BUSINESS FAILURE PREDICTION USING
DISCRIMINANT ANALYSIS

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DECLARATION

This management project is my original work and has not been presented for a degree in any other University.

Signed: Keige, P. Ngige

This management project has been submitted for examination with my approval as University Supervisor.

Signed

MR. J.K. NJIRAINI
I would like to acknowledge the invaluable support of MR. J.K. NJIRAINI, my supervisor, without whose assistance this project would not have been possible. Special thanks also go to MR. ANDREW GREGORY and MR. H.K. WAITHAKA for their assistance.

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ABSTRACT

Business firms are formed to operate into the foreseeable future. However, there are cases where a business firm fails to fulfill the objectives for which it was formed or even to survive in the environment in which it was formed. In such cases, the stakeholders in the firm lose substantially, both in monetary and non-monetary terms. But if the failure of a business could be predicted with reasonable accuracy, then the stakeholders can act in good time to avoid or minimize the possible losses.

In this paper, the aim was to formulate a model to predict business failure. Data on some Kenyan companies that failed within the period 1980-1990, was collected. These companies were matched with comparable successful firms; and ratios from their financial statements subjected to discriminant analysis.

The results showed that it is possible to predict failure with up to 90% accuracy two years before the event. In this case, current ratio, fixed charge coverage, retained earnings to total assets, return on total assets, return on net worth, average collection period and sales to total assets, were identified as the critical ratios that discriminate failed from non-failed firms in Kenya.
CHAPTER 1

INTRODUCTION

1.1 BACKGROUND:

The prediction of business failure has for a long time attracted the attention of both business managers and scholars. The failure of a business results in losses to various stakeholders, e.g. money by lenders, tax revenue by the government, investment by shareholders, jobs by employees, products by society and general economic slowdown. Therefore failure is costly to society, and its avoidance would eliminate the losses therein associated. Alternatively, if failure can be predicted precisely well in advance, there would be a reduction of the costs associated with it. Failure is in various forms as outlined herebelow:

1.1.1 Forms of Business Failure:

Generally business failure has been described as the inability of a firm to meet its obligations. Two major categories of failure can be distinguished:

1. WESTON AND COPELAND: Managerial Finance; Dryden Press, Eighth Edition pg. 952
Economic failure:

This situation occurs when the firm cannot operate "economically". This implies the firm is unable to realize revenues sufficient to cover costs, thus making operating losses continually. Economic failure would also occur in cases where the firm's returns on investment are less than the firm's cost of capital. In such a situation, the owners may want to divest from the business because their investment is not earning sufficient returns. Partial liquidation resulting from large scale cutbacks in operations also falls under economic failure.

Financial failure:

This is in two perspectives; technical insolvency and bankruptcy.

A firm which cannot meet its current obligations as they fall due is suffering from Technical insolvency. This is the case when current liabilities exceed current assets. While bankruptcy is a situation where total liabilities exceed the "fair" value of assets, i.e. a negative net worth.

However not all failure results in liquidation and winding up. Normally liquidation and winding up is as a result of a court order.

1.1.2 Causes of Business Failure:

The causes of corporate failure could be internal or external.

Internal causes are mainly the result of bad management.
Bad management may engage in malfeasance and fraud, thereby dissipating the organization's resources and causing failure. Lack of adequate or relevant experience means management cannot be able to cope and respond to the demands of the industry. For example lack of responsiveness to technological advancements due to application of obsolete technology thus leading to inability to match competition.

Poor communication may lead to a communication breakdown and loss of coordination. This will further compound the problem of management for responses to environmental threats will be uncoordinated, leading to eventual failure of the firm. Also, inability to control costs will lead to financial distress and failure. For example, trade unions may demand wages, the payment of which leads the firm to financial distress.

External factors include Government action and restrictions, e.g. foreign exchange controls and import restrictions may deny a firm essential raw materials and cause its collapse. Others may be natural catastrophes e.g. fires, and demographic changes.

1.1.3 Dealing with Business Failure:

A business that has failed has number of options, which result in either cessation of the firm or its continuation. These are as follows:

Out of court procedures:

In these, the firm may continue to exist by getting an extension from its creditors i.e. postponement of payment of debts, or by being granted a composition, where creditors agree to take less than the full amount due in full settlement.

