Corporate Bankruptcy: Testing the Efficacy of the Altman Z-Score

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Abstract

The purpose of this research is to evaluate modifications of the Altman Z-Score model. The Z-Score is used in this study to assess multiple companies in different industry sectors, while altering the variable components. The several financial ratios comprising the models are assessed and ultimately, the accuracy of the models is questioned. Consideration of interchanging financial ratios in the model aims to provide a more beneficial use of the model. Finally, in manipulating the variables of the Altman Z-Score, indication of other applications for the model are expected. Further exploratory study into the accuracy of the models could provide a more accurate analysis.

Keywords: Bankruptcy Prediction, Model Efficacy, Altman Z-Score

I. Introduction

The need for accurate predictors of corporate bankruptcy is essential. The widespread effects of bankruptcy have led to the development of many models as predictors. Financial ratios have continuously been considered as accurate predictors of corporate failure (Moscalu & Vintila, 2012). Using basic financial statement data to analyze the financial health of companies has been expanded on in the past 60 years. The Altman Z-Score (1968) was introduced in doing so. However, the Altman Z-Score is found as a non-viable indicator of failure. This paper manipulates the original Z-Score formula, changing certain financial ratios to better assess the going concern of a business.

The general concept of corporate failure is a situation in which the lack of profits to cover business expenses leads to the discontinuation of business operations. Common factors that contribute to corporate failure are economic distress, mismanagement, fraudulent management, and financial distress. Economic downturn frequently leads to corporate failure across many industries, evident in and after the financial crisis of 2007-2008. Poor management of activities leads to poor performance in consideration of employees and assets. Falsification in financial statements and accounting records often see to corporate failure, as the case with Enron, Lehman Brothers, and many more.

Argenti said there are two types of failure. First, economic failure, defined as firm's failure to achieve the return on capital invested. Second, financial failure, a situation when a company faces financial insolvency (1986). According to Altman and Narayanan, failure can mean many others things like bond default, loan default, delisting of a company, special financing, and liquidation (1997). For the methods in this paper, the general sense of corporate failure as insolvency, or the inability to meet financial obligations, leads to corporate bankruptcy. Bankruptcy, according to BusinessDictionary, is a legal procedure for liquidating a business that cannot fully repay its debts out of its current assets. The legal status can occur voluntarily as an insolvent debtor, or involuntarily. Involuntary bankruptcy involves court petitions filed by one or more creditors with the bankruptcy court. The two major objectives of bankruptcy are fair settlement of the creditors' claims through liquidation and providing the debtor with an opportunity for a fresh start through corporate restructuring (2017).

The consequences of corporate bankruptcy can have detrimental economic and social impacts on societies. As a result, unemployment rates may increase and consumer spending may decrease. Multiple failures across many industries may even see to an economic crisis.

Failure affects all who are associated with a company. Even through financial and corporate restructuring, many employees will find themselves out of work, even leading to personal bankruptcy. In addition, many will find benefits such as pension plans cut. It is clear that the ability to assess corporate failure accurately is important from the perspective of a firm's stakeholders, creditors, and employees (Chen, Premachandra, & Watson, 2011).

II. Precedent Work

Financial ratios have been predominantly used in bankruptcy prediction models, beginning with a single ratio to measure credit worthiness, the current ratio. Today, ratio analysis involves the use of many financial and economic ratios, used for much more than just bankruptcy prediction. William Beaver published *Financial Ratios as Predictors of Failure* in 1966 as an exploration into the accuracy of using financial ratios to predict corporate bankruptcy. Beaver compared failed and non-failed firms using 30 financial ratios derived from financial statement items. These ratios covered cash flows, net-income, debt to total asset, liquid asset to total asset, liquid asset to current debt, and turnover. Utilizing univariate analysis, Beaver examined the predictive ability of each ratio, one at a time. The results stood that financial ratios were able to tell signs of deterioration years before failure. However, overlap between each ratios' outcome is apparent with univariate analysis (1966). Where a net-income to sales ratio shows signs of a healthy firm, a working capital to total assets might lean towards failure. Cash flow problems, low earnings, and a reduction in total assets can have serious implications on ratio analysis. These factors must be considered carefully when analyzing the financial health of corporations. The limitations of univariate analysis have led to the development of more advanced statistical methods to predict failure (Vintila, 2004). Beaver alludes to multivariate analysis, using several ratios at a time, as a way of expanding on ratio analysis as accurate predictors of failure.

