Application and Comparison of Altman Models to Predict financial failure of Companies

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Abstract:

This research paper aimed to conduct a comparative analytical study between the original Altman model and his second revised model in predicting financial failure of companies. The study concluded that there is a difference in the results of applying Altman's models to predict financial failure, but the second revised Altman model is considered the best in predicting failure.

Joint stock companies listed on the Amman Stock Exchange during the three years prior to the event of liquidation and failure, with a rating accuracy of 86.67% compared to Altman's original.

Keywords: *financial failure; predicting financial failure; Altman models.*

1. INTRODUCTION

The issue of predicting the failure of companies is one of the topics that have attracted the attention of researchers, managers, analysts and other stakeholders, because of its importance in reducing failure and its negative effects on companies, investors and the economy as a whole. Because of the stumbling and failures of large companies in the economy, interest in predicting corporate failure began in the early thirties of the last century, researchers' interest in forecasting increased in the early 1960's at the hands of some researchers such as Beaver, Altman and other researchers,

Several methods of predicting financial failure and failure have emerged, perhaps the most prominent of which is Altman's Z-score model (1968),

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Which is known as one of the best models to predict the failure of companies, as Altman used in building his model a statistical method that was not popular at that time: the analysis of multiple discrimination, and the Altman model has proven its predictive ability and efficiency in many countries of the world. The model has been revised by Altman (1984) who has updated the parameters and adapted indices in different populations.

Hence, the problem of this research crystallized, represented in the extent of the effectiveness of Altman models (the original and the second) in predicting the failure of a sample of joint stock companies listed on the Amman Stock Exchange in a sufficient period of time to allow measures to be taken to correct their current position to move away from the risk of bankruptcy and liquidation.

This question is divided into the following questions:

- How effective was Altman's original model at predicting corporate failure?
- What is the ability of the revised Altman model (the second model) to distinguish between failed companies listed on the Amman Stock Exchange and those that failed?
- Is it possible to rely on Altman's two models to predict the failure of companies listed on the Amman Stock Exchange?
- What is the best model which able to predict the failure of joint stock companies listed on the Amman Stock Exchange?

Study hypotheses

Based on the study problem, the following hypotheses were formulated:

- Altman's original model can predict failure of failed companies within the three years preceding the event of liquidation;
- The second revised Altman models can distinguish between failed companies listed on the ASE and non-failed ones.
- The two Altman models can be relied upon to predict the failure of companies listed on the Amman Stock Exchange with a good and acceptable degree of accuracy.
- Altman's second revised model is the best and most capable model for predicting the failure of joint stock companies listed on the

Amman Stock Exchange.

the importance of studying

The study derives its importance from the importance of financial failure and its prediction by identifying the most effective model in predicting the failure of joint stock companies listed on the Amman Stock Exchange, which helps the management of these companies and their stakeholders to predict their future performance and the extent of their ability to continue, and the possibility of Altman's original model and his his second model to predict financial failure and which of these models can be used and relied upon at the Amman Stock Exchange.

Objectives of the study

This study aims to develop a theoretical framework in order to define financial failure and Altman's original model and his second revised model that he devised based on his review of the original model, also to indicate the degree of validity and suitability of Altman models for application in companies listed on the Amman Stock Exchange.

Study Approach

The researcher relied on the use of the experimental and descriptive analytical method in conducting the study, as it is one of the most used methods in social and human studies, with the aim of studying the ability to predict the failure of companies using Altman's quantitative models to predict on companies listed on the ASE. To collect the study data, the researcher relied on the annual financial reports of the companies published on the Amman Stock Exchange website for the period from 2011 to 2018.

2. The theoretical framework of the study

2.1. The concept of financial failure:

Many financial and accounting researchers disagreed about the definition of financial failure, and became there are many concepts and terminology associated with this concept, which made the views of those interested in determining the stages and types of failure, some of them believe that financial failure means the failure of the institution to pay its obligations at maturity, and others believe that it means the institution to stop paying its debts due to insufficient Liquid assets to cover their financial obligations.