Merger:

Generally a merger forms one economic unit from two or more previous units. The failing firm joins another firm, either as an independent subsidiary or it is absorbed into the operations of the other firm.

Formal legal procedures:

These include liquidation or reorganization.

Reorganization is undertaken if it's thought the business is still feasible and can recover from financial distress, and when liquidation will result in extreme loss as compared to reorganization. It involves a restructuring of the business or scaling down of its operations.

Liquidation involves closing down the business and disposing off its assets and using the proceeds to settle outstanding obligations.
CHAPTER 2

LITERATURE REVIEW:

FAILURE PREDICTION MODELS:

The prediction of failure has interested both Academic researchers and Business managers for a long time. Various methods of prediction have been developed over the last decades. These methods can broadly be classified as ratio based and non-ratio based methods. These methods will be reviewed with the accompanying literature below:

2.1 Ratio Based Failure Prediction Models:

Introduction:

In practice financial ratios are used in many areas e.g. by bank loan officers and credit rating agencies to assess the performance of business firms and pinpoint candidates for failure or loan default.

The use of ratios is based on the realization that failing firms’ ratios are significantly different from non-failing firms ratios.

Generally ratio based models are in two categories:

i) Univariate models

ii) Multivariate models

In this section, both of these models will be surveyed, and their strengths and weaknesses highlighted.

2.1.1 Univariate Models:

The key characteristic which distinguishes these models from other ratio based models is that analysis is based on individual ratios. Thus overall assessment is a product of the individual ratio assessments.

TAMARI (1966) Studied the balance sheets of sixteen industrial companies in Israel which had been declared bankrupt and Twelve companies which were on the verge of bankruptcy in the five year period 1956 - 1960. He found that the financial ratios of these companies were lower than for the industry as a whole for the five years prior to bankruptcy; and that indeed these ratios had fallen during the period.

Debt ratio, Net profit margin and quick ratio, were found to have dropped markedly during the five years prior to bankruptcy. Specifically he found that 70% of the bankrupt companies had a current ratio less than 1:1, while only 30% of all industrial firms in Israel had a similar ratio between 1958 and 1960. Long term financing was insufficient to cover long term investments, while the relative share of equity was lower for
bankrupt firms in the year prior to bankruptcy than among all industries in the five year period reviewed. Majority of bankrupt companies made losses in four out of the five years prior to bankruptcy while the industry profits actually rose by 80%.

Tamari constructed an index of risk whereby ratios considered as indicators of financial soundness were weighted, according to their importance to the financial analyst. When the index was tested, it was found that firms with below 30 points had a higher probability of going bankrupt than other firms, say those with 60 points or more.

An example of such an index follows:

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity capital/Total liabilities</td>
<td>25</td>
</tr>
<tr>
<td>Profit trend</td>
<td>25</td>
</tr>
<tr>
<td>Current ratio</td>
<td>20</td>
</tr>
<tr>
<td>Value of production/inventory</td>
<td>10</td>
</tr>
<tr>
<td>Sales/receivables</td>
<td>10</td>
</tr>
<tr>
<td>Value of production/working capital</td>
<td>10</td>
</tr>
</tbody>
</table>

Adapted from Meir Tamari: Financial ratios as a means of forecasting bankruptcy; management international review, Vol.4, 1966pg19.
BEAVER (1968) in a survey of 79 failed and 79 non-failed firms drawn from Moody's industrial manuals during the period 1954 to 1964, found that non-liquid asset ratios were better predictors of failure both in the short and long term.

2.1.2 Multivariate Models:

ALTMAN (1968), used financial ratios and the technique of discriminant analysis to develop a model to predict corporate bankruptcy. Discriminant analysis is a way of classifying an observation into one of several a priori groupings or make predictions where the dependent variable appears in quantitative form.¹

Altman's model computes a score which "discriminates" bankrupt from non-bankrupt firms, while univariate models evaluated each ratio at a time to assess potential failure.

