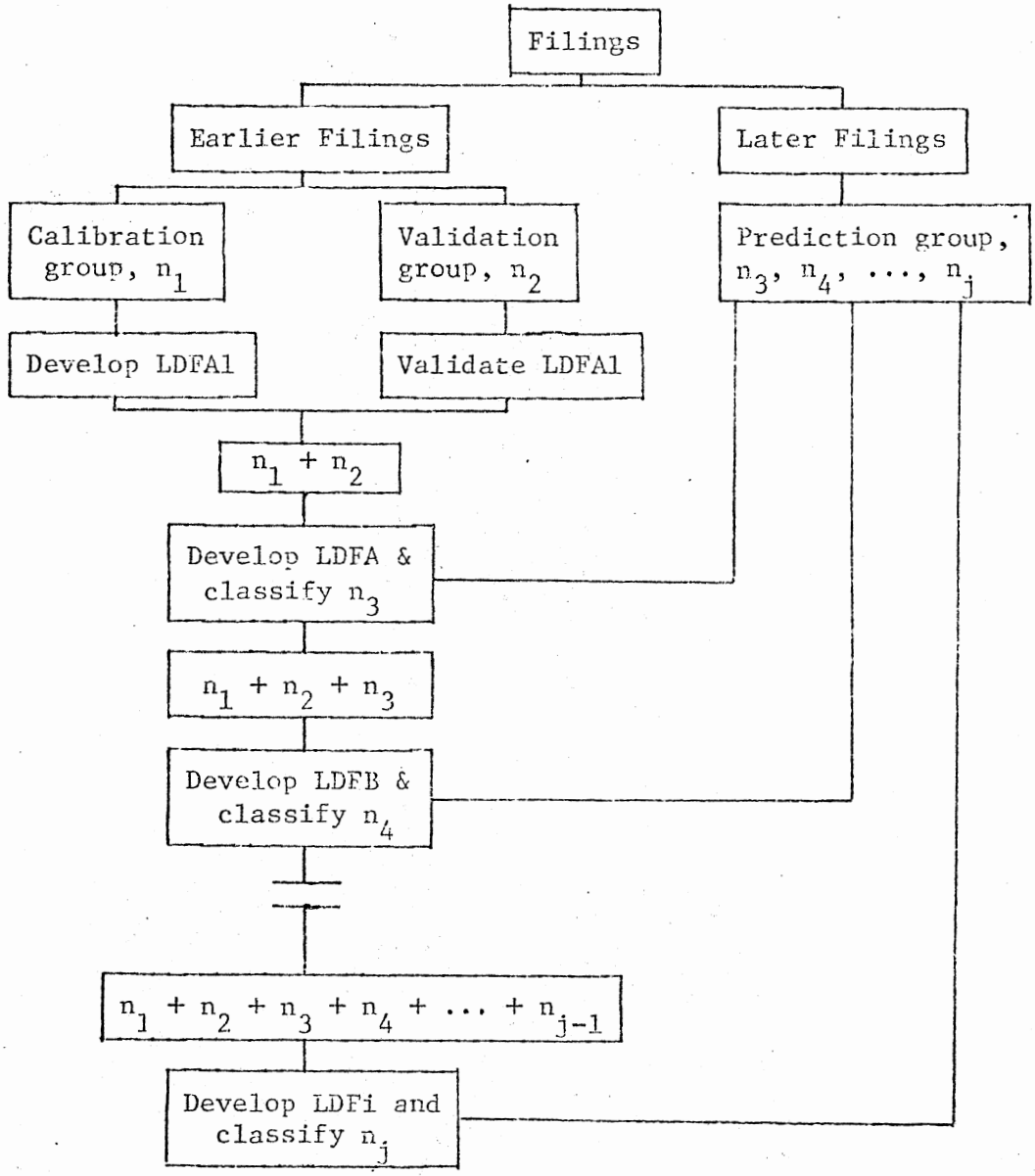


Figure 1. Methodology

methodology calls for LDFA to predict the outcome of those seven firms filing in 1970, the first predicted group, n_3, i.e., numbers 17, 18, 19, 20, 22, 23, and 24. Successful prediction is achieved when LDFA classifies the prediction group n_3 better than a proportional chance model based on the firms used in building LDFA.

The 27 firms filing for the time span 1959 through 1970, $n_1 + n_2 + n_3$, were then subjected to the calibration and validation procedure discussed above. The 1959 through 1970 group was the basis for LDFB, assuming successful validation. The methodology called for LDFB to predict the outcome of the seven firms filing in 1971, n_4. This procedure was continued until the 1959-1973 data was used in an attempt to build a predictive model for 1974.

Error Analysis

The format for presentation of results is frequently referred to as an accuracy matrix (Table I). Actual group membership is equivalent to the a priori groupings. The H's are correct classifications (or hits) and the M's are misclassifications (or misses). M_1 represents a Type I error and M_2 a Type II error. Type I error occurred if a firm predicted not to fail, will fail, and Type II error occurs if a firm predicted to fail, will not fail.