The concept of failure has been associated with the economic researcher Beaver, who is the first to use this term to indicate the beginning of the institution to reach bankruptcy, where it is defined as "the inability of a firm to pay its financial obligations as they mature. Operationally a firm is said to have failed when any of the following events have occurred: bankruptcy, bond default, an overdrawn bank account or non-payment of a preferred stock dividend ". (Castagna & Matolcsy, 1981, p. 31)

However The researcher Deakin sees the failed companies "only included those firms which experienced bankruptcy, insolvency, or which were otherwise liquidated for the benefit of creditors in his default analysis". (Weiying, 2008, p. 06)

Altman also briefly defined corporate failure as "a company that is legally bankrupt and placed in liquidation". (Coelho, 2014, p. 23)

Blum defines it as "events signifying an inability to pay debts as they come due, entrance into a bankruptcy proceeding, or an explicit agreement with creditors to reduce debts". (Blum, 1974, p. 03)

Also it can be defined as "the condition of a firm when it is unable to meet its financial obligations to its creditors in full. it is deemed to be legally bankrupt and is usually forced into insolvency liquidate". (Berryman, 1983, p. 49)

Based on previous definitions of financial failure, a comprehensive definition consistent with the requirements of the study can be formulated as follows: Financial failure is a financial situation that does not occur suddenly but is the result of a set of accumulations and complications that start from a certain situation, and a certain degree of liquidity shortage, which develops in the absence of attention from a bad situation to a worse situation, to the point where available financial resources are unable to meet obligations owed to creditors, and usually the institution is forced to liquidate.

2.2. Development of Altman's Z score Model

In 1968, Edward Altman published what has become the best known predictor of bankruptcy. This predictor is a statistical model that combines five financial ratios to produce a product called a Z-score. The model has proven to be a dependable instrument in forecasting failure in a diverse mix

of business entities Altman (Altman E. , 1968). Altman's original model is calculated as:

$$\mathbf{Z= 0.012X1+0.014X2+0.033X3+0.006X4+0.999X_5}$$

Working capital/total assets (X_1) is a measure of liquid assets in relation to the firm's size.

Working capital is simply the excess of current assets over current liabilities. In accounting, assets are considered current if they are expected to be converted into cash or used within one year or one operating cycle of the company if it is longer than one year. Examples of current assets include cash, accounts receivable, and inventories. Similarly, current liabilities are obligations the firm expects to settle within one year or one operating cycle. The most typical current liabilities are short-term debt and accounts payable (Chuvakhin & Gertmenian, 2003, p. 02). Altman's research finds this ratio to be more helpful than other liquidity ratios, such as the current ratio or the quick ratio. (Heine, 2000, p. 10)

Retained earnings/total assets (X2) represent a measure of cumulative profitability reflecting the firm's age as well as its earning power. A history of profitable operations and reduced debt is signified by firms that retain earnings or reinvest operational profits. Low retained earnings may indicate a poor business year or reduced longevity for the firm. According to Dun and Bradstreet, 50% of businesses fail within the first five years of operation (Heine, 2000, p. 11). A measure of an organization's operating efficiency separated from any leverage effects is a true depiction of asset production. Represented as earnings before interest and taxes/total assets (X3), this ratio estimates that cash supply available for allocation to creditors, the government, and shareholders. Altman classifies the ratio as a superior measure of profitability that is better than cash flow.

Altman defines the market value of equity, or market capitalization, as a summation of both preferred and common stock or market value of equity/book value of total debt (X4). The stock market, the primary estimator of a firm's worth, suggests that price changes may foreshadow pending problems if a firm's liabilities exceed its assets. Altman believes this ratio is

a more effective financial distress predictor than net worth/total debt (book values).