The model took the following form:

\[ Z = V_1X_1 + V_2X_2 + V_3X_3 + \ldots \ldots V_nX_n \]

It was used to transform individual values to a single discriminant score or Z value which would be used to classify firms. $V_1$, $V_2$, $V_3$, ..., $V_n$ are the discriminant coefficients, while $X_1$, $X_2$, $X_3$, ..., $X_n$ are independent variables.

A sample of 66 corporations drawn from the U.S.A was used, 33 being firms which filed for bankruptcy during 1946 - 1965; and with an asset range from $0.7$ million to $25.9$ million. These firms were carefully matched with equal sized firms which were not bankrupt, thus making 66. He used Test data for one reporting period prior to bankruptcy.

Using the Balance sheets and income statements of the firms, he calculated twenty two ratios. These were in five broad categories i.e. profitability, leverage, solvency, liquidity, and activity ratios.

Using statistical significance tests, evaluation of intercorrelations among ratios, observation of predictive accuracy of various profiles and personal judgement; a ratio profile was established and the discriminant function was as follows: $Z$.

$$Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5$$

where $X_1$ = working capital/total assets

$X_2$ = retained earnings/total assets

$X_3$ = earnings before interest and taxes/total assets

$X_4$ = market value equity/book value of total debt

$X_5$ = sales/total assets

$Z$ = overall index
Firms with Z scores greater than 2.99 were found to be in the non-bankrupt sector while those with a score below 1.81 all went bankrupt. This left a gray area between 1.81 and 2.99. A firm falling in this area was difficult to classify.

An "F" test was performed to test the discriminating ability of the variables, and at 0.001 level, X1 to X4 were significant. X5 did not show a significant difference between groups.

Using data from the initial sample, the model achieved 95% accuracy in classifying firms correctly, for data one year to bankruptcy. For data two years to bankruptcy, the model achieved 72% accuracy in classification.

Using secondary samples, one of bankrupt firms and another of non-bankrupt firms, the model achieved 96% accuracy in classifying bankrupt firms, and 79% accuracy in classifying non-bankrupt firms.

When testing was done for more than two years, the model proved unreliable, which implied that it could only be accurate up to two years prior to bankruptcy.

Potential weaknesses:

Gray area:

A Z-score between 1.81 to 2.99 was difficult to classify, resulting in a zone of ignorance. This can present difficulties in practical application of the model.
Difficulties in interpretation:

In practice it is difficult to give meaning to the Z score. One cannot be able to say what a given measurement means in any terms.

Altman’s model was reliable for up to two years prior to bankruptcy. However this is too short a time for third parties, especially long term lenders to extricate themselves from the failing institutions without incurring considerable losses.

ALTMAN and McGOUGH (1974) sought to develop a criterion to aid the auditor in identifying situations where the status of a company as a going concern is in doubt.

They tested Altman’s model with data from 34 companies that went bankrupt since 1970. They examined the annual reports of these companies prior to bankruptcy to determine the relevant Z-Score and the corresponding auditors’ opinions. Their conclusion was that the model had shown superiority in signaling going concern problems for companies that actually entered bankruptcy, and could be an effective aid to the auditor in forming his judgement.
DAMBOLENA and KHOURY (1980) sought to improve on the Altman model by introducing ratio stability in the discriminant model. They held that it was the stability of every ratio that is relevant and not just the earnings. Therefore they used a ratio stability measure and stepwise discriminant analysis.

A sample of 46 firms from the United States, paired into failed and non-failed categories was used. They extracted data on 12 financial statement items for 8 years prior to failure, for firms that failed during the 1969-75 period.

From this data they calculated 19 ratios as well as four different measures of stability namely standard deviation of each ratio for three and four years periods, standard error of estimate around a 4 year linear trend and coefficient of variation over four years. The ratios were grouped into four major groups i.e. Profitability, activity, turnover and indebtedness measures.