The sum of the southeast diagonal elements equals the hits and, when divided by the total firms classified, yields the success of the MDA in classification. This

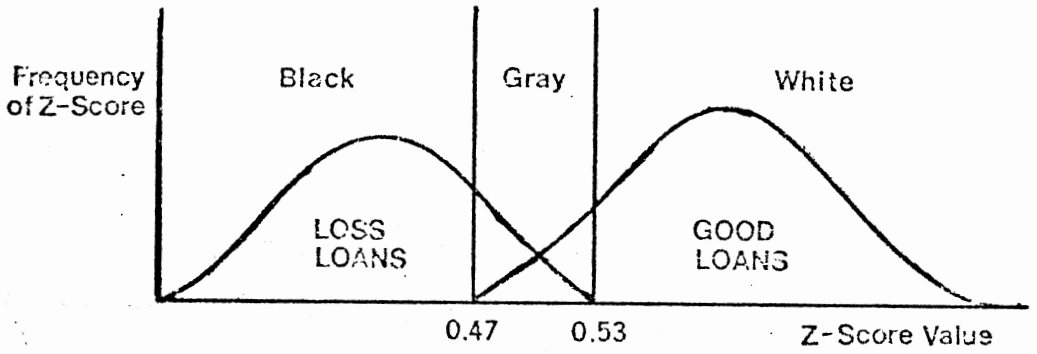
percentage is analogous to R^2, the coefficient of determination in regression analysis. R^2 measures the percent of the variation of the dependent variable explained by the independent variables (2).

TABLE I

ACCURACY MATRIX

Actual Group Membership	Predicted Group Membership		Totals
	Bankrupt	Non-Bankrupt	
Bankrupt	H	M_1	
Non-Bankrupt	M_2	H	
Totals			

Finally, those firms which the predictive models (LDFA, LDFB, etc.) failed to classify correctly were subject to closer examination. Generally, there is a "gray area" or "zone of ignorance" in which the majority of misses occur. The cutoff Z score for classification was chosen as the midpoint between the group centroids. Figure 2 illustrates the potential problem of using only the midpoint as the cutoff. This gray area has the potential for other nonfinancial analysis which is beyond the scope of this research.



Source: R. O. Edmister, "Small Business Failure Ratio Analysis," Journal of Financial and Quantitative Analysis (1972).

Figure 2. Error Analysis

In this example with a midpoint of 0.50, only liquidated firms are to the left of 0.47 and only reorganized firms are to the right of 0.53. Therefore, all misses are between 0.47 and 0.53, and this is the gray area upon which the financial data fails to produce a good predictive model (10).

Summary

The purpose of this chapter was to specify and qualify the methodology employed in this research. This chapter contains a discussion of: 1) the model identification, 2) explanation of the model, 3) definition of the population and methodological application, and 4) error analysis. Chapter III presents the application and interpretation of this methodology.

CHAPTER III

ANALYSIS OF DATA

Introduction

This chapter summarizes, analyzes, and interprets the research results. In particular, the MDA models for time span are presented, analyzed, and interpreted.

Results for the 1959-1969 Groups

The original group for 1959-1969 was drawn by the sampling procedure described in Chapter II and may be found in Appendix B. The means of the ratios for the liquidated and reorganized firms for the original calibration group, C_1, were different at a significance level of .02. Box's M test for equality of variance-covariance matrices could not be calculated for C_1 due to the failure of either of the matrices to be non-singular. Therefore, the individual group covariance matrices rather than the pooled covariance matrices were used in computing the MDA. The unstandardized discriminant function coefficients for LDFA1 and the percentage of variation explained by each ratio are given in Table II.

TABLE II

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS AND PERCENTAGE OF VARIATION EXPLAINED BY VARIABLE FOR C_1

Ratios (Appendix A)	Unstandardized Discriminant Function Coefficients	Percentage of Variation Explained by Variable
R5	20.15510	9.08
R10	-81.41589	24.39
R14	-0.4556393D-01	4.24
R17	0.4297008D-01	2.55
R22	-7.977937	7.84
R28	78.50834	15.47
R30	121.2069	22.15
R31	19.34672	14.28
Constant	-5.794785	100.00

The discriminant function LDFA1 presented in Table II is written in the form:

$$Z_i = - 5.794785 + 20.155 \cdot R5 - 81.416 \cdot R10$$
$$- .046 \cdot R12 + \ldots + 19.347 \cdot R31$$

Using this equation the following Z scores in Table III were calculated for the firms in C_1. Group 1 represents liquidated firms and Group 2 represents reorganized firms.