The next ratio, sales/total assets (X5) signifies a standard turnover measure that unfortunately varies from one industry to another. Yet, the ratio is an indicator of a firm's efficient use of assets to create sales (Chuvakhin & Gertmenian, 2003, p. 03). Altman has defined this as ".....one measure of management's capacity in dealing with competitive conditions" (Heine, 2000, p. 12). Finally, Eidleman (1995) explains the applicability of the previously discussed ratios. Specifically, Eidleman states "Each of these ratios is multiplied by a predetermined weight factor, and the results are added together. The final number -the z-score- will yield a number between -4 and +8. Scores that add to a z-score<1.81 have a high probability of bankruptcy, while scores>2.67 represent financial soundness. The gray area or zone of ignorance exists when firms have z-scores between 1.81 and 2.67. (Eidleman, 1995, p. 52)

Altman's pioneer study is based on a sample of 66 publicly traded, manufacturing firms. Thirty-three of the firms had filed for bankruptcy and all had assets over $1 million. His model correctly predicts financial failure for 95% of the firms, one year prior to their demise. Accuracy decreases to 72% two years out and to 52% three years prior to insolvency (Altman, 1968). Type I errors, those that predict a bankruptcy that does not occur, are shown for 6% of the firms analyzed. Type II errors also were shown for 6% of the firms analyzed. Type II errors predict a solvent firm that files bankruptcy. (Altman & Hotchkiss, 1993)

In 1983, Altman developed a revised Z-score model for privately held firms. "Credit analysis, private placement dealers, accounting auditors, and firms themselves are concerned that the original model is only applicable to publicly traded entities (since X4requires stock2 price data)" (Altman & Hotchkiss, 1993, p. 202). The revised Z-scores substitute the book value of equity for the market value in X4. The new Z-score model ratios are listed below:

X1= Working capital/total assets

X2= Retained earnings/total assets

X3= EBIT/total assets

X4= book value of equity /total liabilities

X5= Sales/total assets

A change in the weight factor is also calculated.

The revised Z-score formula follows:

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

Cut off scores are also adjusted so that scores of <1.23 indicate bankrupt firms and scores of >2.90 are indicators of non bankrupt firms. Firms with scores between 1.23 and 2.90 are determined to exist in the grey area or zone of ignorance. Altman's new sample produces similar results as the original Z-score model, indicating 90.9% accuracy in bankruptcy forecasting at least one year prior to actual failure. Firms with scores over 2.90 have a 97% chance of continuing operations with financial health. (Sanobar, 2012, pp. 214-217)

Table1 illustrates Altman's prediction failure models.

Table 1. Altman's Z-Score Models**.**

Coefficients Variables	**Original Model (1968)**	**Revised Model (1983)**
X	1.21	0.717
X	1.41	0.847
X	3.30	3.107
X	0.60	0.42
X	0.999	0.998
Constant	-	-
Cutoff scores		
Bankrupt firms	<1.81	<1.23
Non Bankrupt Firms	>2.67	>2.90
Grey Area	1.81-2.67	1.23-2.90

Source: Prepared by the researcher.

In Conclusion, Altman's revised Z-score model is one of the most effective Multiple Discriminant Analysis, which has been researched

throughout the last 40 years. Altman's Model has being used in various industries to predict bankruptcy. Researchers have used Altman's Z score model in the service industry, manufacturing industry, publically listed companies, and banks alike to predict if the business will have a downfall. It can be safely said that Altman's Z score Model can be applied to modern economy to predict distress and bankruptcy one, two & three years in advance.

3. Applied side of the study

3.1. The study population

The study population consists of all the public shareholding companies listed on the ASE. The number of companies in the study community reached 195 companies according to the ASE website in 2018 (https://www.exchange.jo/en).

3.2. Sample study

The study sample was selected from the study population, where we divided the study sample into two groups, the first group was the failed companies and the second group was the non- failed companies, whose financial data are available during the study period (2011, 2018). Failure companies were selected from a total of ninety-five (195) companies present in the study population, this selection was in accordance with the criteria of failure in our study, which was represented in the companies that stopped practicing the activity, which were liquidated, and were taken according to the location of the Securities Depository Center.

While fifteen non- failed companies were selected to meet the number of failed companies, this choice was according to companies that have not stopped their activities and have not been liquidated, which have achieved profits during the last three years, and was taken at random while trying to diversify sectors excluding the financial sector.