Predictive accuracy of a model without stability measures was tested and compared with the accuracy of one with stability measures. It was noted that the model with stability measures was superior in predictive accuracy.
Limitations of Ratio Based Models:

Ratio based models are subject to some of the limitations of financial ratios, the main being that they use accounting data. Accounting data is subject to different interpretations and even manipulation. Use of different accounting methods as in inventory valuation and depreciation. For example, two firms with similar performance and financial position may report different profit figures and asset values due to differences in accounting methods. Subsequent ratios will reflect these differences, and any model analyzing these two firms may classify them as different, whereas there is no actual difference in performance or financial situation; but merely accounting manipulation.

In the absence of financial accounting data, ratio analysis is impossible to carry out, thus ratio based models cannot be used. This is a problem in a country like Kenya where many small businesses do not maintain any accounting records at all, or keep them in incomplete form. It's difficult to calculate financial ratios for such firms, hence impossible to use ratio based models to predict their failure or otherwise.
2.2 NON RATIO BASED MODELS:

In business failure prediction, there are models which use other basis than financial ratios to predict failure. Though such models are not as common as ratio based models, nor as easy to understand and apply, they can be very useful in cases where there is suspected or known falsification of financial statements, or where such statements are not available.

CATASTROPHE MODEL:

This model is very useful in situations where the path towards failure is not smooth and continuous, but is explosive, sudden or catastrophic. Catastrophe theory maintains that changes in a systems parameter can cause catastrophe behaviour in a dependent variable or state.6

Catastrophe models have three important properties:7

Divergence:

Small continuous changes in parameters or initial conditions can lead to large discontinuous changes (catastrophes) in a state or variable.


7. Ibid pg.1190
Asymmetry:
Implies that as parameters increase or decrease, there will be a discontinuous jump in the dependent variable as a parameter increases which will be different from its behaviour when the parameter is decreasing.

Stability:
Catastrophe condition is robust to marginal changes in the underlying relationships. i.e. some relationships may change marginally but catastrophe will still occur.

Using two conflicting variables, e.g rage and fear, a simple model of catastrophe has been demonstrated by Ho and Saunders. The dependent variable in this case is aggression. As fear increases slowly relative to rage, catastrophe changes in behaviour will occur e.g. sudden changes from attack to defense as fear begins to gradually dominate rage. (see diagram 1)

At point 1, there is a high level of rage relative to fear, causing a high level of aggression. But as fear is increased, keeping rage constant; aggression will gradually fall until that point where any marginal increase in fear will lead to a large discontinuous fall in aggression. (point 3). This is catastrophic behaviour. Such a situation on an equilibrium surface is folded and represents the cusp catastrophe.
Figure 1 The Cusp Catastrophe

Figure 1 The cusp catastrophe
Using the above logic Ho and Saunders (1980) developed a catastrophe model for bank failure. Using probability of failure as the dependent variable and the riskiness of the bank and activities of regulatory bodies as parameters, they were able to show that even if regulatory bodies were to act as lenders of the last resort infinitely, a catastrophic jump in the probability of failure of a bank could occur. (see diagram 2)

In the diagram, as the bank increases its risky loans portfolio, hence its riskiness, depositors react by withdrawing deposits (d). Initially the bank can cover the withdrawals by drawing on its capital and reserves, but at some point it will not be able to cover the withdrawals by capital hence regulatory authorities come as lenders of the last resort (g).

But as risky loans increase withdrawals increase and regulatory bodies lend more, and the rate of intervention eventually overtakes the rate of withdrawals, (point x). Beyond this there will come a point where the probability of failure (f) will suddenly rise in a discrete fashion thereby producing a catastrophe.

In Kenya, market based models cannot be easily applied, for the stock market is small and only 56 firms are quoted in the stock exchange. Therefore a ratio based method is chosen, for it makes it possible to incorporate all firms, whether publicly quoted or not.
Figure 2  $G$ and $d$ Functions
CHAPTER 3:

3.1 STATEMENT OF THE PROBLEM

Business enterprises are usually formed to operate into the foreseeable future. This is the basis of the going concern assumption. But when failure occurs, the going concern assumption is violated and the various stakeholders incur substantial losses. Such losses could be avoided or reduced if there was an early warning system to predict impending doom. The problem therefore is one of developing a discriminant function to predict such failure before it actually occurs.

3.2 OBJECTIVES OF THE STUDY:

This study aims at developing a discriminant function for use in predicting failure in Kenya. Further, the function so developed will be tested.

