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Assessing Bankruptcy of Indian Listed Firms Using Bankruptcy Models, Decision Tree and Neural Network

[1]Sheeba Kapil, [2]Shrey Agarwal

[1,2]Indian institute of Foreign Trade, India

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Abstract

Bankruptcy is that state of insolvency in which a company or an organization cannot discharge their financial obligation or are unable to meet the payments to their creditors. As the company cannot keep up with their debts, they cannot continue with their activities. The prediction of this stage of the company is important to the various stakeholders of the company such as the investors, the creditors, the regulators and the lenders. This study discusses the assessment of bankruptcy using traditional bankruptcy models along with the new methods like Decision Tree Framework, Neural Network Framework to predict bankruptcy using the latest advancements in technology and challenge the traditional Altman Z Model.

1. Introduction

Bankruptcy is that state of insolvency in which a company or an organization cannot discharge their financial obligation or are unable to meet the payments to their creditors. As the company cannot keep up with their debts, they cannot continue with their activities. The prediction of this stage of the company is important to the various stakeholders of the company such as the investors, the creditors, the regulators and the lenders. Certain stakeholders which hold a position in the company in their derivatives portfolio would require the information on timely basis so as to assess the default risk probability of the organization.

There are various indicators which are used to evaluate the performance of the firm which are based on the financial data of the firm and vary from sector to sector as their key performance indicators such as Net Profit Margin, Return on Equity, PE Ratio, PB Ratio, ratio of price to sales, Current Ratio for its liquidity, Debts to judge its solvency. A combination of these factors has been used for bankruptcy prediction through various models.

The prediction of bankruptcy for an organization will guide the management to reorganize its assets, restructure the firm and for the corporates to reassess their portfolio. The prediction needs to focus on the aspect of timeliness as the lead time

which is given by the prediction model is vital. For the prediction of bankruptcy over the years various models have been developed using various statistical tools such as T-tests, multiple discriminated analysis, log it regression etc. There are various models such as Beaver's Model, KMV Merton's Distance Model, Springate Model, In05 etc. The most commonly used tool for bankruptcy prediction over the years is Altman Z-score Model developed in 1968.The indicators these models focus on are the various factors of a company's financial performance such as cash-flow, productivity of the assets, the ability to repay the debt , the market size of the firm, financial leverage and profitability etc. The study focuses no Altman Z score and its correlation to the various financial performance indicators, in order to determine the significance of performance indicators to bankruptcy

2. Review of Literature

Phillipe De Jardin, (2009) reviewed variable selection methods to build empirical bankruptcy models. The author has used various criteria such as, 'Popularity in the literature, Univariate analysis, Stepwise search, Genetic Algorithms, Regression, to select the explanatory variables to include in bankruptcy models. From this he posits that one will get a better result by comparing the outcomes found with different regression techniques as they are the most viable techniques for creating the regression model, but the selection methods should have a separate set of reasoning.

Narendar V Rao., Gokhul Atmanathan, Manu Shankar, Srivatsan Ramesh, (2013) analyzed the sustainability of the Bankruptcy Prediction Models in conjunction of their application in the Indian Manufacturing Sector.

Ravi Singla, Gurmeet Singh, (2017) used regression model to find the relationship between Probability of default of the Steel companies of India and firm size of the same. The prediction model of Altman's Z-Score has been used to predict the probability of default of the firm, while total sales and total assets are used to indicate the size of the firm. The conclusion led to the finding that the size of the firm is inversely related to the probability of failure of the firm. With the decreasing firm size, the probability of failure increases and increasing firm size, the probability of default decreases.

Miroslava Dolejšova, (2015) compared the performances of small firms in the Zlin and Olomouc Regions using the Altman Z-Score Model, the Springate Model, the IN05 Model, the Zmijewski Model on 16 companies from 2006 and 2010. The result showed that while Zmijewski Model identified companies to be insolvent, the other 3 models showed that they were financially sound. The Z-test resulted into at least 80% of the firms being financially sound while the T-Test concluded that the financial performance for the firms remained same over the years 2006-10.

Joseph Wolfe, (2003) used Tobin's q in a more substantial way, to judge the performance for firms comparatively. It was compared with Altman Z score to measure the firm's probability of default, and examined it as indicator of the firm's effectiveness from the viewpoint of investment.

Jarmila Horváthová and Martina Mokrišová, (2018) assessed whether Data Envelopment Analysis is an appropriate tool for an alternate to Altman Z Score for prediction of bankruptcy. They compared three tools for bankruptcy prediction which are financial ratios, DEA and Altman Z score.

Ishioma Odibi, (2015) analyzed the relationship of Z-Score and Corporate failure and whether the companies which were failing were listed in PN-17. The outcome shows that 4 of the financial ratios were significantly related for the Z-Score's prediction of corporate failure. The limitation was the scope of the study, which can be further used on various other financial ratios and parameters with a higher level of significance

Hafiz A. Alaka, (2016) gave 8 significant tools which are based on 13 important criteria in the area of prediction models. The methodology for the tools are Neural Network, decision Tree while the criteria are accuracy, result transparency etc. The conclusion given was that no single tool is better than other, but a hybrid model is better with an integration of all the tools.

Daniel Brindescu-Olariu, (2016) developed a method to measure the risk of financial distress for all Romanion Companies. The result showed that debt ratio cannot perfectly predict the state of the company.

Shariq Mohammed, (2016) assessed the overall financial performance of the company for evaluating the health of the company. The methodology used was Altman's Prediction Analysis Model's Z Score. The financial position of the company was good, but the study was just based on a single company thus the scope can be expanded to other companies and sectors.

3. Objective of the study

The study aims to

- To assess the correlation between Altman Z Score and the key performance indicators with credit ratings provided for the companies, for understanding the impact of the determinants on the model
- For evaluation of relationship of variables such as ROE, PE, Average of Debt/Assets on the depended variable i.e. Z-Score using Multi-Layer Perceptron Neural Network
- To examine the classification of the Z-Score in the categories of Altman vs the Performance Indicators using the Decision tree framework through Chi-Square Automatic Interaction Detector, thereby examining their efficiency.

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4. Research Design

4.1 Bankruptcy Models

Altman Model

The Altman Z Score model, "characterized as a financial model to foresee the probability of bankruptcy of firms was created by Edward I. Altman in 1968. His objective for predicting bankruptcy began around the time of great depression, in light of a sharp ascent in the occurrence of default. Studies demonstrate that the model has 72% to 80% dependability of predicting bankruptcy.