TABLE III

DISCRIMINANT SCORES, ACTUAL AND PREDICTED GROUP CLASSIFICATION FOR C_1

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
25	2	2	11.7866
26	1	1	-6.9701
30	1	1	-5.9285
31	1	1	-4.2845
98	1	1	-5.3005
64	1	1	-6.2702
34	2	2	13.6348
78	1	1	-5.5656
39	1	1	-4.1857
74	2	2	13.0897

The group means or centroids for the Z scores for C_1 are given in Table IV. Z_{crit}, the midpoint between the groups, based on known membership, is computed as follows:

$$Z_{crit} = \frac{-5.50159 + 12.83705}{2}$$

$$Z_{crit} = 3.6677$$

The discriminant function LDAF1 was used to calculate Z scores for the validation group, V_1, drawn from the same time span (Table V). The classification results for V_1 are given in Table VI.

TABLE IV

GROUP MEANS (GROUP CENTROIDS)
FOR C_1

Group	Means (Centroids)
1	-5.50159
2	12.83705

TABLE V

Z SCORES FOR THE FIRMS IN V_1
AND CLASSIFICATION OF V_1

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
28	1	2	14.1414
27	2	1	-153.5157
29	1	1	-56.1229
72	1	1	-33.7379
93	1	1	-173.5625
02	2	1	3.6341
62	2	1	-9.3273
90	1	2	191.6451
36	2	2	28.6793
38	1	1	-14.2644

TABLE VI

CLASSIFICATION RESULTS - V_1

Actual Group	Number of Cases	Predicted Group Membership 1	2	Total
Group 1	6	4 40%	2 20%	6
Group 2	4	3 30%	1 10%	4
Total	10	7	3	10

The results in Table VI indicate that half of the cases were correctly classified and half were incorrectly classified. Two firms had been predicted not to fail which actually did fail, or Type I errors, and three firms which did not fail were predicted to fail, or Type II errors. The results of trying to validate LDAF1 were disappointing, especially when considered in light of a proportional chance model.

LDAF1 was formulated on data where the firms had a 70 percent probability of liquidation and a 30 percent probability of reorganization. Applying the proportional chance rule of classification into the group with the largest membership yielded a 70 percent correct classification as contrasted to a 50 percent correct classification for LDFA1. The 40 percent error for the model was all Type II, since the liquidated group has the higher prior probability.

The analysis of the cost of Type I and Type II error was beyond the scope of this research. LDFA1 did not predict group membership for the validation group at an acceptable level. Therefore, LDFA was not computed and there was no prediction performed for the seven firms filing in 1970. Rather, the 27 firms filing from 1959-1970 were used in an attempt to validate a model.

Results for 1959-1970 Groups

A new calibration group, C_2, for the years 1959 through 1970, was drawn by the sampling procedure described in Chapter II. The included firms may be found in Appendix C. The means of the ratios for the liquidated and reorganized firms were different at a significance level of 0.0005. As in the previous run, Box's M test for equality of variance-covariance matrices could not be calculated for C_2 due to the failure of either of the matrices to be non-singular. Therefore, the individual group covariance matrices rather than the pooled covariance matrices were used in computing the MDA. The unstandardized discriminant function coefficients for LDAF2 and the percentage of variation explained by ratio are given in Table VII.

Using the equation presented in Table VII, the Z scores in Table VIII were calculated for the firms in C_2. The group means or centroids for the Z scores are

given in Table IX. Z_{crit} is computed as follows:

$$Z_{crit} = \frac{-12.51928 + 22.53471}{2}$$

$$Z_{crit} = 5.00772$$

TABLE VII

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS AND PERCENTAGE OF VARIATION EXPLAINED BY VARIABLE FOR C_2

Ratios (Appendix A)	Unstandardized Discriminant Function Coefficients	Percentage of Variation Explained by Variable
R5	62.57421	17.00
R11	-43.70733	3.52
R12	0.1631644	0.05
R15	-0.5609940D-02	14.20
R16	-0.1088863D-01	6.00
R17	0.2856782	6.24
R27	0.5197229D-02	17.07
R28	-6.224968	0.84
R31	9.519427	11.89
R33	12.38593	5.38
R35	-5.548119	5.58
R39	-1.772687	12.22
Constant	-25.27998	
		100.00

TABLE VIII

DISCRIMINANT SCORES, ACTUAL AND PREDICTED GROUP CLASSIFICATION FOR C_2

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
18	2	2	22.7597
23	2	2	20.0367
25	2	2	24.5562
30	1	1	-12.0756
31	1	1	-12.6239
19	2	2	22.5315
20	1	1	-12.4198
17	1	1	-12.7510
72	1	1	-11.6204
98	1	1	-12.8120
63	1	1	-12.7564
78	1	1	-12.5152
36	2	2	22.7895
38	1	1	-13.0993

TABLE IX

GROUP MEANS (GROUP CENTROIDS) FOR C_2

Group	Means (Centroids)
1	-12.51928
2	22.54371

LDFA2 was used to calculate Z scores for the validation sample V_2. The results of this calculation are given in Table X. The classification results for V_2 are given in Table XI. Table XI indicates that LDAF 2 correctly classified approximately 62 percent of the cases. Type I and Type II errors were 23 percent and 15 percent, respectively.