3.3 SIGNIFICANCE OF THE STUDY:

The study would be of interest to stakeholders in business firms, for it can be useful as an early warning system to predict impending failure. It would also be useful to scholars and academics, for it would add to the body of knowledge and provide a basis for further research in business failure.
3.4 RESEARCH DESIGN

The population of interest is those companies, registered with the Registrar of Companies; that went into receivership from 1980 to 1990. Data has been extracted from the annual accounts of these companies, for four years prior to year of receivership or liquidation. Each of these companies has been matched with a similar non-failed company, on the basis of industry and absolute net assets size, and ratios calculated from these accounts, following the method used by Altman. These ratios are the following:

- Current ratio
- Quick ratio
- Working capital to total debt
- Equity to total liabilities
- Total debt to total assets
- Times interest earned
- Fixed charge coverage
- Cash flow coverage
- Retained earnings to total assets
- Profit margin on sales
- Return on total assets
- Return on net worth
- Inventory turnover
- Average collection period
- Fixed assets turnover
3.5 TECHNIQUE OF ANALYSIS

Discriminant analysis has been used. Specifically, a discriminant function was formulated from the ratios. The function is in the form:

\[ Z = a_1x_1 + a_2x_2 + a_3x_3 + \ldots + a_nx_n. \]

where:

\[ Z = \text{discriminant score} \]
\[ a_1, a_2, \ldots, a_n = \text{discriminant coefficients} \]
\[ x_1, x_2, \ldots, x_n = \text{independent variables} \]
4.1. DATA ANALYSIS

Discriminant analysis is a multivariate technique that seeks to determine whether a set of variables significantly differentiate among two or more sets of data, as well as determine the specific combination of variables that most efficiently differentiate among groups.  

In this case, the aim was to determine that set of ratios that maximizes the differences between failed and successful firms. An initial sample of fifteen ratios were calculated from the financial statements of 20 companies in Kenya that failed between 1980 and 1990 (SEE APPENDIX 1). These ratios were initially all subjected to discriminant analysis, the results of which are shown in APPENDIX 2. To eliminate the ratios with a weak predictive power, a correlation test using a statgraphics package was carried out and ratios with a correlation of more than 0.8 were identified and in each case one of them eliminated from the sample. The elimination procedure was based on the relative magnitude of the coefficient of the ratio in an initial discriminant function that contained all the variables. (see appendix 2) This was done mainly because of the data capacity limitations of the

statgraphics package. Ratios remaining after the elimination were subjected to further discriminant analysis, resulting in the following discriminant function: (FULL STATISTICS:APPENDIX 3)

\[ Z = -0.36716x1 + 0.16603x7 + 13.258x8 + 2.82167x10 - 0.65541x11 + 0.01818x13 + 1.02299x15 - 2.72963 \]

where;

\[ x1 = \text{current ratio} \]
\[ x7 = \text{Fixed charge coverage} \]
\[ x8 = \text{Retained earnings to total assets} \]
\[ x10 = \text{Return on total assets} \]
\[ x11 = \text{Return on net worth} \]
\[ x13 = \text{Average collection period} \]
\[ x15 = \text{sales to total assets} \]

The above ratios are are discussed herebelow:

current ratio:

This ratio is calculated as current assets divided by current liabilities. It indicates the extent to which claims of a short term nature are covered by current assets, these being assets that are expected to be converted into cash within the maturity period of the claims. Though no standard exists as to
the level of this ratio, it should at least be 1:1; implying that claims of a short term nature should be covered by assets of a short term nature.

Fixed charge coverage:

Fixed charges include interest payments, lease obligations, and other amounts that the firm is obligated by contractual arrangements to pay regularly. It indicates the firm's ability to cover fixed obligations from the income generated from its obligations. The ratio is calculated as follows:

\[
\text{Fixed Charge Coverage} = \frac{\text{Income before tax} + \text{Interest charges} + \text{Lease obligations}}{\text{Interest charges} + \text{Lease obligations}}
\]

Retained earnings to total assets:

This ratio, calculated by dividing retained profits by the total assets, shows how much of the income of the firm is ploughed back into the business. This is important because retained earnings comprise one of the principal sources of internal financing.