Z = 1.2A x 1.4B x 3.3C x 0.6D x 0.99E

A = Working Capital / Total assets (it measures the relative amount of liquid assets)
B = Retained Earnings / Total assets (it determines cumulative profitability)
C = EBIT / Total assets (it measures earnings away from the effects of taxes and leverage)
D = MV of equity / BV of total liabilities (it incorporates the effects of a decline in market value of a company's shares)
E = Sales / Total assets (it measures asset turnover)

A Z score of "greater than 2.99 means that the entity being measured is safe from bankruptcy. A score of less than 1.81 means that a business is at considerable risk of going into bankruptcy, while scores in between should be considered a red flag for possible problems."

Springate Model

Springate uses multiple discriminant analysis (MDA) methods to select 4 ratios from a set of around 20 ratios in the literature that are capable of distinguishing the companies that are going to bankrupt and in good condition. In spite of that, the Springate score is still a less popular model for bankruptcy predictions than Altman's model

Z = 1.03F + 3.07G + 0.66H + 0.4I

F = Working capital / Total Asset
G= Net Profit before Interest and Taxes / Total Asset
H= Net Profit before Taxes / Current Liabilities
I = Sales / Total Asset

The critical value of $the Springate model is 0.862, and if the Z value is lower than that, it indicates the possibility of bankruptcy and if the Z value is above the critical value then the company is considered to be safe.

Zmijewski Model

X = -4.33 - 4.51J + 5.67K + 0.004L

J = Net Income / Total Assets
K = Total Debt / Total Assets
L = Current Assets / Current Debt

Contrasting the Altman's Z- score model, Zmijewski X-Score does not have criteria threshold values to look at the outcomes against. For the most part, the X-score acquired from Zmijewski model is apportioned into two classes. In the event that the X-score is negative, at that point the organization is characterized in a solid financial condition. Contrariwise, in the event that the X-score is positive, at that point the organization can be classified to lead to financial distress.

IN05 Model

IN05 have a place with the class of indices of credibility created by Neumaierová and Neumaier. IN05 mirrors the perspective of creditors as well as owners.

$$Z = 0.13M + 0.04N + 3.97O + 0.21P + 0.09Q$$

M = Total Assets/ Total Debt
N = EBIT/ Interest Expenses
O = EBIT/ Total Assets
P = Sales/ Total Assets
Q = Current Assets/ Current Liabilities

A Z score of "greater than 1.6 means that the entity being measured is safe from bankruptcy and is in healthy zone. A score of less than 0.9 means that a business is at considerable risk of going into bankruptcy and is in unhealthy position, while scores in between should be considered a red flag and companies are in a grey zone."

4.2 Data Collection and Its Source

The data used in this study, to predict bankruptcy score using various models, is using CMIE PROWESS Database. The Data period is from 2014 to 2018 and the companies that are selected for this study are all the Listed Companies on National Stock Exchange of India (NSE). There are a total of 1950 Companies listed on NSE belonging to varied sectors however, not all the firms' data is complete and some financial data is missing, therefore only 1460 companies are being taken into the sample set which have a comprehensive data.

After collection of Data, this study delves into calculating the Firm Performance Indicators (KPIs) and correlating it with the Altman Z-Score to see which variables are statistically significant in predicting bankruptcy score and which variables are not.

4.3 Key variables used as Firm Performance Indicators

1) Net Profit Margin – Net profit Margin tells about the profitability position of a firm and also acts as a predictor of firm's likelihood to default on loans. It is a proxy for the efficiency of the firm and is an important parameter in evaluating the lending decisions.

2) Debt/Assets – This ratio is an indicator of the financial leverage position of a firm which speaks about the % of assets that are being financed by the creditors of the company. High ratio is an indication of significant financial risk.

3) P/E (Market Value) – The reason for considering this valuation multiple in this study is that when a company is facing bankruptcy issues, the valuation of a company starts to fall which will have a direct impact on the P/E ratio of the company as they will not be able to generate enough returns. This ratio is an indicative measure of investor sentiment whether they're optimistic or pessimistic about company's performance.

4) Firm Size – This study has taken log of total assets to proxy the firm size. Other factors like Sales and Market Capitalization can also be used but past research states that Total Assets is the most preferred one because Sales as well as Market Cap can vary significantly with industries in which a company is situated.

5) Current Ratio – This ratio measures the short-term solvency position of a firm i.e. whether a given company will be able to pay of their short term obligations in due time or not. Bankruptcy has a direct impact on the long-term as well as short-term solvency of a company.

6) Credit Rating – Credit Rating Agencies assign Credit Rating to the companies which investors as well as lenders use to gauge whether a given company will be able to repay in due course of time or not. Fundamentally there is a direct correlation between the Credit Rating and Altman Z Score.

7) Tobin's Q – This ratio is calculated as total market value of the firm/total asset value of the firm. This ratio tells whether a given firm is overvalued or undervalued. A low Q value (0-1) means that cost to replace the assets of the firm is greater than the value of its stock. And Q Value (greater than 1) implies that firm's stock is more expensive than the replacement cost of its assets.

4.4 Multilayer Perceptron Neutral Network

A multilayer perceptron (MLP) is a class of artificial neural system. A MLP has a minimum of three layers of nodes, an info layer, a hidden layer, and an output layer.

With the exception of the information node, every node is a neuron that utilizes a nonlinear activation function. MLP uses a managed learning method called back propagation for preparing its numerous layers and non-linear activation recognizes MLP from a linear discernment.

It can recognize information that isn't directly distinguishable and in the given study this framework has helped determine which variables are more significant than other in predicting bankruptcy

4.5 Classification Tree Framework

This framework is one of the recent frameworks to be established which using SPSS arrives at results that tells us about various variables that has an impact on the dependent variable which in this given study is Altman Z Score. This method uses CHAID (Chi-square automatic interaction detection) technique which divides the data on the basis of relationship between dependent and independent variable.

5. Research Methodology

Using MS Excel, the Bankruptcy Scores for the companies is calculates using 4 models namely:

- Altman Z-Score Model
- Springate Model
- Zmijewski Model
- IN05 Model.