Edward Altman's Z-Score Model

In 1968, NYU Assistant Finance Professor Edward Altman introduced a model to depict likelihood of bankruptcy. Altman's model evaluates a company based on common financial and economic data found on annual 10K reports. A score is calculated and "then becomes the basis for classification of firms into one of the a *priori* groupings (distressed and non-distressed)" (Altman, 2000, p. 7).

Altman used multiple discriminant analysis (MDA) on a sample of 66 public manufacturing corporations to arrive at his model. He matched 33 bankrupt firms (Group 1) to 33 healthy firms (Group 2) in regards to industry and asset size. Asset size for the sample was restricted from $1 million to $25 million in accordance to the asset range of the bankrupt firms in Group 1. Altman then classified 22 potential variables into five standard ratio categories: liquidity, leverage, profitability, solvency, and activity ratios. According to the ratios' popularity in literature and potential relevancy to the study, he selected the five ratios that best represent the prediction of corporate bankruptcy. Unlike univariate analysis, MDA provided Altman the opportunity to develop a linear combination of variables to differentiate between the two groups.

After evaluating the five variables by statistical significance, variable correlation, and predictive accuracy, Altman established the original Z-score function for public manufacturing firms as (Altman, 1968):

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

MDA and the computer algorithm used to evaluate each set of financial ratios objectively determined the coefficients (Altman, 2006).

The original Z-score model requires absolute percentage values for variables X_1 through X_4. X_5 is the only variable that did not require an absolute percentage when evaluating the model (Altman, Haldeman, & Narayanan, 1977). Due to the original format of the variables, Altman introduced a slightly modified version for more practical use (2000):

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \qquad (1)$$

where the variables are defined as:

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
Z = Overall index

Z-Score Variables

X_1: Working Capital/Total Assets (WC/TA). Altman found this liquidity ratio to be the most valuable in predicting bankruptcy, according to statistical significance on both a univariate and multivariate basis. Working capital is the difference between current assets and current liabilities. The working capital ratio on its own is a measure of efficiency and short-term financial health. The WC/TA ratio measures net liquid assets to overall capitalization. A firm with a low ratio is likely experiencing operating losses that diminish the working capital accountant, decreasing relative to the total assets (Altman, 1968).

X_2: Retained Earnings/Total Assets (RE/TA). Retained earnings reports the total amount of profits reserved for reinvestment in the business or specific objectives such as payment of debt or the purchase of a capital asset (Businessdictionary.com, 2017). Retained earnings are subject to change due to dividend declarations and quasi-reorganizations, leaving a bias on the ratio. This ratio incorporates the factor of a firm's age. The assumption that younger firms are not able to collect a significant amount of retained earnings relates to a low RE/TA ratio and vice versa. This assumption implies a higher chance for younger firms of being classified as bankrupt, compared to older firms. This is common in the real world, as in 1993 nearly 50% of all failed firms did so in their early years. Not only a measure of cumulative profitably, this ratio also reflects a firm's leverage. A firm with a high RE/TA ratio suggests the dependence on profits to finance assets rather than debt (Altman, 2000).

X_3: Earnings Before Interest and Taxes/Total Assets (EBIT/TA). This ratio reflects the true productivity of a firm's assets, as this version of return on assets is independent of any leverage of tax factors. The EBIT/TA ratio is appropriate for studies of corporate bankruptcy since a firm's survival is ultimately based on the ability to generate profit by utilizing its assets (Altman, 1968).