Return on total assets:

Return on total assets indicates how effectively the firm has employed its total resources. This is important because for survival, the firm should be able to employ its resources to gen-
erate sufficient returns to justify their investment. The ratio is calculated by dividing Net income plus after tax interest expense by total assets.

Return on Net worth:

This indicates how much return the shareholders investment is earning from the firm's operations. If the return does not conform to the expectations of shareholders, they may divest from the company thus threatening its survival. It is calculated by dividing Net income by Net worth.

Average collection period:(A.C.P)

A.C.P. indicates the average period the firm has to wait from the time it makes a sale to the point when the payment is received. It indicates how well management is able to collect cash from sales, for a heavy burden in receivables indicates tied up capital which could be otherwise invested elsewhere to produce some returns. The ratio is calculated by dividing receivables by sales per day.

Sales to total assets:

This ratio indicates how much a given investment in assets is able to generate in sales revenue. Generally the more sales a given level of assets earns the better the performance of the firm.
CHAPTER 5:

5.1 CONCLUSION

In general ratios can be used to predict company failure. However the types of ratios that will best discriminate between failing companies and successful companies appear to differ from place to place. From the analysis presented, it would appear that in Kenya; current ratio, fixed charge coverage, retained earnings to total assets, return on total assets, return on net worth, average collection period and sales to total assets can be used successfully in predicting failure for a period upto two years before it occurs.

This suggests that stakeholders in a business enterprise should pay attention to liquidity, leverage and activity ratios. However the model attained an overall correct classification of 95% in the first one year, which is similar to results obtained by Altman (1968). This should however not be construed to imply that these are the only ratios that can predict failure successfully. It is possible that other ratios can do equally well, and thus the results herein should not be taken like holy writ.
5.2 RECOMMENDATIONS OF THE STUDY:

The results of the study suggest that stakeholders in a business firm can predict failure before it occurs by paying attention to current ratios, gearing ratios, and performance ratios. The fact that such can help predict failure for up to two years before it occurs implies that stakeholders in a business enterprise can avoid the losses associated with failure by taking appropriate action well in advance. It is also an early warning system to other interested parties. Therefore it is suggested that financial ratios be adopted as useful tools in failure prediction and especially using multivariate approaches.

5.3 LIMITATIONS OF THE STUDY:

The results herein presented should be viewed subject to the following limitations:

- The ratios used to develop the model are only a few among a large number of possible ratios. Therefore it cannot be claimed that these are the best predictors, but are only a part of a possibly large group of predictors. Research in other countries has shown that some other ratios successfully predicted failure up to five years before it actually occurred. Tamari (1966) identified Debt ratio, quick ratio, and Net profit margin as good predictors of failure in Israeli companies. In this study not all the possible variables were tested, due to limitations of time.
The software package used had limitations as to the amount of data it could take. Thus the initial lotus worksheet on which the ratios were calculated had to be substantially reduced to fit into the data capacity of the statgraphics package in 640 kilobyte DOS microcomputer. A more robust software package could definitely have done a better job.

The matching sample of successful firms could not be strictly matched on stratified random sample basis for financial information on privately owned companies if not publicly available. Also the reporting practices of some of the companies in the sample could not allow some of the ratios to be calculated. For this reason four failed firms were matched with non-failed firms with an absolute net asset size of up to shs. five million more. It is possible that a more strict matching could have obtained different results.

5.4 SUGGESTIONS FOR FURTHER STUDIES:

In Kenya, few if any studies have been undertaken in the past in this area of business failure prediction. But failures do constantly occur. In the mid-eighties for example, there were mass failures of indigenous financial institutions, and yet this did not stimulate research into failure prediction; despite the
heavy losses that were incurred by various stakeholders, which could otherwise have been avoided if such failure could have been predicted well in advance.

Since it can be reasonably expected that there will always be companies failing, research into failure prediction is inevitable. This paper therefore should not be taken as the final word on the matter, but should merely act as the pathbreaker towards further research. However the problem of data availability remains acute, as those managing many firms consider financial statements to be confidential information and do not easily release such information particularly where the firm is a potential candidate for failure.