3.3. Apply the original Altman original form to the joint stock companies listed on the Amman Stock Exchange

The main variables of the study are the financial ratios of the Altman model (independent variables), while financial failure is the dependent variable. The results of applying this model to the study sample are as

follows:

Table 2. Altman original model results for failed and non-failed companies**.**

number	Company code	Arithmetic mean of Z	Company Status	The result
01	JOWL	0.21	Failed company	Achieve
02	AJFM	0.26	Failed company	Achieve
03	JOTN	0.04	Failed company	Achieve
04	ICER	0.40	Failed company	Achieve
05	AREN	0.03	Failed company	Achieve
06	UNIC	0.74	Failed company	Achieve
07	GLCI	0.09	Failed company	Achieve
08	FNVO	0.27	Failed company	Achieve
09	AMAN	0.02	Failed company	Achieve
10	IENG	0.07	Failed company	Achieve
11	JOCF	-0.01	Failed company	Achieve
12	PRED	5.91	Failed company	Not Achieve
13	UNIF	-1.01	Failed company	Achieve
14	DKHS	0.59	Failed company	Achieve
15	AMDI	0.19	Failed company	Achieve
16	GENI	0.38	Non-Failed company	Not Achieve
17	JODA	1.14	Non-Failed company	Not Achieve
18	RMCC	0.63	Non-Failed company	Not Achieve
19	APOT	56.04	Non-Failed company	Achieve
20	ICAG	0.62	Non-Failed company	Not Achieve
21	UMIC	1.29	Non-Failed company	Not Achieve
22	AIFF	0.59	Non-Failed company	Not Achieve
23	NATA	0.58	Non-Failed company	Not Achieve

24	NAST	2.17	Non-Failed company	Can not be judged
25	JOWM	0.21	Non-Failed company	Not Achieve
26	MANE	2.11	Non-Failed company	Can not be judged
27	JTEL	0.55	Non-Failed company	Not Achieve
28	TAJM	0.12	Non-Failed company	Not Achieve
29	JOHT	0.66	Non-Failed company	Not Achieve
30	JOEP	0.94	Non-Failed company	Not Achieve

Source: Prepared by the researcher based on the financial statements of the study samples during three years.

The above table shows the results of applying the Z-score to the failed and non- failed companies. What can be seen from the failed companies is that all of them have deteriorated in the three years that preceded the liquidation based on the average Z values obtained, UNIF was the most degraded company, with results showing the failure of the organization over the three years preceding the liquidation, followed by JOCF and AMAN.

The results of the previous table also show that the model was able to predict the failure of all companies over the three years prior to the liquidation, except for the PRED company, which predicted the model safety during the years of study

As for the non- failed companies, it is clear from the previous table that Altman model predicted failure in all years of study except APOT, which considered the model sound throughout the years of study, as well as NAST and MANE, which show the difficulty of determining their position during the three years before liquidation, and through these results we conclude Two things:

- There are signs of financial failure in sound companies that are not referred to liquidation and do not disclose them;
- the model does not achieve the desired results when the company is sound and not threatened by financial failure;

3.4. Apply the Altman Revised model to the joint stock companies listed on the Amman Stock Exchange

The main variables of the study are the financial ratios of the Altman model (independent variables), while financial failure is the dependent variable. The results of applying this model to the study sample are as follows:

Table 3. Altman Revised model results for failed and non-failed companies.

number	Company code	Arithmetic mean of Z	Company Status	The result
01	JOWL	-4,51	Failed company	Achieve
02	AJFM	0,66	Failed company	Achieve
03	JOTN	-1,97	Failed company	Achieve
04	ICER	2,88	Failed company	Can not be judged
05	AREN	-2,33	Failed company	Achieve
06	UNIC	3,7	Failed company	Not Achieve
07	GLCI	-2,15	Failed company	Achieve
08	FNVO	-0,96	Failed company	Achieve
09	AMAN	-1,04	Failed company	Achieve
10	IENG	-0,24	Failed company	Achieve
11	JOCF	-6,03	Failed company	Achieve
12	PRED	1210,48	Failed company	Not Achieve
13	UNIF	-187,27	Failed company	Achieve
14	DKHS	0,87	Failed company	Achieve
15	AMDI	-3,46	Failed company	Achieve
16	GENI	13,7	Non-Failed company	Achieve
17	JODA	8,42	Non-Failed company	Achieve
18	RMCC	3,27	Non-Failed company	Achieve
19	APOT	11675,87	Non-Failed company	Achieve
20	ICAG	4,53	Non-Failed company	Achieve
21	UMIC	18,99	Non-Failed company	Achieve