X_4: Market Value of Equity/Book Value of Total Liabilities (MVE/TL). Liabilities are the total amount of long and current term, while equity in this ratio is the market value of all shares of stock outstanding, preferred and common. This measure is considered the insolvency ratio, showing how much value a firm can lose before its liabilities exceeds its

equity value. A market value is included in this ratio, unlike most insolvency investigations (Altman, 2000).
X_5: Sales/Total Assets (S/TA). This capital-turnover ratio measures the sales generating efficiency of a firm's assets. It also measures management's competitive ability, relating to sales. The S/TA ratio is included due to the many relationships of other variables.

With the parameters in set for the variables discussed above, Altman tested the success of his model in forecasting bankruptcy. He then divided the Z-values into three categories based on ranges of Z-values with false predictions.

$Z > 2.99$	*Safe Zone*
$1.81 < Z < 2.99$	*Gray Zone*
$Z < 1.81$	*Distress Zone*

The most probable range of false prediction was between 1.81 and 2.99, considered as the zone of ignorance or gray area. A Z-value less than 1.81 indicates a strong likelihood of bankruptcy, and greater than 2.99 indicate a low likelihood of bankruptcy (Altman, 1968).

Z'-Score Model 1983
The original Z-score model introduced in 1968 was analyzed using data from publicly held manufacturers. In order to accommodate for other industrial sectors, Altman revised his original model and published the Altman Z'-Score for private manufacturing firms (1983):

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5 \quad (2)$$

The reestimation of the model substitutes book value of equity for the market value of equity in X_4. As the coefficients changed for the revised model, so did the Z-score results and the zones of discrimination (Altman, 1983).

$Z' > 2.9$	*Safe Zone*
$1.23 < Z' < 2.9$	*Gray Zone*
$Z' < 1.23$	*Distress Zone*

Z"-Score Model 1993
After publishing the revised Z'-Score model, Altman continued research in predicting corporate bankruptcy. Altman developed the Z"-Score model to evaluate non-manufacturing firms and emerging market companies respectively (1993):

$$Z'' = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \quad (3)$$
$$Z'' = 3.25 + 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \quad (4)$$

The Z"-Score eliminated the X_5 variable from the equation "in order to minimize the potential industry effect which is more likely to take place when such an industry sensitive variable as asset turnover is included" (Altman, 2000, p. 26). X_4 substitutes book value for market value again in the Z"-Score models. The revised Z"-Score model leads to another change in the zones of discrimination (Altman, 1993):

$Z'' > 2.6$	*Safe Zone*
$1.1 < Z'' < 2.6$	*Gray Zone*
$Z'' < 1.1$	*Distress Zone*

This paper will focus on the original Z-Score model, the manipulation and its accuracy thereof.

III. Methodology

I changed the variables X_4 and X_5 of the original Altman Z-Score model in an attempt to better evaluate companies and their indication of failure. With X_4, additional paid-in-capital (APIC) is substituted for market value of equity, as APIC provides a reported amount of market value based upon the amount paid in by investors in excess of the par value price of stock. The X_5 variable of sales over total assets is replaced with dividends paid over sales. Dividends paid as a percentage of sales provide a look at the amount a company returned to its investors from its revenues. This ratio provides an insight into cash flows, previously ignored in the original Z-Score model. I evaluated 10 companies of different sectors of industry. Five of which filed for bankruptcy, and five non-failed companies. The different sectors of industry included in the sample cover retail, real estate development, and energy. This manner of evaluation will ultimately test the accuracy of the Z-Score model in consideration of the manipulated formula, and whether or not this manipulation increases the indication of failure.

Failed Companies

A. Original Z-Score Calculations

- Toys “R” Us, Inc.

Toys "R" Us, Inc.			
Variable	**Ratio**	***2016***	***2015***
X_1	Working Capital / Total Assets	0.07	0.05
X_2	Retained Earnings / Total Assets	-0.15	-0.13
X_3	EBIT / Total Assets	0.05	0.03
X_4	MV of Equity / Total Liabilities	0.00	0.00
X_5	Sales / Total Assets	1.69	1.74
Z-Score	=	**1.75**	**1.71**

- Peabody Energy Corporation

Peabody Energy Corporation (BTU)			
Variable	**Ratio**	***2015***	***2014***
X_1	Working Capital / Total Assets	-0.55	-0.01
X_2	Retained Earnings / Total Assets	-0.05	0.12
X_3	EBIT / Total Assets	-0.15	-0.01
X_4	MV of Equity / Total Liabilities	0.24	0.23
X_5	Sales / Total Assets	0.51	0.51
Z-Score	=	**-0.58**	**0.76**

- MF Global

MF Global (MFGL)			
Variable	**Ratio**	***2010***	***2009***
X_1	Working Capital / Total Assets	-0.19	-0.40
X_2	Retained Earnings / Total Assets	-0.01	0.01
X_3	EBIT / Total Assets	0.00	0.00
X_4	MV of Equity / Total Liabilities	0.04	0.03
X_5	Sales / Total Assets	0.06	0.04
Z-Score	=	**-0.17**	**-0.43**

- Arch Coal, Inc.

Arch Coal, Inc. (ARCH)			
Variable	**Ratio**	***2014***	***2013***
X_1	Working Capital / Total Assets	0.12	0.14
X_2	Retained Earnings / Total Assets	-0.16	-0.09
X_3	EBIT / Total Assets	-0.02	-0.07
X_4	MV of Equity / Total Liabilities	0.45	0.45
X_5	Sales / Total Assets	0.35	0.34
Z-Score	=	**-3.26**	**0.48**

- Paragon Offshore PLC

Paragon Offshore PLC			
Variable	**Ratio**	***2014***	***2013***
X_1	Working Capital / Total Assets	0.00	0.05
X_2	Retained Earnings / Total Assets	-0.28	0.00
X_3	EBIT / Total Assets	-0.16	0.11
X_4	MV of Equity / Total Liabilities	0.52	0.00
X_5	Sales / Total Assets	0.61	0.48
Z-Score	=	**0.00**	**0.91**

B. Modified Z-Score Calculations

- Toys “R” Us, Inc.

Toys "R" Us, Inc.			
Variable	**Ratio**	***2016***	***2015***
X_1	Working Capital / Total Assets	0.07	0.05
X_2	Retained Earnings / Total Assets	-0.15	-0.13
X_3	EBIT / Total Assets	0.05	0.03
X_4	Additional P.I.C. / Total Liabilities	0.01	0.01
X_5	Dividends Paid / Sales	0.00	0.00
Z-Score	=	**0.05**	**-0.03**

- Peabody Energy Corporation

Peabody Energy Corporation (BTU)			
Variable	**Ratio**	***2015***	***2014***
X_1	Working Capital / Total Assets	-0.55	-0.01
X_2	Retained Earnings / Total Assets	-0.05	0.12
X_3	EBIT / Total Assets	-0.15	-0.01
X_4	Additional P.I.C. / Total Liabilities	0.24	0.23
X_5	Dividends Paid / Sales	0.00	0.01
Z-Score	=	**-1.09**	**0.26**

- MF Global

MF Global (MFGL)			
Variable	**Ratio**	***2010***	***2009***
X_1	Working Capital / Total Assets	-0.19	-0.40
X_2	Retained Earnings / Total Assets	-0.01	0.01
X_3	EBIT / Total Assets	0.00	0.00
X_4	Additional P.I.C. / Total Liabilities	0.04	0.03
X_5	Dividends Paid / Sales	0.01	0.02
Z-Score	=	**-0.21**	**-0.45**

- Arch Coal, Inc.

Arch Coal, Inc. (ARCH)			
Variable	**Ratio**	***2014***	***2013***
X_1	Working Capital / Total Assets	0.12	0.14
X_2	Retained Earnings / Total Assets	-0.16	-0.09
X_3	EBIT / Total Assets	-0.02	-0.07
X_4	Additional P.I.C. / Total Liabilities	0.45	0.45
X_5	Dividends Paid / Sales	0.00	0.01
Z-Score	=	**-3.77**	**0.14**

- Paragon Offshore PLC

Paragon Offshore PLC			
Variable	**Ratio**	***2014***	***2013***
X_1	Working Capital / Total Assets	0.00	0.05
X_2	Retained Earnings / Total Assets	-0.28	0.00
X_3	EBIT / Total Assets	-0.16	0.11
X_4	Additional P.I.C. / Total Liabilities	0.52	0.00
X_5	Dividends Paid / Sales	0.01	0.00
Z-Score	=	**-0.61**	**0.44**

Non-Failed Companies

A. Original Z-Score Calculations

- Black Hills Corporation

Black Hills Corporation (BKH)			
Variable	**Ratio**	***2012***	***2011***
X_1	Working Capital / Total Assets	-0.09	-0.03
X_2	Retained Earnings / Total Assets	0.13	0.12
X_3	EBIT / Total Assets	0.03	0.02
X_4	MV of Equity / Total Liabilities	0.29	0.25
X_5	Sales / Total Assets	0.31	0.31
Z-Score	=	**0.68**	**0.64**

- GameStop Corporation

GameStop Corp. (GME)			
Variable	**Ratio**	***2017***	***2016***
X_1	Working Capital / Total Assets	0.12	0.08
X_2	Retained Earnings / Total Assets	0.43	0.46
X_3	EBIT / Total Assets	0.03	0.11
X_4	MV of Equity / Total Liabilities	0.01	0.00
X_5	Sales / Total Assets	1.83	1.73
Z-Score	=	**2.68**	**2.84**

- Mattel, Inc.

Mattel, Inc. (MAT)			
Variable	**Ratio**	***2017***	***2016***
X_1	Working Capital / Total Assets	0.24	0.22
X_2	Retained Earnings / Total Assets	0.35	0.55
X_3	EBIT / Total Assets	-0.07	0.08
X_4	MV of Equity / Total Liabilities	0.36	0.44
X_5	Sales / Total Assets	0.78	0.84
Z-Score	=	**1.56**	**2.38**

- Hasbro, Inc.

Hasbro, Inc. (HAS)			
Variable	**Ratio**	***2017***	***2016***
X_1	Working Capital / Total Assets	0.45	0.32
X_2	Retained Earnings / Total Assets	0.81	0.81
X_3	EBIT / Total Assets	0.16	0.15
X_4	MV of Equity / Total Liabilities	0.30	0.31
X_5	Sales / Total Assets	0.98	0.99
Z-Score	=	**3.37**	**3.20**

- Vail Resorts, Inc.

Vail Resorts, Inc. (MTN)			
Variable	**Ratio**	***2017***	***2016***
X_1	Working Capital / Total Assets	-0.04	-0.07
X_2	Retained Earnings / Total Assets	0.13	0.20
X_3	EBIT / Total Assets	0.10	0.11
X_4	MV of Equity / Total Liabilities	0.53	0.40
X_5	Sales / Total Assets	0.46	0.65
Z-Score	=	**1.24**	**1.45**

B. Modified Z-Score Calculations

- Black Hills Corporation

Black Hills Corporation (BKH)			
Variable	**Ratio**	***2012***	***2011***
X_1	Working Capital / Total Assets	-0.09	-0.03
X_2	Retained Earnings / Total Assets	0.13	0.12
X_3	EBIT / Total Assets	0.03	0.02
X_4	Additional P.I.C. / Total Liabilities	0.29	0.25
X_5	Dividends Paid / Sales	0.06	0.05
Z-Score	=	**0.42**	**0.37**

- GameStop Corporation

GameStop Corp. (GME)			
Variable	**Ratio**	***2017***	***2016***
X_1	Working Capital / Total Assets	0.12	0.08
X_2	Retained Earnings / Total Assets	0.43	0.46
X_3	EBIT / Total Assets	0.03	0.11
X_4	Additional P.I.C. / Total Liabilities	0.01	0.00
X_5	Dividends Paid / Sales	0.02	0.02
Z-Score	=	**0.86**	**1.13**

- Mattel, Inc.

Mattel, Inc. (MAT)			
Variable	**Ratio**	***2017***	***2016***
X_1	Working Capital / Total Assets	0.24	0.22
X_2	Retained Earnings / Total Assets	0.35	0.55
X_3	EBIT / Total Assets	-0.07	0.08
X_4	Additional P.I.C. / Total Liabilities	0.36	0.44
X_5	Dividends Paid / Sales	0.06	0.10
Z-Score	=	**0.84**	**1.64**

- Hasbro, Inc.

Hasbro, Inc. (HAS)			
Variable	**Ratio**	***2017***	***2016***
X_1	Working Capital / Total Assets	0.45	0.32
X_2	Retained Earnings / Total Assets	0.81	0.81
X_3	EBIT / Total Assets	0.16	0.15
X_4	Additional P.I.C. / Total Liabilities	0.30	0.31
X_5	Dividends Paid / Sales	0.05	0.05
Z-Score	=	**2.44**	**2.26**

- Vail Resorts, Inc.

Vail Resorts, Inc. (MTN)			
Variable	**Ratio**	***2017***	***2016***
X_1	Working Capital / Total Assets	-0.04	-0.07
X_2	Retained Earnings / Total Assets	0.13	0.20
X_3	EBIT / Total Assets	0.10	0.11
X_4	Additional P.I.C. / Total Liabilities	0.53	0.40
X_5	Dividends Paid / Sales	0.08	0.06
Z-Score	=	**0.85**	**0.87**

IV. Results

The purpose of this paper is to test the manipulation of the Altman Z-Score and its related accuracy in predicting failure with large-scale corporations. Of the five failed and five non-failed corporations that were tested, the modified Z-Score model provided substantial results as to indicating failure. As evident in the methodology, the modification placed the Z-Scores of the failed corporations further in the distress zone than the original Z-Score had. The non-failed corporations were tested with corporations in mind that could be leaning towards bankruptcy. Such corporations include Mattel, Hasbro, and GameStop. These companies were tested because of the possible effects due to the bankruptcy of Toys "R" Us and the immense success of online retailers like Amazon. The original Z-Score provided results in the safe zone. However, when tested with the modified Z-Score, results fell in the gray zone or the distress zone. These indications of failure need be taken with careful consideration, and should be looked at with more factors than just the Z-Score calculation.

Overall, the modified Z-Score model is found to be an accurate predictor. The Z-Score is an easy tool to gauge the financial health of a company. Managers can use it to target specific factors when making decisions to mitigate risk or produce optimal returns. Investors can easily evaluate companies and assess different financial ratios in doing so. According to Hill, "external viewers of financial ratios have the most experience in the investment perspective" (2012). Yet, user of the various Altman Z-Score models and the modified Z-Score model should be hesitant with the results. Based on financial data, the ratios can be skewed due to fraudulent accounting methods. Overstating earnings drives the Z-Score up, while overstating assets drives the score down. Retailers are often found to report negative working capital. Due to high inventory turnover, retailers often have the opportunity to use the revenues to grow the business before having to pay the vendor. This positive aspect of retailer operations affects the X_1 variable, driving the Z-Score down.

In conclusion, manipulation of the Z-Score model provides a more accurate predictor than the original Altman Z-Score model, but should not be the only tool used to predict corporate

failure. It is very important to interpret results with care, as they are only as accurate as the data that goes into it. Yet, the restrictions in this study such as the small sample size and lack of a wide diversity across industries are noted. In order to gain a better understanding of the predictive accuracy of the Altman Z-Score and various manipulations of the model, an exploration into the model would provide substantial results. Such exploration could include more variations of financial ratios used, another multiple discriminant analysis run to provide proper variable weighting in correlation to the ratios used, and a larger sample size to account for more sectors of industry.

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