Therefore a concerted effort is necessary on the part of both academicians and business managers, for research in the area to be comprehensively undertaken. Managers to provide the necessary information, and academicians and researchers to undertake the relevant research.

Of particular interest would be inquiry into whether those companies that decline to disclose information about themselves and are hostile to researchers are failure candidates.
APPENDIX 0: KEY TO THE FINANCIAL RATIOS

APPENDIX 0: KEY TO RATIOS USED IN THE ANALYSIS

X1 = CURRENT RATIOS
X2 = QUICK RATIO
X3 = WORKING CAPITAL TO TOTAL DEBT
X4 = EQUITY TO TOTAL LIABILITIES
X5 = TOTAL DEBT TO TOTAL ASSETS
X6 = TIMES INTEREST EARNED
X7 = FIXED CHARGE COVERAGE
X8 = RETAINED EARNINGS TO TOTAL DEBT
X9 = PROFIT MARGIN ON SALES
X10 = RETURN ON TOTAL ASSETS
X11 = RETURN ON NET WORTH
X12 = INVENTORY TURNOVER
X13 = AVERAGE COLLECTION PERIOD
X14 = FIXED ASSETS TURNOVER
X15 = SALES/TOTAL ASSETS
**APPENDIX 1:** FINANCIAL RATIOS USED FOR THE SAMPLE FIRMS USED TO DEVELOP THE MODEL.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
<th>X5</th>
<th>X6</th>
<th>X7</th>
<th>X8</th>
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<th>X10</th>
<th>X11</th>
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**Note:** Code 1 implies a failed firm, while Code 2 implies a non-failed firm.
APPENDIX 2: RESULTS OF THE INITIAL DISCRIMINANT FUNCTION USING ALL THE 15 RATIOS

Discriminant Analysis for YEAR1: YEAR1

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Discriminant Analysis for YEAR1: YEAR1

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Discriminant Analysis for YEAR1: YEAR1

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## Discriminant Analysis for YEAR1

### Group Centroids

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### Classification Results

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APPENDIX 3: RESULTS OF THE FINAL DISCRIMINANT FUNCTION

Discriminant Analysis for YEAR1. YEAR1

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Discriminant Analysis for YEAR1. YEAR1

Standardized Discriminant Function Coefficients

1

| X1   | -1.12049 |
| X7   | 0.81684  |
| X8   | 2.18530  |
| X10  | 0.72106  |
| X11  | -0.90870 |
| X13  | 1.04186  |
| X15  | 1.07389  |

Discriminant Analysis for YEAR1. YEAR1

Unstandardized Discriminant Function Coefficients

1

| X1   | -0.36716 |
| X7   | 0.16803  |
| X8   | 13.2580  |
| X10  | 2.82167  |
| X11  | -0.65541 |
| X13  | 0.01818  |
| X15  | 1.02299  |
| CONSTANT | -2.72963 |

Discriminant Analysis for YEAR1. YEAR1

Group Centroids

1  -2.13629
2  2.13629
### Classification Results for YEARR1.YEAR1

#### Predicted Group (count percentage)

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### Appendix 4: Results of Testing the Model with Company Data Two Years Prior to Failure

Year 2

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**NOTE:** State implies that class the companies in the sample are classified to be in, i.e., failed (F) or successful (S).
APPENDIX 5: RESULTS OF TESTING THE MODEL WITH A HOLDOUT SAMPLE OF FIRMS.

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<td>0.051131</td>
<td>0.16603</td>
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<td>2.82167</td>
<td>22.9741</td>
<td>-0.65541</td>
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<tr>
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<td>0.963464</td>
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<td>0.441443</td>
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<td>8.259065</td>
<td>2.82167</td>
<td>21.43322</td>
</tr>
</tbody>
</table>

NOTE: ACTUAL STATE: 1 = FAILED FIRM, while 2 = NON-FAILED FIRM

STATE IS THE PREDICTED CLASS OF THE COMPANY i.e F for FAILED and S for NON-FAILED
BIBLIOGRAPHY:


