

FINANCIAL STATEMENT ANALYSIS

Lecture 12

INSOLVENCY AND BUSINESS FAILURE PREDICTION

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NB

This is a continuation of lecture 11

Quantitative models

Quantitative models identify financial ratios with values which differ markedly between surviving and failing companies, and which can subsequently be used to identify companies which exhibit the features of previously failing companies. Commonly-accepted financial indicators of impending failure include: low profitability related to assets and commitments low equity returns, poor liquidity, high gearing and high variability of income.

The two most frequently used statistical techniques in business failure prediction are multiple linear discriminant analysis (MLDA) and logit analysis (LA). Most failure prediction models use multiple discriminant analysis, a statistical technique used to evaluate financial decisions that proposes a set of alternatives, such as different shares of stock in a portfolio, to classify observations in two a priori defined and mutually exclusive groups (failing or non-failing). This happens based on a combination of independent variables (financial ratios).

An MLDA model consists of a linear combination of variables. The values of these variables are combined into one discriminant score. This score gives an indication of the financial health of the firm. The discriminant score is used to differentiate between firms that are expected to fail and those expected not to fail in the foreseeable future. So, a certain cut-off point has to be set.

The general linear discriminant function is the following:

$$D = d_0 + d_1 V_1 + d_2 V_2 + \dots + d_m V_m \quad (1)$$

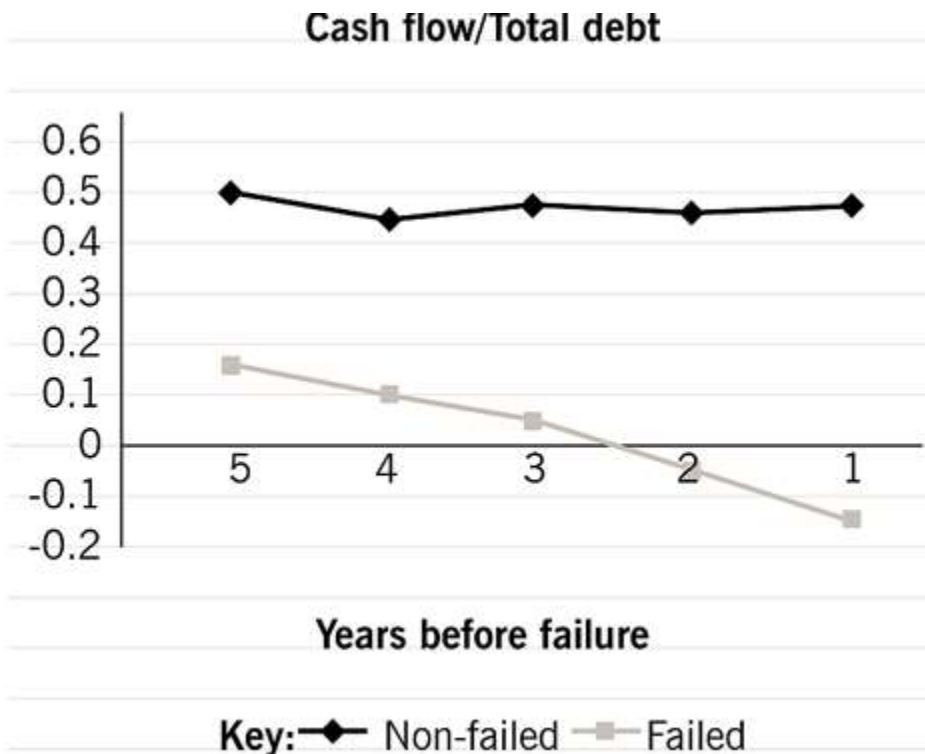
with D = discriminant score between - 1 and + 1;
 $V_1 \dots V_m$ = independent variables of the model;
 $d_0 \dots d_m$ = linear discriminant coefficients.

Some of the common models include;

1. BEAVER MODEL (1967)

William Beaver (1967), one of the earliest researchers, was the first to use statistical technique of univariate analysis to predict corporate failure on the basis of mean values of thirty different financial ratios which were later reduced to fourteen ratios. Beaver used a dichotomous classification test on two samples of firms (79 bankrupt firms and 79 non-failed firms of approximately the same size and industry group) based on the calculated ratios to discriminate between failed and non-failed firms for as long as five years prior to failure.

Beaver selected a sample of 79 failed firms and 79 non-failing firms and investigated the predictive power of 30 ratios when applied five years prior to failure. Beaver discovered that there was significant difference between the financial ratios of failed firms and non-failed firms. Not only were they lower but deteriorated as failure approaches. He then concluded that of the variables analyzed cash flow/total debt was the single most important factor to consider in predicting failure. Beaver's model was able to accurately classify 78% and 87% of the sample of firms five years and one year before failure respectively. This can be illustrated as below:



From the graph above, it is evident that the cash flow over debt of failing firms when plotted shows a declining trend. Although the simplicity of the univariate approach is appealing, there are a number of potential problems:

1. Company classification is based on one ratio at a time, which may give inconsistent and confusing classification results for different ratios used on the same company.
2. It contradicts reality, in that the financial status of a company is complex and cannot be captured by one single ratio.
3. The optimal cut-off point is chosen on an ex-post basis, ie when the actual failure status of each company is known. As a result, the cut-off points may be sample-specific and the classification accuracy may be much lower when applied on a predictive basis.

2. ALTMAN MODEL (U.S. - 1968)

Edward I. Altman (1968) was the first person to successfully use step-wise multiple discriminate analysis to develop a prediction model with a high degree of accuracy. Using the sample of 66 companies, 33 failed and 33 successful, Altman's model achieved an accuracy rate of 95.0%. Altman's model takes the following form;

The discriminant function of the form $Z = v_1 x_1 + v_2 x_2 + v_3 x_3 + v_4 x_4 + v_5 x_5$

Where v_1, \dots, v_5 are the discriminant coefficients

x_1, \dots, x_5 are the independent variables

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5$$

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 of Equity/Book Value of Total Liabilities

X_5 =Sales/Total Assets

If the Altman Z-Score is close to or below 3, it is wise to do some serious due diligence before considering investing. The Z-score results can be interpreted as below:

- Z Score above 2.99 -“Safe” Zones. The company is considered ‘Safe’ based on the financial figures only.
- 1.8 It; Z It; 2.99 -“Grey” Zones. There is a good chance of the company going bankrupt within the next 2 years of operations.
- Z below 1.80 -“Distress” Zones. The score indicates a high probability of distress within this time period.

The ratios capture different aspects of profitability & risk, namely;

- **Net Working Capital/Total Assets:** Captures short-term liquidity risk.
- **Retained Earnings/Total Assets:** Captures accumulated profitability and relative age of a firm.
- **Earnings before Interest and Taxes/Total Assets:** Measures current profitability.

- **Market Value of Equity/Book Value of Liabilities:** A debt/equity ratio, but incorporates market's assessment of firm equity value. Captures long-term solvency risk and the market's overall assessment of the firm's profitability and risk.
- **Sales/Total Assets:** Indicates the ability of a firm to use assets to generate sales.

Revaluation of the model

The original formula crafted by Altman, was very limited only to manufacturing companies that have gone public, but many companies are not public so they have no market value. Altman then created two more formulas to evaluate bankrupt firms, namely the formula for manufacturing companies that have not gone public and non-manufacturing companies that have gone public and can also be used in general.

Adapting the model for Non-manufacturing/service companies

For non-manufacturing companies and companies in general (generalize), Altman indicates bankruptcy using the formula:

$$Z = 6.56X1 + 3.26X2 + 6.72X3 + 1.05X4$$

Where:

Z: Bankruptcy Index

X1: Working capital (current assets-current liabilities) / total assets

X2: Retained earnings / total assets

X3: Earnings before interest and taxes / total assets

X4: Book value of preferred and common equity / book value of total liabilities

The assessment criteria for non-manufacturing companies:

Z-Score	Market value
Z < 1,10	Bankrupt
1,10 – 2,60	Grey Area
Z > 2,60	Non-Bankrupt

Adapting the model for private companies

Perhaps the most common question regarding the application of the model is what needs to be done to implement it for private companies. Analysts, auditors, and the firms themselves are concerned that the original model applies only to public enterprises. To be exact, the Z-Score is a model for public companies, and any modifications would not have a scientific value. For example, the most apparent change would be to replace the market value of the shares by the book value of the shares and then to recalculate V4X4. Back then, analysts had limited choices and followed this procedure due to the lack of alternatives.

Instead of modifying one of the model variables to compute the Z-Score, it is preferable to completely revise the model by replacing the market values of the shares with their book values for X4. It is easy to assume that all coefficients will change, not only the parameter of the new variable and that the classification criterion and values will also change.

The result of the revalued Z-Score model with the new X4 variable is:

$$Z' = 0.717X1 + 0.847X2 + 3.107X3 + 0.420X4 + 0.998X5$$

Adapting the model for companies in Emerging Markets

We can initially analyze Emerging Market companies in a way similar to the traditional analysis of corporations. It is challenging to build a model for an emerging market based on a selection of companies in emerging markets because of the lack of experience there. To deal with this problem, in 1995, Altman, Hartzell, and Peck changed the original Z-Score model of Altman to create an Emerging Market Model (EMM).

For the relative value analysis, they added the corresponding US corporate credit spreads to the sovereign bond spreads. Back then, rating agencies ranked very few of the emerging markets companies. Risk assessments such as the one provided by the EMM were often the only reliable indicator of credit risk used by emerging markets investors. Altman, Hartzell, and Peck report that modified ratings prove to be accurate in predicting both bankruptcies and improvements.

The modified Z''-Score bankruptcy model for emerging markets is:

$$Z'' = 3.25 + 6.56X1 + 3.26X2 + 6.72X3 + 1.05X4$$

Example one

The data below was extracted from the books of Zilch Inc. for the past four years;

	Amount in millions			
	2020	2019	2018	2017
Working capital	1453.14	1455.24	1458.37	1459.35
Total assets	2649.1	2756.37	2735.36	2667.39
A (working capital/total assets)				
Retained earnings	1024.63	1034.35	1018.34	1015.37

B (retained earnings/ total assets)				
Earnings before interest and taxes	51.163	53.354	54.426	49.235
C (earnings before interest and taxes/ total assets)				
Book value of equity	774.625	1175.37	978.857	498.265
Total liabilities	374.479	376.276	298.265	299.626
D (book value of equity/ total liabilities)				
Sales	716.188	714.165	713.143	721.365
E (sales / total assets)	0.27035	0.2591	0.26071	0.27044
Z score				

Required

Complete the table above and using Altman's Z-score model and evaluate the solvency position of the business.

SOLUTION

	Amount in millions			
	2020	2019	2018	2017
Working capital	1453.14	1455.24	1458.37	1459.35
Total assets	2649.1	2756.37	2735.36	2667.39
A (working capital/total assets)	0.54854	0.52795	0.53315	0.54711
Retained earnings	1024.63	1034.35	1018.34	1015.37
B (retained earnings/ total assets)	0.38678	0.37526	0.37229	0.38066
Earnings before interest and taxes	51.163	53.354	54.426	49.235
C (earnings before interest and taxes/ total assets)	0.01931	0.01935	0.019897	0.0185

Book value of equity	774.625	1175.37	978.857	498.265
Total liabilities	374.479	376.276	298.265	299.626
D (book value of equity/ total liabilities)	2.06854	3.12368	3.28184	1.66296
Sales	716.188	714.165	713.143	721.365
E (sales / total assets)	0.27035	0.2591	0.26071	0.27044
Z score	2.775	3.3558	3.4562	2.5185

$$\begin{aligned}
Z &= 1.2A + 1.4B + 3.3C + 0.6D + .999E \\
&= 1.2 \times 0.54854 + 1.4 \times 0.38678 \\
Z &< 2.675; \text{ then the firm is classified as "failed"}
\end{aligned}$$

WHERE

- A = Working Capital/Total Assets
- B = Retained Earnings/Total Assets
- C = Earnings before Interest and Taxes/Total Assets
- D = Market Value of Equity/Book Value of Total Debt
- E = Sales/Total Assets

Solvency has improved but had dipped in the current year

Example two

Benny is the CFO of a company which manufactures custom car parts. The company, which started as a local car shop, has evolved into a regional product provider. Benny has been part of the team since he gained his BBA degree and has helped the company manage the success it acquired.

With the recent credit market situation, Benny wants to make sure his company will be able to meet the financial obligations it has committed to. Benny decides to calculate for the Altman Z Score; manufacturing has been hit hard enough that he feels he has to. With this decision, he begins assembling company financial reports to find the factors of the Altman Z Score equation as they relate to his company.

Benny collected the information below;

Working Capital = sh5,000,000
Retained Earnings = sh1,000,000
Operating Income = sh10,000,000
Market Value of Equity = sh2,000,000
Book Value of Total Liabilities = sh500,000

Sales = sh15,000,000
 Total Assets = sh3,000,000

Required
 Using Altman Z-score model, evaluate the viability of the organisation.

Example three

The data below belong to two different firms in the same industry;

Firm X

	Amount in millions				
	2018	2017	2016	2015	2014
Working capital	2534.598	1327.458	1160.253	1253.267	1342.287
Total assets	3231.287	3269.097	3436.761	3452.279	3327.278
A (working capital/total assets)					
Retained earnings	168.958	167.789	169.602	171.784	173.865
B (retained earnings/total assets)					
Earnings before interest and taxes	689.642	654.358	246.032	652.826	589.295
C (earnings before interest and taxes/total assets)					
Book value of equity	321.678	315.113	273.492	275.263	289.267
Total liabilities	1289.908	1050.000	1905.000	1792.000	1865.678
D (book value of equity/total liabilities)					
Sales	2946.239	2962.986	2900.858	2125.286	2948.256
E (sales / total assets)					
Z score					

Firm Z

	Amount in millions				
	2018	2017	2016	2015	2014
Working capital	1442.26	1443.14	1451.26	1452.69	1459.26
Total assets	468.365	469.104	467.252	469.256	471.245
A (working capital/total assets)					
Retained earnings	216.289	214.625	213.258	211.572	209.259

B (retained earnings/ total assets)					
Earnings before interest and taxes	52.356	51.163	51.264	53.246	53.987
C (earnings before interest and taxes/ total assets)					
Book value of equity	475.252	474.625	476.352	478.253	479.258
Total liabilities	4273.25	4174.48	4173.27	4227.25	4267.28
D (book value of equity/ total liabilities)					
Sales	714.527	716.188	718.562	719.264	721.415
E (sales / total assets)					
Z score					

Required

Using Altman Z score model, compare the two companies.

3. SPRINGATE (CANADIAN - 1978)

This model was developed in 1978 by Gordon L.V. Springate; following procedures developed by Altman. Springate used step-wise multiple discriminate analysis to select four out of 19 popular financial ratios that best distinguished between sound business and those that actually failed. The Springate model takes the following form;

$$Z = 1.03x_1 + 3.07x_2 + 0.66x_3 + 0.4x_4$$

$Z < 0.862$; then the firm is classified as "failed"

Where

X_1 = Working Capital/Total Assets

X_2 = Net Profit before Interest and Taxes/Total Assets

X_3 = Net Profit before Taxes/Current Liabilities

X_4 = Sales/Total Assets

This model achieved an accuracy rate of 92.5% using the 40 companies tested by Springate. Botheras (1979) tested the Springate Model on 50 companies with an average asset size of sh2.5 million and found an 88.0% accuracy rate. Sands (1980) tested the Springate Model on 24 companies with an average asset size of sh63.4 million and found an accuracy rate of 83.3%.

4. ZMIJEWSKI MODEL (1983)

An extension of bankruptcy prediction study was conducted by Zmijewski (1983) whom added financial ratio validity as corporate financial failure detection tool. The model successfully developed is as follows:

$$X = -4.336 - 4.513X_1 + 5.679X_2 - 0,004X_3$$

Where

X1: ROA (Net income / total assets)

X2: Leverage (Total debt / total assets)

X3: Liquidity (Current assets / current liabilities)

Zmijewski claimed that companies are considered in distress if the probability is more than 0. In another words, the value of X is 0. Therefore, cut-off value which applies in this model is 0. This means companies with the X value more than 0 are predicted with financial distress in the future. However, companies with the X value below 0 are predicted not to experience financial distress.

5. GROVER MODEL (2003)

The Grover method is a method used to predict bankruptcy, this method was created by Jeffrey S. Grover by designing and reassessing the Altman Z-Score method. Jeffrey S. Grover used samples according to the Altman Z-Score model in 1968, by adding 13 new financial ratios. The sample used was 70 companies with 35 companies that went bankrupt and 35 companies that did not go bankrupt, from 1982 to 1996. The resulting model is as follows:

$$G = 1,650X_1 + 3,404X_2 - 0,016 X_3 + 0,057$$

Where

X1 is working capital by total assets

X2 is net profit before interest and tax/total assets;

X3 is return on assets (ROA).

Grover model categorized companies in bankruptcy with the score less than or equal to -0,02 ($Z < -0,02$). While the value for companies categorized as not in bankrupt is 0,01 ($Z > 0,01$)

6. FULMER MODEL (U.S. - 1984)

Fulmer (1984) used step-wise multiple discriminate analysis to evaluate 40 financial ratios applied to a sample of 60 companies -30 failed and 30 successful. The average asset size of these firms was sh455,000. The model takes the following form;

$$H = 5.528 (V_1) + 0.212 (V_2) + 0.073 (V_3) + 1.270 (V_4) - 0.120 (V_5) + 2.335 (V_6) + 0.575 (V_7) + 1.083 (V_8) + 0.894 (V_9) - 6.075$$

$H < 0$; then the firm is classified as "failed"

Where

V_1 = Retained Earning/Total Assets

V_2 = Sales/Total Assets

V_3 = EBT/Equity

V_4 = Cash Flow/Total Debt

V_5 = Debt/Total Assets

V_6 = Current Liabilities/Total Assets

V_7 = Log Tangible Total Assets

V_8 = Working Capital/Total Debt

V_9 = Log EBIT/Interest

Fulmer reported a 98% accuracy rate in classifying the test companies one year prior to failure and an average 81% accuracy rate more than one year prior to bankruptcy.

7. BLASZTK SYSTEM (CANADIAN 1984)

This is one of the business failure prediction methods that were not developed using multiple discriminate analysis. This system was developed by William Blaszk in 1984. The essence of the system is that the financial ratios for the company to be evaluated are calculated, weighted and then compared with ratios for average companies in that same industry as given by Dunn & Bradstreet. One of this method's strengths is that it does compare the company being evaluated with companies in the same industry.

8. CA-SCORE (CANADIAN 1987)

This model was developed under the direction of Jean Legault of the University of Quebec at Montreal, using step-wise multiple discriminate analysis. Thirty financial ratios were analyzed in a sample of 173 Quebec manufacturing businesses having annual sales ranging between \$1-20 million.

The model takes the following form -:

$$\text{CA-Score} = 4.5913 (*\text{shareholders' investments (1)/total assets (1)}) + 4.5080 (\text{earnings before taxes and extraordinary items} + \text{financial expenses (1)/total assets (1)}) + 0.3936 (\text{sales (2)/total assets (2)}) - 2.7616$$

$\text{CA-Score} < - 0.3$; then the firm is classified as "failed"

1. Figures from previous period
2. Figures from two previous periods

- * Shareholders' investments are calculated by adding to shareholders' equity the net debt owing to directors.

This model, as reported in Bilanas (1987), has an average reliability rate of 83% and is restricted to evaluating manufacturing companies.

Assignment

Explain the turnaround strategies that can be used by companies facing financial distress

References

ACCA Study text Paper F3 Financial Accounting (International).

David O. & Eyo I. (2013). Corporate Failure: Causes and Remedies. *Business and Management Research* 2(4), 19 – 24.

Barasa, J. L. (2007). An evaluation of business failure prediction methods: Literature survey. Independent study paper.

Bellovary, J. L., Giacomino, D. E., & Akers, M. D. (2007). A review of bankruptcy prediction studies: 1930 to present. *Journal of Financial education*, 1-42.

Csikosova, A., Janoskova, M., & Culkova, K. (2019). Limitation of Financial Health Prediction in Companies from Post-Communist Countries. *Journal of risk and financial management*, 12(15), 1 – 14.

Grover, J. (2003). Validation of a cash flow model: A non-bankruptcy approach. Ph.D. dissertation, Nova Southeastern University.

Hantono (2019). Predicting financial distress using Altman score, Grover score, Springate score, Zmijewski score (Case study on Consumer Goods Company), *Accountability* 8(1), 1-16.

<https://magnimetrics.com/altman-z-score-analysis/>

Zmijewski, M.E., (1983). Methodological Issues Related to the Estimation of Financial Distress Prediction Models, *Journal of Accounting Research*, 22, 198.