Once the bankruptcy scores are calculated, this study focuses on calculating the key Firm Performance Indicators which have been studied in the past research papers to have an impact on Altman Z-Score

Total Assets

H_0 - Altman Z-Score and Total Assets have no significant relation between them
H_1 - Altman Z-Score and Total Assets have a significant relation between them

Net Profit Margin

H_0 - Altman Z-Score and Net Profit Margin have no significant relation between them

H_1 - Altman Z-Score and Net Profit Margin have a significant relation between them

Total Debt

H_0 - Altman Z-Score and Total Debt have no significant relation between them
H_1 - Altman Z-Score and Total Debt have a significant relation between them

Price/Earning

H_0 - Altman Z-Score and P/E have no significant relation between them
H_1 - Altman Z-Score and P/E have a significant relation between them

Current Ratio

H_0 - Altman Z-Score and Current Ratio have no significant relation between them
H_1 - Altman Z-Score and Current Ratio have a significant relation between them

Return On Equity

H_0 - Altman Z-Score and Return on Equity have no significant relation between them

H_1 - Altman Z-Score and Return on Equity have a significant relation between them

Credit Rating

H_0 - Altman Z-Score and Credit Rating have no significant relation between them

H_1 - Altman Z-Score and Credit Rating have a significant relation between them

Tobin's Q

H_0 - Altman Z-Score and Tobin's Q have no significant relation between them

H_1 - Altman Z-Score and Tobin's Q have a significant relation between them

- After establishing the Null and Alternate Hypothesis, using the IBM SPSS software, correlation test between Altman Z-Score and different variables was run and on the basis of the results either the Null (H_0) or the Alternate (H_1) Hypothesis is rejected.
- Using SPSS Software, this study also focuses on identifying the variables which have more impact than others on the Altman Z-Score using the Neural Networks Framework. This framework gives importance to independent variables regarding their impact on the dependent variable. Also ROC-AUC curve is used to test the Altman Z-Score as these curves are widely used to test the validation of the models' default prediction accuracy.
- Another method to test the accuracy of Z-Score prediction model that is being used in this study is Decision Tree Diagram which used CHAID technique where the dependent variable is Z Score while the independent variables are CR, ROW, P/E, Tobin's Q and Average D/A. This technique bifurcates the data into nodes and identifies the factors which are most relevant or significantly related to Z-Score.

6. Data Analysis and Discussion

6.1 Correlation of Altman Z Score with Firm Performance Indicators

6.1.1 Altman Z-Score and Total Assets (Firm Size)

Descriptive Statistics			
	Mean	Std. Deviation	N
Z Score	7.075521	2159.6541815	7183
Total Assets (log)	3.860041	.8019205	7183

Table 2: Descriptive Statistics of Altman Z-Score and Total Assets

Correlation			
		Z Score	Total Assets (log)
Z Score	Pearson Correlation	1	-.010
	Sig. (2-tailed)		.412
	Sum of Squares and Cross-products	33497610611.060	-120388.133
	Covariance	4664106.184	-16.762
Total Assets (log)	Pearson Correlation	-.010	1
	Sig. (2-tailed)	.412	
	Sum of Squares and Cross-products	-120388.133	4618.575
	Covariance	-16.762	.643

Table 3: Correlation of Altman Z-Score and Total Assets

Historically, many a research has been conducted where the debate had been about what parameter to be selected as a proxy for the size of the firm and after several discussions, the 3 main parameters that have been chosen are Market Capitalization, Sales and Log value of Total Assets with the latter being the most preferred parameter. After running the correlation test on the Z-Score and Total Assets the results indicate that the **correlation between the 2 variables is -0.010** which implies that there exists **no correlation or a weak negative correlation** between the 2 variables. The level of significance (alpha α) chosen is 0.01 while the significance level (p value) from the output is 0.412 which shows that **H_0cannot be reject** i.e. there is not enough evidence to suggest relation between 2 variables and it can be concluded that correlation is not statistically significant and whatever correlation occurred was just by chance. The **negative value of covariance suggests that the two variables will move in opposite directions**.

6.1.2 Altman Z-Score and Net Profit Margin (Profitability)

Descriptive Statistics			
	Mean	Std. Deviation	N
Z Score	7.075521	2159.6541815	7183
Net Profit Margin	.398939	134.8062879	7050

Table 4: Descriptive Statistics of Altman Z-Score and Net Profit Margin

Correlation			
		Z Score	NetProfit Margin
Z Score	Pearson Correlation	1	.058**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	33497610611.060	206431.364
	Covariance	4664106.184	29.285
	N	7183	7050
Net Profit Margin	Pearson Correlation	.058**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	206431.364	128099610.853
	Covariance	29.285	18172.735
	N	7050	7050

**. Correlation is significant at the 0.01 level (2-tailed)

Table 5: Correlation of Altman Z-Score and Net Profit Margin

The profitability position of a company is affected when a company is closing towards being bankrupt. After running the correlation test, the correlation coefficient came out to be 0.058 which signifies **weak positive correlation** but by comparing (alpha α) and the p value, the results are statistically significant at 0.01 level of significance. This implies that there is enough evidence to suggest that the **correlation we observed does exist in the population** and thus **Null Hypothesis (H_0)can be rejected**and **alternate Hypothesis (H_1) can be accepted**. The **positive covariance** value also suggests that Z-Score and Net Profit margin **move in the similar direction**

6.1.3 Altman Z-Score and Total Debt (Solvency)

Descriptive Statistics			
	Mean	Std. Deviation	N
Z Score	7.075521	2159.6541815	7183
Total Debt	16779.956856	98373.0645791	7183

Table 6: Descriptive Statistics of Altman Z-Score and Total Debt

Correlation			
		Z Score	Total Debt
Z Score	Pearson Correlation	1	.000
	Sig. (2-tailed)		.967
	Sum of Squares and Cross-products	33497610611.060	-738229880.195
	Covariance	4664106.184	-102788.900
Total Debt	Pearson Correlation	.000	1
	Sig. (2-tailed)	.967	
	Sum of Squares and Cross-products	-738229880.195	69502080132670.460
	Covariance	-102788.900	9677259834.680

Table 7: Correlation of Altman Z-Score and Total Debt

Over the year, many research papers indicate that as the Z score falls and company is inching towards bankruptcy, the debt keeps on piling on the balance Sheet of the company or their cash reserves deplete to not be able to service their debt obligations or meet the debt covenants. The **correlation coefficient between the 2 variables is close to 0 but positive which suggests that 2 variables move together**. According to the (alpha α) and the p value comparison, this study **cannot reject the H_0** and it is concluded that there **doesn't exist significant relation between the 2 variables** which is contrary to the results of the past research methodologies. However, the **negative covariance** suggests that as the bankruptcy z-score decrease, the total debt increases which is consistent with the past research done.

6.1.4 Altman Z-Score and P/E (Market Value)

Descriptive Statistics			
	Mean	Std. Deviation	N
Z Score	7.075521	2159.6541815	7183
P.E	31.005204	218.1205844	7183

Table 8: Descriptive Statistics of Altman Z-Score and P/E

Correlation			
		Z Score	P/E
Z Score	Pearson Correlation	1	.000
	Sig. (2-tailed)		.976
	Sum of Squares and Cross-products	33497610611.060	-1217730.107
	Covariance	4664106.184	-169.553
P/E	Pearson Correlation	.000	1
	Sig. (2-tailed)	.976	
	Sum of Squares and Cross-products	-1217730.107	341695064.626
	Covariance	-169.553	47576.589

Table 9: Correlation of Altman Z-Score and P/E

The P/E ratio helps investors determine the market value of a stock as compared to the company's earnings. A high P/E could mean that a stock's price is high relative to earnings and possibly overvalued. Conversely, a low P/E might indicate that the current stock price is low relative to earnings. Historically, the stock prices are hit massively when the company is closing in on bankruptcy. Again the **correlation between the 2 variables is close to 0 yet positive which shows that exists no correlation or weak positive correlation i.e.** the correlation is not statistically significant and **this study cannot reject the null (H_0)** and the conclusion that can be drawn is that no relation exists between the 2 variables. However, there has been evidence that with falling bankruptcy score, the P/E should also fall and according to our research P/E will fall but at a slow rate. **From the perspective of Covariance, there is a negative relation between the 2 variables** suggesting that as the bankruptcy z-score decrease, the P/E increases but as prices should fall, it contradicts with the past research results.

6.1.5 Altman Z-Score and Current Ratio (Liquidity)

Descriptive Statistics			
	Mean	Std. Deviation	N
Z Score	22.627063	1710.9360177	7182
Current Ratio	1.786104	12.6928601	7182

Table 10: Descriptive Statistics of Altman Z-Score and Current Ratio

Correlation			
		Z Score	Current Ratio
Z Score	Pearson Correlation	1	.004
	Sig. (2-tailed)		.725
	Sum of Squares and Cross-products	21020956068.824	647606.242
	Covariance	2927302.057	90.183
Current Ratio	Pearson Correlation	.004	1
	Sig. (2-tailed)	.725	
	Sum of Squares and Cross-products	647606.242	1156921.550
	Covariance	90.183	161.109

Table 11: Correlation of Altman Z-Score and Current Ratio

The Current Ratio is basically a measure of solvency which is directly in relation to the bankruptcy score i.e. it influences the solvency of a company who is on the verge of being bankrupt. After running the correlation test on the Z-Score and Current Ratio, **correlation between the 2 variables is 0.004** which indicates that there exists **no correlation or a weak positive correlation** between the 2 variables. The level of significance (alpha α) chosen is 0.01 while the significance level (p value) from the output is 0.725 which shows that **this study cannot reject the H_0** i.e. there is not enough evidence to suggest relation between 2 variables and it can be concluded that correlation is not statistically significant and whatever correlation occurred was just by chance. The **positive value of covariance suggests that the two variables will move in similar directions** i.e. as the bankruptcy score decreases, and the firm approaches the danger zone, the Current Ratio will also decrease which is a signal of threat to the solvency of the company.

6.1.6 Altman Z Score and Tobin's Q (Risk and Future Prospects)

Descriptive Statistics			
	Mean	Std. Deviation	N
Altman	7.0755	2159.65418	7183
Tobin's Q	13.9582	726.11744	7183

Table 12: Descriptive Statistics of Altman Z-Score and Tobin's Q Ratio

Correlation			
		Altman	Tobin's Q
Altman	Pearson Correlation	1	.057**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	33497610611.060	642363095.750
	Covariance	4664106.184	89440.698
Tobin's Q	Pearson Correlation	.057**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	642363095.750	3786684673.753
	Covariance	89440.698	527246.543

**. Correlation is significant at the 0.01 level (2-tailed).

Table 13: Correlation of Altman Z-Score and Tobin's Q Ratio

Tobin's Q is a measure of risk that a firm faces by evaluating the market value of the firm with the total assets of the firm and as a whole it can gauge whether the market is overvalued or undervalued. After running the correlation test, it is found that the correlation coefficient is 0.057 which signifies **weak positive correlation** but by comparing (alpha α) and the p value, the results are statistically significant at 0.01 level of significance. This implies that there is enough evidence to suggest that the **correlation does exist in the population** and this study can **reject the Null Hypothesis (H_0)** and **accept the alternate Hypothesis (H_1)** and conclude that there exists significant relation between the 2 variables. The **positive covariance** value also suggests that Z-Score and Tobin's Q **move in the similar direction.**

6.1.7 Altman Z-Score and Return on Equity (Profitability)

Descriptive Statistics			
	Mean	Std. Deviation	N
Z Score	2.305453	7.1682746	5747
ROE	3.324168	41.9140269	5747

Table 14: Descriptive Statistics of Altman Z-Score and Return on Equity

Correlation			
		Z Score	ROE
Z Score	Pearson Correlation	1	.039**
	Sig. (2-tailed)		.003
	Sum of Squares and Cross-products	295253.392	66761.224
	Covariance	51.384	11.619
ROE	Pearson Correlation	.039**	1
	Sig. (2-tailed)	.003	
	Sum of Squares and Cross-products	66761.224	10094490.339
	Covariance	11.619	1756.786

**. Correlation is significant at the 0.01 level (2-tailed).

Table 15: Correlation of Altman Z-Score and Return on Equity

ROE is a measure of profitability which measures the ability of the firm to generate profits for its shareholder's investments in the company. After running the tests, it is found that correlation coefficient is 0.039 which signifies **weak positive correlation** but by comparing (alpha α) and the p value, the results are statistically significant at 0.01 level of significance.

This implies that there is enough evidence to suggest that the **correlation so observed does exist in the population** and **Null Hypothesis (H_0) can be rejected** and **alternate Hypothesis (H_1) can be accepted** i.e. if a company is going to be bankrupt, they will not be able to generate returns for its shareholders. The **positive covariance**value also suggests that Z-Score and ROE **move in the similar direction** that if bankruptcy scores decrease, the ROE also decreases.

6.1.8 Altman Z-Score and Credit Rating

Descriptive Statistics			
	Mean	Std. Deviation	N
Z Score	2.096758	1.9906647	1043
Credit Rating	-1.665388	4.2728128	1043

Table 16: Descriptive Statistics of Altman Z-Score and Credit Rating

Correlation			
		Z Score	Credit Rating
Z Score	Pearson Correlation	1	.440**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	4129.181	3895.698
	Covariance	3.963	3.739
Credit Rating	Pearson Correlation	.440**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	3895.698	19023.721
	Covariance	3.739	18.257

**. Correlation is significant at the 0.01 level (2-tailed)

Table 17: Correlation of Altman Z-Score and Credit Rating

Over the decade the research with respect to analyzing the relation between bankruptcy z score and credit rating has shown that there exists a significant relation between the 2 variables and the credit rating for the given company keeps on decreasing as the company is moving towards bankruptcy. The similar result is found using the sample taken in this study and it is being seen that **the correlation is statistically significant at 0.01 level of significance** i.e. with 99% confidence interval **H_0can be rejected** which states that there doesn't exist a relation between the 2 variables. While interpreting the covariance results, **the positive value of covariance** suggests that both the variables move in similar direction i.e. if bankruptcy score decreases and firm enters into the danger zone, the credit rating will also fall and vis-à-vis.

6.2 The Classification or Decision Tree Method

The results of the classification Tree Model on our sample size are as follows

Classification				
Observed	Predicted			
	0	1	2	Percent Correct
0	230	74	46	65.7%
1	139	131	54	40.4%
2	95	59	80	34.2%
Overall Percentage	51.1%	29.1%	19.8%	54.6%
Growing Method: CHAID Dependent Variable: Z Score Category				

Table 18: Model Summary of Decision Tree Framework

Risk	
Estimate	Std. Error
.514	.017
Growing Method: CHAID Dependent Variable: Z Score Category	

Table 198: Classification of Decision Tree Framework

Classification				
Observed	Predicted			
	0	1	2	Percent Correct
0	230	74	46	65.7%
1	139	131	54	40.4%
2	95	59	80	34.2%
Overall Percentage	51.1%	29.1%	19.8%	54.6%
Growing Method: CHAID Dependent Variable: Z Score Category				

Table 19: Classification of Decision Tree Framework

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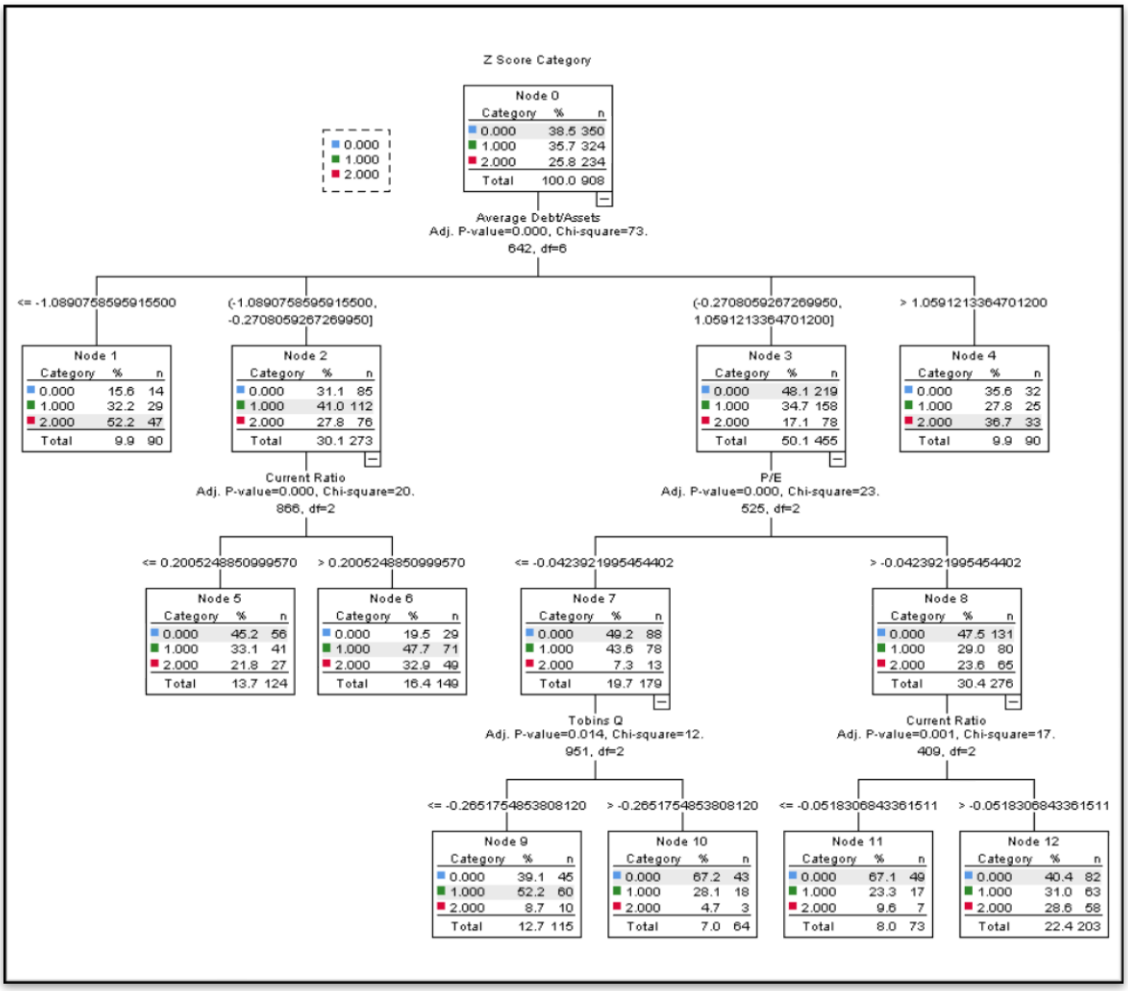

Figure 1: Result of Decision Tree Framework

6.2.1 Discussion

• Decision Tree using CHAID (Chi Square Automatic Interaction Detection) has been made where the independent variable is Z-Score (Altman Bankruptcy Prediction Score) while the dependent variables are Current Ratio, ROE, Average Debt/Assets, Tobin's Q as well as P/E.

• Node 0 contains the variable that this study aims at predicting. Altman Z Score has been categorized in this study where Category 0 represents (score less than 1.8 which denotes danger zone), Category 1 represents (score between 1.8 and 3 which denotes moderate zone) and Category 2 represents (score greater than 3 which denotes safe zone).

• Average Debt/Assets is the first variable that is used to further categorize the data and is the most relevant factor that should be considered while the company is analyzing its bankruptcy score because debt/assets is a measure of financial leverage which tells about the % of assets that are being financed by creditors. Depending upon the average debt/assets score, the data is further bifurcated into 4 nodes which implies that when a company is about to face bankruptcy or is in moderate/safe zone, what are their respective debt/asset positions.

• If a company's average debt/assets is less than equal to -1.08, it means the given company is financially sound and in a position to not go bankrupt but if debt/asset range is between -1.08 to -0.27, then there is some concern about the solvency of the company therefore the study delves further into the cause and check for company's short term solvency by checking the Current Ratio which further segregates the data into Node 5 and node 6.

• However, if debt/asset value lies between -0.27 to 1.05, then the firm's debt is greater than the assets i.e. assets are not enough to service the firm's debt obligation and the market has already begun to devalue the firm and its assets much below the fair value of the assets which leads this study to check the P/E of the respective firms which categorizes the data into Node 7 and Node 8.

• If the debt/asset value is greater than 1.05, it signifies that the firm has already reached the verge of bankruptcy and it has been devalued by the market completely and it is time for the company to file for bankruptcy.

• While checking for P/E, if the value is less than -0.04, then the next thing this study checks is Tobin's Q ratio which is one of the risk adjusted measures and talks about the replacement value of the assets in case of bankruptcy. However, if the P/E is greater than -0.04, then this study checks the Current Ratio to assess the short term solvency of the firm i.e. whether the firm is even in a position to service their short term debt obligations or not.

• According to the Table No. 19, with 65% accuracy it is being predicted by the decision tree regarding the steps to be followed when a company has a z score of less than 1.8 while the accuracy level is decreasing when predicting the correct path for the companies when their bankruptcy score is greater than 1.8 and they are either in moderate zone or safe zone. The overall accuracy is at 54.6% approx. The accuracy of 54.6% is so because of the inconsistency of the data as some value shave been missing and the missing values were assumed to be 0 for the purpose of this study

6.3 Neural Network Framework

Case Processing Summary			
		N	Percent
Sample	Training	613	67.5%
	Testing	295	32.5%
Valid		908	100.0%
Excluded		0	
Total		908	

Table 20: Risk Summary of Neural Network

Network Information			
Input Layer	Covariates	1	Current Ratio
		2	ROE
		3	Tobin's Q
		4	P/E
		5	Average Debt/Assets
	Number of Units		5
	Rescaling Method for Covariates		Standardized
Hidden Layer(s)	Number of Hidden Layers		1
	Number of Units in Hidden Layer 1[a]		2
	Activation Function		Hyperbolic tangent
Output Layer	Dependent Variables	1	Zscore Category
	Number of Units		3
	Rescaling Method for Scale Dependents		Standardized
	Activation Function		Softmax
	Error Function		Cross Entropy
a. Excluding the bias unit			

Table 21: Risk Summary of Neural Network

Model Summary		
Training	Cross Entropy Error	645.771
	Percent Incorrect Predictions	47.4%
	Stopping Rule Used	1 consecutive step(s) with no decrease in error
	Training Time	0:00:00.16
Testing	Cross Entropy Error	314.590
	Percent Incorrect Predictions	49.2%
Dependent Variable: Zscore Category		
a. Error computations are based on the testing sample.		

Table 22: Model Summary of Neural Network

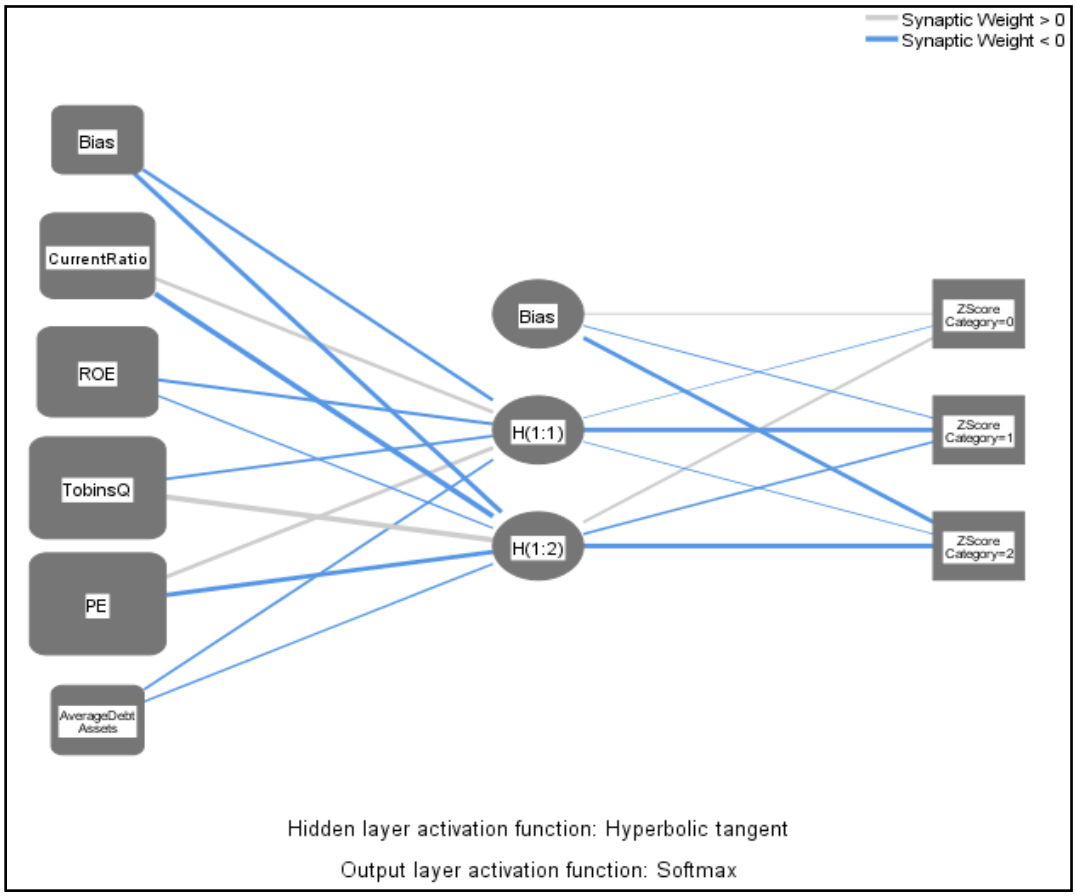

Figure 2 : Diagram of Neural Network

Parameter Estimates						
Predictor		Predicted				
		Hidden Layer 1		Output Layer		
		H(1:1)	H(1:2)	[ZScoreCategory=0]	[ZScoreCategory=1]	[ZScoreCategory=2]
Input Layer	(Bias)	-.321	-.475			
	Current Ratio	.404	-.645			
	ROE	-.233	-.157			
	Tobin'sQ	-.220	1.064			
	PE	.418	-.490			
	Average Debt/Assets	-.210	-.187			
Hidden Layer 1	(Bias)			.135	-.132	-.421
	H(1:1)			-.042	-.524	-.121
	H(1:2)			.226	-.199	-.574

Table 23: Parameter Estimates of Neural Network ROC CURVE

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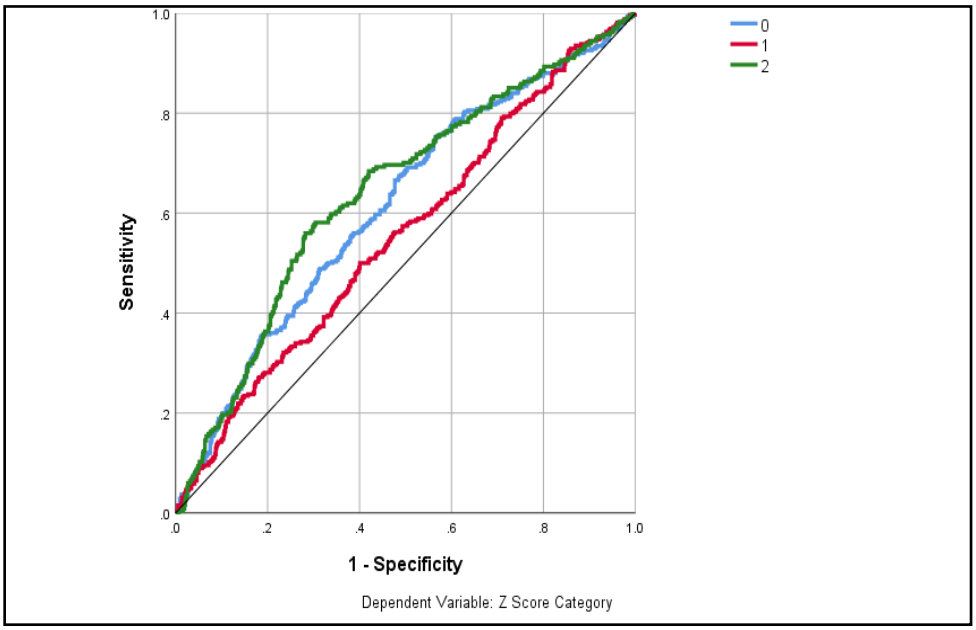

Figure 3: ROC Curve

Area Under the Curve		
		Area
Z Score Category	0	.613
	1	.556
	2	.640

Table 24: Area under the ROC Curve

Independent Variable Importance		
	Importance	Normalized Importance
Current Ratio	.185	75.7%
ROE	.201	82.5%
Tobin's Q	.243	99.8%
P/E	.244	100.0%
Average Debt/Assets	.127	52.0%

Table 25: Independent Variable Importance in Neural Network

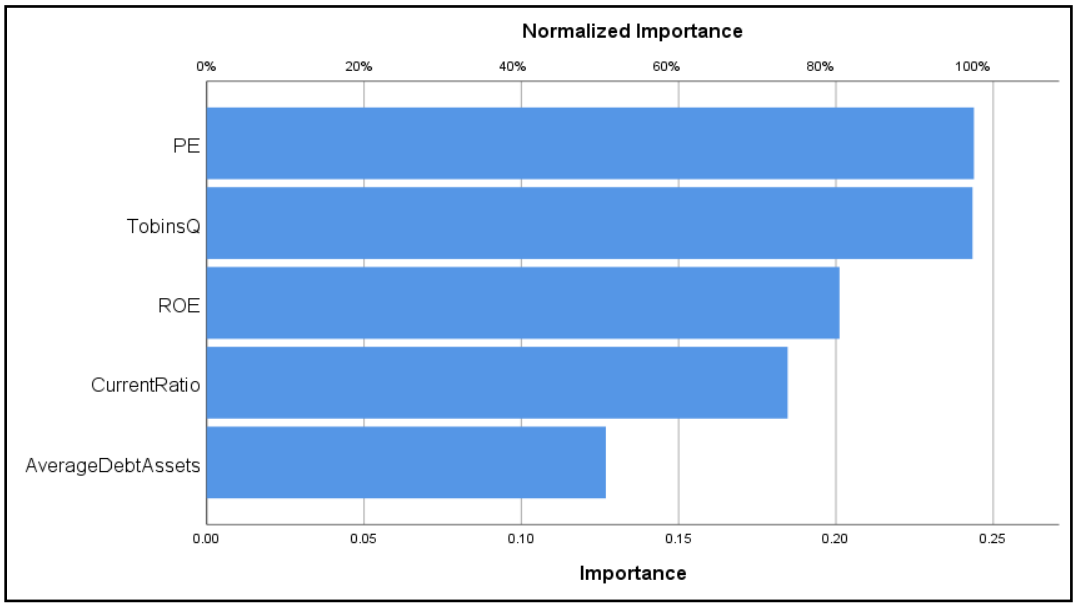

Figure 4: Comparison of Independent Variable and its normalized importance in Neural Network

6.3.1 Discussion

• The focus of the study and this test is on multilayer perceptron method. Table No. 20 shows the number of cases assigned to training sample and holdout sample which is 67.5% and 32.5% respectively.

• The Table No.21 displays information about the neural network and is useful for ensuring that the specifications are correct. Our Dependent Variable are the 3 categories of Altman Z Score 0, 1,2 divided on the bases of distressed zone, moderate zone and safe zone. Our covariates are Current Ratio, ROE, Tobin's Q, P/E Ratio and Average of Total Debt/Total Assets whose values are standardized.

• Figure No.2 displays the connection between the parameters and the dependent variable. The lines show the relations estimated. The blue lines are the lines which denote that synaptic weight is <0, while the others have a higher weight. For example, there is relatively higher bias in the distressed category than the other 2 categories. Current Ratio that denotes liquidity highly impacts the first hidden layer which has higher impact on distressed zone.

• Table No. 22 displays the information about the results of training and applying the final network to the holdout sample, which shows the percent of incorrect predictions by 57.4%.

• The Upper left part of Table No. 23 depicts the impact from input factors to hidden layers, while the other shows the impact of hidden to the output for each parameter. For example, Tobin's Q has the highest impact on hidden layer 2 which has the highest relation with the safe zone category

• Figure No. 3 gives a visual display of sensitivity and specificity for all possible cut-offs in a single plot. The independent variable importance shows how much the measure of network model predicted value changes for different values of the independent variable. Normalized importance is simply the importance values divided by largest value and expressed as percentages. In our case the highest has been given to P/E and Tobin's Q, while ROE and Current Ratio are slightly less, while Average Debt/Assets are given the least importance in order of impact.

6. Conclusion

The correlation result of Altman Z Score with Total Assets (Firm Size) is **-0.010** which signifies weak negative correlation. According to the research paper "**Assessing the Probability of the Failure by using Altman's model and Exploring its relationship with Company Size**" Total Assets does have a negative correlation with the Z Score and Probability of Failure, however that relationship is quite strong and significant at 0.01 level of significance owing to the fact that the companies chosen there were asset heavy as they belonged to the steel sector whereas the sample taken in this study comprises of the companies listed on the NSE belonging to different sectors like IT, Retail etc. which are not Asset heavy thus they lower the value of correlation.

1) While trying to establish the relationship between Altman Z Score and Net Profit Margin, this study arrives at a value of **0.058** i.e. weak positive correlation which is however significant at 0.01 level of significance (alpha). According to the paper **"Bankruptcy Prediction Using Altman Z Score Model: A case of Public Listed Manufacturing Companies in Malaysia"** this relationship is also significant. This goes on to depict that the relationship between profits and bankruptcy score more or less remains same across geographies as well as industries because when a company is on the verge of being a bankrupt, their majority of cash reserves as well as assets are being used to service their debt obligations and the profit margins fall drastically also because of the negative sentiment in the market about that company.

2) The correlation between Altman Z Score and Price/Earnings Ratio is **less than 0.001** which shows that there does not exist a relationship between the two variables and it is not possible to reject the Null Hypothesis and the results are not statistically significant. According to the research paper **"Valuation of Distresses Firms"** the results have been similar due to the fact that the applicability of valuation multiples is somewhat constrained when the subject company is in decline or in a situation of distress because ratios like P/B and P/E work only with positive numbers. While valuing distressed companies, analysts have to move up the income statement and use the first positive metric they find. Therefore, the use of revenue and EBITDA multiples is much more frequent when valuing distressed firms or firms that are about to be bankrupt.

3) The value of Correlation between Altman Z Score and Return on Equity is **0.039** which signifies weak positive correlation however this result is statistically significant at 0.01 level of significance and Null Hypothesis can be rejected and concluded that there exist a relationship between 2 variables. According to the research Paper "**"Bankruptcy Prediction Using Altman Z Score Model: A case of Public Listed Manufacturing Companies in Malaysia"** the resultant correlation is also significant which goes on to prove that the profitability of the company is hampered when there is a drop in their bankruptcy score i.e. they are moving from safe/moderate zone to danger zone. The firms which are debt heavy fundamentally would use their earnings and cash flows to service their debt obligations first before creating value for the investments of its shareholders. The positive covariance also depicts that the Bankruptcy Score and ROE move in similar directions.

4) The relationship between bankruptcy score and credit rating of a company has historically been like this – if the company's bankruptcy score falls, or if it is inching towards bankruptcy, the credit rating agencies devalue the company by lowering their credit rating. This goes on to show that there exists a significant and direct relationship between the bankruptcy score and credit rating irrespective of the geographical location of the company or the sector to which it belongs. According to the tests carried out during this research, the correlation between 2 is significant which also aligns with the result of the research paper **"Altman Vs Merton- Are Corporate Credit Rating Changes New Information"** where the rating falls as company is not able to fulfill their obligation and therefore this study can reject the null hypothesis and conclude that there is no relation between Credit Rating and Bankruptcy Z Score. The positive value of covariance also affirms the same thing as the correlation result.

5) According to the Pearson Correlation method, there exists weak correlation between the two variables Total Debt and Altman Z Score and the correlation is not statistically significant at 0.01 level of significance (alpha). In the paper, **"Bankruptcy and financial distress prediction in the mobile telecom industry in Ghana"**, the impact of debt is not significant on the Bankruptcy Score and in the paper, "**Bankruptcy prediction based on the debt ratio"** it is concluded that debt cannot predict with perfect accuracy the state of the company. In our study, the sample size is inclusive of the sectors which are not debt heavy or have only short term debt such as Fast-Moving Consumer Goods, Information Technology and Pharmaceutical Sector etc. This sample is also inclusive of the companies which have a sound financial position than can be used to service their debt when required or may get influx of cash as they realize they are heading towards financial distress. This is in contradiction to the fundamental reasoning that as the company will inch

towards bankruptcy, its leverage will keep increasing as the debt will be unable to be serviced.

6) The result to the correlation test shows that there is a weak positive correlation between the two variables Current Ratio and Altman Z Score. In the paper, **"Financial Ratios for Bankruptcy Prediction a Consensus Approach"** it states short-term liquidity ratios are consistent predictors of financial distress, but the data just pertains to financial institutions. Fundamentally, as the company is inching towards financial distress, the cash reserves and quick assets will be used to service the piling debt and liabilities. Thus, the Current assets should reduce, decreasing the current ratio and as it is heading towards bankruptcy the Z-Score will keep decreasing. The sample size in this study, due to conflicting nature of the data that is inclusion of all sectors with varied key performance indicators, is unable to establish a strong positive correlation between the Altman Z Score and the Liquidity Ratio

7) Tobin's Q is a measure of risk that a firm faces by evaluating the market value of the firm with the total assets of the firm as an indicator to gauge if the market is overvalued or undervalued. Our test results show that there exists a weak positive correlation between the two variables Altman Z-Score and Tobin's Q Ratio, but is statistically significant at 0.01 level of significance. As a firm move towards bankruptcy, the market starts to devalue or reduce the value of the firm. Thus, there will be a decreasing Tobin's Q ratio as the numerator will keep decreasing. The Altman Z Score will also decrease as the company will move from safe to moderate to distress zone

References

1. Altman I.E, Iwanicz-Drozdowska M, Laitinen E.K, Suvas A (2017), "Financial Distress Prediction in an International Context: A Review and Empirical Analysis of Altman's Z-Score Model", Journal of International Financial Management and Accounting, Vol 28, No. 2, 131-171
2. Altman, E.I., "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," Journal of Finance 23 (1968), pp. 589–609.
3. Ohlson, J.A., "Financial Ratios and the Probabilistic Prediction of Bankruptcy," Journal of Accounting Research 18 (1980), pp. 109–131.
4. Zmijewski, M.E., "Methodological Issues Related to the Estimation of Financial Distress Prediction Models," Journal of Accounting Research 22 (1984), pp. 59–82.
5. Smith, M. and D. Liou, "Industrial Sector and Financial Distress," Managerial Auditing Journal 22 (2007), pp. 376–391.

6. Kwak, W., Shi, Y., J.J. Cheh and H. Lee. "Multiple Criteria Linear Programming Data Mining Approach: An Application for Bankruptcy Prediction," Data Mining and Knowledge Management 3327 (2005), pp. 164–173.
7. Ohlson, J.A., "Financial Ratios and the Probabilistic Prediction of Bankruptcy," Journal of Accounting Research 18 (1980), pp. 109–131.
8. Grice Jr, J.S. and M.T. Dugan, "Re-Estimations of the Zmijewski and Ohlson Bankruptcy Prediction Models," Advances in Accounting 20 (2003), pp. 77–93.
9. Altman, E. I. (2013). 17 Predicting financial distresses of companies: revisiting the Z-score and ZATA models1. Handbook of Research Methods and Application in Empirical Finance, 428.
10. Mohammed, A. & Kim-Soon, N. (2012). Using Altman's model and current ratio to assess the financial status of companies quoted in the Malaysia Stock Exchange. International Journal of Scientific and Research Publications, 2(7), 1-11.
11. Yao, X. and Liu, Y. (1997). A new evolutionary system for evolving artificial neural networks. IEEE Trans. Neural Netw., 8(3), pp.694-713.
12. Yoon, Y., Swales, G. and Margavio, T. (1993). A Comparison of Discriminant Analysis versus Artificial Neural Networks. J Oper Res Soc, 44(1), pp.51-60.
13. Chen K. H. and Thomas A. Shimerda. (1981). "An Empirical Analysis of Useful Financial Ratios", Financial Management, 10(1): 51-60.