TABLE X

Z SCORES FOR THE FIRM IN V_2 AND CLASSIFICATION OF V_2

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
28	1	2	19.3015
24	1	1	-5.7993
26	1	1	-48.7577
22	1	1	0.3269
27	2	1	-26.4689
29	1	2	24.5437
64	1	1	-16.9735
34	2	2	23.3468
92	2	2	6.7385
62	2	2	5.5362
90	1	1	-76.0796
39	1	2	14.0678
74	2	1	-10.5946

TABLE XI

CLASSIFICATION RESULTS - V_2

Actual Group	Number of Cases	Predicted Group Membership 1	2	Total
Group 1	8	5 38.5%	3 23.1%	8
Group 2	5	2 15.4%	3 23.1%	5
Total	13	7	6	13

Classification using LDFA2 and the proportional chance model yielded the same overall accuracy of 62 percent. However, the error distribution is different between the two. LDFA2 yielded Type I and Type II errors of 23 percent and 15 percent, respectively, as illustrated in Table XI. The proportional chance model yielded the same 38 percent error rate but all of the error is Type II since all firms were classified as liquidated. A proportional chance model will always yield either all Type I error or all Type II error if there are any errors. As previously stated, analysis of the costs of Type I and and Type II errors was beyond the scope of this research.

LDAF2 did not predict group membership for the validation group at an acceptable level based on the definition of predicting more correct outcomes than a

proportional chance model. Therefore, no predictive model was calculated. Rather, the 1959-1971 firms were used in an attempt to validate a model.

Results for the 1959-1971 Groups

The third calibration group, C_3, for the years 1959 through 1971, was drawn as previously specified. The included firms may be found in Appendix B. The means of the ratios for the liquidated and reorganized firms were different at a significance level of 0.0156. Again, Box's M could not be performed due to the failure of either of the matrices to be non-singular. Based on the individual variance-covariance matrices, the unstandardized discriminant function coefficients for LDFA3 and the percentage of variation explained by each ratio are given in Table XII. Using the equation presented in Table XII the Z scores in Table XIII were calculated for the firms in C_3. The group means or centroids for the Z scores for C_3 are given in Table XIV. Z_{crit} is computed as follows:

$$Z_{crit} = \frac{3.40709 - 3.83297}{2}$$

$$Z_{crit} = -0.42588$$

LDFA3 was used to calculate Z scores for the validation sample V_3. The results of this calculation are given in Table XV and the classification results for V_3 are given in Table XVI.

TABLE XII

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS AND PERCENTAGE OF VARIATION EXPLAINED BY VARIABLE FOR C_3

Ratios (Appendix A)	Unstandardized Discriminant Function Coefficients	Percentage of Variation Explained by Variable
R1	-0.3126096D-01	.01
R5	-14.61550	8.71
R13	20.40138	9.96
R15	-0.1607339D-03	.81
R19	2.931404	4.94
R20	-11.66225	8.17
R24	-0.8154310D-03	.83
R25	-0.1518471D-03	.11
R34	4.540696	5.63
R35	-0.8100850	24.84
R37	0.9137574	29.01
R39	0.5093136	6.97
Constant	2.540172	
		100.00

Table XVI indicates that LDAF3 correctly classified 47 percent of the cases. Type I and Type II errors were 29.4 percent and 23.5 percent, respectively. A proportional chance model based on the highest probability of group membership yielded correct classification of 53 percent of the firms. Classification accuracy using

TABLE XIII

DISCRIMINANT SCORES, ACTUAL AND PREDICTED GROUP CLASSIFICATION FOR C_3

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
12	2	2	-1.3827
9	1	1	2.6036
18	2	2	-3.2660
23	2	2	-4.8388
24	1	1	3.2022
25	2	2	-5.3950
30	1	1	2.0058
11	2	2	-4.0772
19	2	2	-4.2293
20	1	1	3.6984
17	1	1	3.3758
10	2	2	-3.3793
72	1	1	4.6324
98	1	1	3.6477
63	1	1	3.4314
78	1	1	4.0666
36	2	2	-4.0954

TABLE XIV

GROUP MEANS (GROUP CENTROIDS) FOR C_3

Group	Means (Centroids)
1	3.40709
2	-3.83297

TABLE XV

Z SCORES FOR THE FIRMS IN V_3 AND CLASSIFICATION OF V_3

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
28	1	2	-2.0436
8	2	1	9.1098
13	2	1	4.1477
14	2	2	-16.0075
26	1	1	2.2691
31	1	1	1.1581
22	1	2	-0.7075
27	2	1	3.2626
29	1	1	-10.2926
64	1	1	3.5340
34	2	2	-5.4676
92	2	2	-8.1358
62	2	2	-3.5931
90	1	1	0.2082
39	1	2	-3.5212
74	2	1	0.5414
38	1	2	-2.8827

TABLE XVI

CLASSIFICATION RESULTS - V_3

Actual Group	Number of Cases	Predicted Group Membership 1	2	Total
Group 1	9	4	5	9
		23.5%	29.4%	
Group 2	8	4	4	8
		23.5%	23.5%	
Total	17	8	9	17

LDFA3 was less than the accuracy of the proportional chance model. Therefore, LDAF3 did not predict group membership at an acceptable level and no predictive model was calculated. Rather, the 1959-1972 firms were used in an attempt to compute a successful predictive model.

Results for the 1959-1972 Groups

The fourth calibration group, C_4, for the years 1959 through 1972, was drawn as previously specified. The included firms may be found in Appendix B. The means of the liquidated and reorganized firms were different at a significance level of 0.149. A significance level of 0.149 may not be low enough for the rejection of the hypothesis of equal means by some users. However, the researcher believed that due to the empirical nature of the research, that level was appropriate to continue at the calculated significance level.

As in previous groups, Box's M could not be performed due to the failure of either of the matrices to be non-singular. Based on the individual variance-covariance matrices, the unstandardized discriminant function coefficient for LDFA4 and percentage of variation explained by each ratio are given in Table XVII.

Using the equation presented in Table XVII, the Z scores in Table XVIII were calculated for the firms in C_4. The group means or centroids for the Z scores for C_4

are given in Table XIX. Z_{crit} is computed as follows:

$$Z_{crit} = \frac{2.86788 - 4.30183}{2}$$

$$Z_{crit} = -1.43395$$

TABLE XVII

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS AND PERCENTAGE OF VARIATION EXPLAINED BY VARIABLE FOR C_4

Ratios (Appendix A)	Unstandardized Discriminant Function Coefficients	Percentage of Variation Explained by Variable
R3	44.79770	9.48
R5	-0.4622532	0.37
R11	23.65708	8.12
R12	-7.421259	4.32
R14	0.1221453D-02	1.90
R20	15.75181	12.33
R21	-2.52428-	3.55
R23	0.1023172D-02	6.80
R24	0.6235746D-03	0.71
R25	0.9481881D-02	8.25
R26	-0.3958668D-02	2.90
R29	-1.241657	2.24
R30	33.00367	7.14
R31	0.1108331	2.29
R32	-103.0397	20.64
R33	1.761650	3.67
R34	0.4379600	0.29
R39	0.3840835	5.01
Constant	-13.82843	
		100.00

TABLE XVIII

DISCRIMINANT SCORES, ACTUAL AND PREDICTED GROUP CLASSIFICATION FOR C_4

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
12	2	2	-1.0750
13	2	2	-4.4317
18	2	2	-4.6203
23	2	2	-5.1983
24	1	1	2.7744
25	2	2	-5.3847
7	1	1	2.8395
30	1	1	1.5171
3	1	1	1.6208
11	2	2	-4.4619
31	1	1	2.9451
22	1	1	4.0872
27	2	2	-4.8410
20	1	1	3.3449
5	1	1	3.0724
98	1	1	3.0612
63	1	1	3.0769
90	1	1	3.0521
78	1	1	3.0230
36	2	2	-4.5916

LDFA4 was used to calculate Z scores for the validation sample V_4. The results of this calculation are given in Table XX. The classification results for V_4

are given in Table XXI. LDAF4 correctly classified 53 percent of the cases with Type I and Type II error of 10.5 percent and 36.8 percent, respectively. A proportional chance model based on the highest probability of group membership yielded correct classification of 53 percent of the cases as well.

TABLE XIX

GROUP MEANS (GROUP CENTROIDS) FOR C_4

Group	Means (Centroids)
1	2.86788
2	-4.30183

LDAF4 does not predict group membership for the validation group at an acceptable level based on the definition of predicting more correct outcomes than a proportional chance model. Therefore, no predictive model was calculated. Rather, the 1959-1973 firms were used in an attempt to validate a model.

Results for the 1959-1973 Groups

The fifth calibration group, C_5, for the years 1959

TABLE XX

Z SCORES FOR THE FIRMS IN V_4 AND CLASSIFICATION OF V_4

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
28	1	1	3.6876
8	2	2	-1.5548
9	1	1	164.3179
4	1	2	-25.3177
14	2	2	-8.2962
26	1	2	-1.9011
19	2	2	-14.7852
6	2	1	0.8454
17	1	2	-14.5380
10	2	2	-14.1618
29	1	2	-4.6195
72	1	2	-2.9669
64	1	2	-20.9132
34	2	2	-6.2752
92	2	1	15.4965
62	2	2	-20.6971
39	1	2	-13.6701
74	2	2	-41.6506
38	1	2	-4.4908

through 1973, was drawn as previously specified. The included firms may be found in Appendix B. The means of the liquidated and reorganized firms were different at a significance level of 0.049. Again, Box's M could not be performed due to the failure of either of the matrices to be non-singular. Based on the individual variance-covariance matrices, the unstandardized discriminant function coefficients and percentage of variation explained by each is given in Table XXII.

TABLE XXI

CLASSIFICATION RESULTS - V_4

Actual Group	Number of Cases	Predicted Group Membership 1	2	Total
Group 1	10	2 10.5%	8 42.1%	10
Group 2	9	2 10.5%	7 36.8%	9
Total	19	4	15	19

Using the equation presented in Table XXII, the Z scores in Table XXIII were calculated for the firms in C_5. The group means (centroids) for the Z scores for C_5 are given in Table XXIV. Z_{crit} is computed as follows:

TABLE XXII

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS AND PERCENTAGE OF VARIATION EXPLAINED BY VARIABLE FOR C_5

Ratios (Appendix A)	Unstandardized Discriminant Function Coefficients	Percentage of Variation Explained by Variable
R2	12.05332	5.20
R4	-45.83171	8.61
R5	19.25840	8.74
R11	-19.44264	3.39
R12	-2.989689	0.97
R17	0.1138896	2.67
R18	10.57610	2.28
R21	-6.484590	5.08
R23	0.1609913D-02	0.60
R25	-0.3553883D-02	1.04
R28	31.08741	4.83
R29	-0.7059952	0.73
R30	-117.7007	18.46
R33	-3.232227	3.86
R35	3.737845	4.81
R36	163.1593	22.75
R37	0.3328803	0.33
R39	-0.7796869	5.65
Constant	6.459005	
		100.00

TABLE XXIII

DISCRIMINANT SCORES, ACTUAL AND PREDICTED GROUP CLASSIFICATION FOR C_5

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
12	2	2	-2.1896
28	1	1	6.8638
13	2	2	-4.3206
18	2	2	-4.9788
14	2	2	-4.4257
3	1	1	2.6689
6	2	2	-3.2413
5	1	1	4.9303
10	2	2	-4.0906
72	1	1	5.0645
64	1	1	5.3358
34	2	2	-4.1382
92	2	2	-5.3894
62	2	2	-4.0254
90	1	1	5.2360
78	1	1	4.4844
39	1	1	5.8856
36	2	2	-4.5499
84	2	2	-4.7880
38	1	1	5.8886

$$Z_{crit} = \frac{5.12643 - 4.19435}{2}$$

$$Z_{crit} = 0.46604$$

TABLE XXIV

GROUP MEANS (GROUP CENTROIDS) FOR C_5

Group	Means (Centroids)
1	5.12643
2	-4.19435

LDFA5 was used to calculate Z scores for the validation sample V_5. The results of this calculation are given in Table XXV. The classification results for V_5 are given in Table XXVI.

Table XXVI indicates LDAF5 correctly classified 30 percent of the cases. Type I and Type II errors were 50 percent and 20 percent, respectively. A proportional chance model based on the highest probability of group membership yielded correct classification of 65 percent of the cases. Classification accuracy using LDFA5 was less than the accuracy of the proportional chance model. Therefore, no predictive model was calculated.

TABLE XXV

Z SCORES FOR THE FIRMS IN V_5 AND CLASSIFICATION OF V_5

Firm Number	Actual Group	Predicted Group	Discriminant Z Scores
8	2	2	-6.2251
9	1	2	-225.4188
4	1	2	-10.2308
23	2	1	14.9400
24	1	2	-10.5441
25	2	1	7.6425
26	1	2	-19.2133
7	1	1	10.2057
30	1	2	-7.3644
11	2	2	-130.2869
31	1	2	-6.8974
22	1	2	-14.5331
19	2	1	10.5466
27	2	2	-0.6455
20	1	2	-10.3087
17	1	1	13.7142
29	1	2	-4.1478
98	1	2	-0.1572
63	1	1	30.4203
53	2	1	4339.9063

TABLE XXVI

CLASSIFICATION RESULTS - V_5

Actual Group	Number of Cases	Predicted Group Membership 1	2	Total
Group 1	13	3 15%	10 50%	13
Group 2	7	4 20%	3 15%	7
Total	20	7	13	20

The data for the 1959-1973 time span was the last available data on which to compute a model. Therefore, the iterative process was terminated at this point.

Summary

In summary, a discriminant function for each of the five available time spans was computed in an attempt to build a successful predictive model. The research effort was unsuccessful in validating a function for any of the time spans and therefore did not reach the predictive stage. The results of the research effort are summarized in Table XXVII. The next chapter contains, in addition to the research summary, a possible explanation of the failure of this research to successfully predict for the population of firms.

TABLE XXVII

CLASSIFICATION SUMMARY FOR ALL VALIDATION GROUPS

Time Span	Percent Correct	
	MDA Model	Proportional Chance Model
1959-1969	50	70
1959-1970	62	62
1959-1971	47	53
1959-1972	53	53
1959-1973	30	60

CHAPTER IV

SUMMARY AND CONCLUSIONS

This chapter contains a summary of the research project presented in the previous chapters and an attempt to explain the failure of the research project to successfully predict for the population of firms.

Summary

Research was performed in which attempts were made to build a predictive model for the ultimate disposition of firms filing under Chapter X of the Bankruptcy Act of 1898. Financial statement ratios were the chosen predictor variables. An accurate predictive model could have led to the avoidance of certain costs incurred in the determination of the disposition of filing firms. The filing period used in this research, July 1, 1959, through July 1, 1974, contained the latest available complete data.

Each time span tested revealed a significant difference between the mean vectors of ratios. The significant difference indicated that discriminant analysis was a proper technique for the research situation. Individual

rather than pooled variance-covariance matrices were used in prediction in an attempt to minimize error.

The researcher could not validate a model for the time span on which the model was built and therefore could not derive a successful predictive model. A proportional choice model for each time span was used as the naive model for evaluation.

Explanation and Limitations

Based on the results presented, the disposition of Chapter X filings was not predictable using multiple discriminant analysis for the firms included in this research. The 43 firms considered are a small sample, but represented all of the firms for which complete audited financial information was available. Over 60 SEC filing firms were excluded due to lack of data. Additionally, several hundred other filing firms were excluded due to the high cost of gathering the data on an individual firm basis. Specific limitations are detailed below.

First, the specific effects of sample size limitations on this research are unknown. In general, there is relatively less reliability associated with small samples than with large samples. The calibration-validation procedure used effectively limited the sample size to approximately 20 firms at a maximum. While the small number of firms may have adversely affected the strength of the model, the amount, if any, of this affect is not known.

Second, financial statement ratios based on current generally accepted accounting principles (GAAP) may not be the means by which one can determine whether or not a firm should be liquidated or reorganized. While previous studies found predictive ability in financial statement ratios, this study did not. Previous studies had predicted whether or not a firm would fail and were based on the cash flow theory presented in Chapter I. There was no specific theory to support the use of the same type methodology to predict liquidation or reorganization. The eventual disposition of a Chapter X filing may hinge on other nonquantifiable factors, including the nature and details of the reorganization plan and the ability of the trustee. The nature and details of the reorganization plan are, in part at least, the result of a political bartering process of which the trustee is an integral part.

Third, the data used in this study is based on the going concern concept. Perhaps a quitting concern concept, i.e., some type of market value basis of accounting, may be more appropriate in the prediction of Chapter X filings, since it would not be an artifact, but rather a current measure of the firm's value.

Lastly, the actual outcomes of the proceedings may be biased. The judgment of the Bankruptcy Courts is final in regard to the allowance of reorganization or the liquidation of a firm.

Further research in this area could concentrate on the data collection problem mentioned by many researchers in this area and encountered by this researcher. There is no centralized collection point for bankruptcy court data nor do the commercial financial reporting services systematically delineate why firms are removed from their listings. Both of these, and especially the latter, would ease the data problems in this area.

Research in the process of plan formulation and adoption might be considered. These represent a political process which was not quantified in this research. In addition, research in non-historical based accounting models may be appropriate. Research using data available from the revised bankruptcy act may be considered. Benefit/cost analysis of the bankruptcy system appears to the researcher to have practical implications.

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APPENDIXES

APPENDIX A

RATIOS USED IN THE STUDY

$$R\ 1 = \frac{\text{Net Working Capital}}{\text{Assets}}$$

$$R\ 2 = \frac{\text{Retained Earnings}}{\text{Assets}}$$

$$R\ 3 = \frac{\text{EBIT}}{\text{Assets}}$$

$$R\ 4 = \frac{\text{Net Worth}}{\text{Assets}}$$

$$R\ 5 = \frac{\text{Sales}}{\text{Assets}}$$

$$R\ 6 = \frac{\text{Current Assets - Inventory}}{\text{Current Liabilities}}$$

$$R\ 7 = \frac{\text{Net Worth}}{\text{Sales}}$$

$$R\ 8 = \frac{\text{Net Working Capital}}{\text{Sales}}$$

$$R\ 9 = \frac{\text{Inventory}}{\text{Sales}}$$

$$R\ 10 = \frac{\text{Cash Flow}}{\text{Current Liabilities}}$$

$$R\ 11 = \frac{\text{Cash + Marketable Securities}}{\text{Current Assets}}$$

$$R\ 12 = \frac{\text{Accounts Receivable}}{\text{Current Assets}}$$

$$R\ 13 = \frac{\text{Inventory}}{\text{Current Assets}}$$

$$R\ 14 = \frac{\text{Cash + Marketable Securities}}{\text{Sales Per Day}}$$

$$R\ 15 = \frac{\text{Accounts Receivable}}{\text{Sales Per Day}}$$

$$R\ 16 = \frac{\text{Inventory}}{\text{Sales Per Day}}$$

$$R\ 17 = \frac{\text{Current Assets}}{\text{Sales Per Day}}$$

$$R\ 18 = \frac{\text{Cash + Marketable Securities}}{\text{Current Liabilities}}$$

$$R\ 19 = \frac{\text{Accounts Receivable}}{\text{Current Liabilities}}$$

$$R\ 20 = \frac{\text{Inventory}}{\text{Current Liabilities}}$$

$$R\ 21 = \frac{\text{Net Income}}{\text{Sales}}$$

$$R\ 22 = \frac{\text{Current Assets}}{\text{Current Liabilities}}$$

$$R\ 23 = \frac{\text{Accounts Payable}}{\text{Sales Per Day}}$$

$$R\ 24 = \frac{\text{Net Working Capital}}{\text{Sales Per Day}}$$

$$R\ 25 = \frac{\text{Other Accruals}}{\text{Sales Per Day}}$$

$$R\ 26 = \frac{\text{Current Bank Debt}}{\text{Sales Per Day}}$$

$$R\ 27 = \frac{\text{Current Liabilities}}{\text{Sales Per Day}}$$

$$R\ 28 = \frac{\text{Net Income}}{\text{Total Liabilities}}$$

$$R\ 29 = \frac{\text{Cash Flow}}{\text{Current Bank Debt}}$$

$$R\ 30 = \frac{\text{Cash Flow}}{\text{Total Liabilities}}$$

$$R\ 31 = \frac{\text{Cash Flow}}{\text{Net Working Capital}}$$

$$R\ 32 = \frac{\text{Cash Flow}}{\text{Assets}}$$

$$R\ 33 = \frac{\text{Cash Flow}}{\text{Current Assets}}$$

$$R\ 34 = \frac{\text{Net Worth}}{\text{Total Liabilities}}$$

$$R\ 35 = \frac{\text{Net Worth}}{\text{Current Liabilities}}$$

$$R\ 36 = \frac{\text{Net Income}}{\text{Assets}}$$

$$R\ 37 = \frac{\text{Retained Earnings}}{\text{Current Liabilities}}$$

$$R\ 38 = \frac{\text{Net Income}}{\text{Net Worth}}$$

$$R\ 39 = \frac{\text{Quick Assets}}{\text{Inventory}}$$

APPENDIX B

FIRMS INCLUDED IN STUDY BY FILING DATE

Year	Firm Number	Firm Name
1959	98	Morehead City Shipbuilding
1962	92	Teletronics Co.
1963	90	Sire Plan Management Corp.
	39	Continental Vending Corp.
	37	Virco Corp.
1965	36	Yale Express System, Inc.
1966	35	Westec Corp.
1967	78	Ladco Corp.
	31	Federal Shopping Way, Inc.
	74	Jade Oil and Gas Co.
1968	72	Louisiana Loan and Thrift
1969	30	Gulf Aerospace Corp.
	29	National Video Corp.
	28	Whiple, Inc.
	64	Norman Finance and Thrift Corp.
	63	Peoples Loan and Investment Co.
	62	Landmark Inns of Durham, Inc.
	27	First Holding Corp.
	26	Manmoth Mountain Inn Corp.
	25	R. Hoe and Co., Inc.
1970	24	RIC International Industries, Inc.
	23	Roberts Co.
	22	Uniservices, Inc.
	20	Flying W Airways, Inc.
	19	Four Seasons Nursing Centers of America, Inc.
	18	San Francisco and Oakland Helicopter Airlines, Inc.
	17	Computer Services Corp.
1971	14	Phoenix Gems, Inc.
	13	Union Investments, Inc.
	12	Moulded Products, Inc.
	11	Federal Coal Co.
	10	Atlanta International Raceway, Inc.

Year	Firm Number	Firm Name
1971 (Cont.)	9	Viatron Computer Services Corp.
	8	Waltham Industries Corp.
1972	7	Heidler Corp.
	6	Dextra Corp.
	5	Creative Merchandising, Inc.
	4	Trans-East Air, Inc.
	3	Gro-Plant Industries
1973	53	Equity Funding Corp. of America
1974	2	Sequoyah Industries, Inc.
	46	Air Industrial Research, Inc.
	1	Woodmar Corp.

APPENDIX C

RANDOM SAMPLE OF DATA BY YEARS

TABLE XXVIII

RANDOM SAMPLE OF DATA BY YEARS

Time Span Based on July 1 Through June 30, Fiscal Year	Firm Number							
	Calibration Group				Validation Group			
July 1, 1959 - June 30, 1969	98	39	30	26	92	36	28	27
	34	78	64		90	72	63	
	31	74	25		38	29	62	
July 1, 1959 - June 30, 1970	98	31	25	18	92	74	62	22
	38	72	23	17	90	29	27	
	36	30	20		29	28	26	
	78	63	19		34	64	24	
July 1, 1959 - June 30, 1971	98	63	19	10	92	31	62	13
	36	25	18	9	90	74	27	8
	78	24	17		39	29	26	
	72	23	12		38	28	22	
	30	20	11		34	64	14	
July 1, 1959 - June 30, 1972	98	30	23	12	92	72	26	9
	90	63	22	11	39	29	19	8
	36	27	20	7	38	28	17	6
	78	25	18	5	34	64	14	4
	31	24	13	3	74	62	10	
July 1, 1959 - June 30, 1973	92	12	74	28	98	27	33	9
	90	5	14	64	31	26	20	8
	39	36	10	62	30	25	19	7
	38	34	3	13	29	24	17	4
	18	78	72	6	63	23	11	53

VITA

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