22	AIFF	124,84	Non-Failed company	Achieve
23	NATA	4,31	Non-Failed company	Achieve
24	NAST	8,2	Non-Failed company	Achieve
25	JOWM	24,61	Non-Failed company	Achieve
26	MANE	7,6	Non-Failed company	Achieve
27	JTEL	5,97	Non-Failed company	Achieve
28	TAJM	2,58	Non-Failed company	Can not be judged
29	JOHT	19,11	Non-Failed company	Achieve
30	JOEP	3,28	Non-Failed company	Achieve

Source: Prepared by the researcher based on the financial statements of the study samples during three years.

We note from Table (03) that the number of companies that achieved Altman's revised model in terms of predicting financial failure and referral for liquidation has reached twelve (12) companies out of fifteen (15) companies, which were included in the study sample and were referred to liquidation, and they are represented in companies No. (01, 02, 03, 05, 07, 08, 09, 10, 11, 13, 14, 15), while the results of the Altman revised model were not achieved by the two companies (06, 12) of the companies referred to liquidation, as for company No. (04) it was found that it was difficult to judge it as failure or success according to the model, and the number of companies that achieved Altman revised model in terms of showing that there were no threats to financial failure and not being referred for liquidation reached fourteen (14) companies out of fifteen (15) companies that was included in the study sample, and was not subject to liquidation, represented by companies No. (16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29, 30), whereas Altman's model at the company No. (28) could not judge whether it was a failure or a success and that out of fifteen (15) companies not referred to liquidation.

Thus, the total number of companies that achieved the model is twenty-six (26) companies out of thirty (30) companies that are referred and not transferred to liquidation, the total number of companies that did not fulfill

the model would be two (02) in addition to two (02) companies that he could not judge if they were unsuccessful or successful out of thirty (30) companies that were referred and not referred to liquidation.

In order to evaluate the effectiveness of the two models, a good rating of the models must be calculated, which reflects the percentage of healthy (non-failed) companies, which are correctly classified within the healthy (non failed) group of companies, and also the percentage of failed companies, which are correctly classified within the failed group of companies, this can be illustrated in the following table:

Table 4. Accuracy Ratio.

Altman Models	Company	**Failed**	**Non-failed**	**Can not be judged**
Original Model (1968)	**Failed**	14 (93.33%)	01 (6.67%)	-
	Non-failed	12 (80%)	1 (6.67%)	02(13.33%)
Revised Model (1983)	**Failed**	12(80%)	02(13.33%)	01(6.67%)
	Non-failed	0	14 (93.33%)	01(6.67%)
Accuracy Ratio				
	Original Model (1968)		**Revised Model (1983)**	
	Number of companies that achieved the model and its percentage: 15 by 50%		Number of companies that achieved the model and its percentage: 26 by 86.67%	
	Number of companies that did not achieve the model and its percentage: 13 by 43.33%		Number of companies that did not achieve the model and its percentage: 02 by 6.67%	

Source: Prepared by the researcher based on the results of the application of Altman models.

We notice from Table No. (04) that the percentage of healthy (non-failed) companies that were classified as healthy (non-failed) according to Altman's models are : 6.67%, 93.33%, respectively, as for the percentage of healthy

(non-failed) companies that Failed according to Altman's models are : 80%, 0%, respectively. which indicates and confirms that the original Altman model (first model) does not achieve the required results when the company is healthy (non-failed) and not threatened with financial failure compared to the revised model (second model) that show is the most capable of classifying these companies within three years before liquidation.

As for the percentage of failed companies that were classified as failed according to Altman's models: 93.33%, 80%, respectively, and for the percentage of failed companies that classified sound (non-failed) according to Altman models: 6.67%, 13.33%,respectively. it can be said from these ratios that Altman's original model has a lower ability to classify failed companies during the three years before liquidation compared to other model that achieved good accuracy ratios.

In general, the good rating percentage for all companies using Altman models is : 50%, 86.67%, respectively, which are considered good and acceptable ratios for the classification of public joint-stock companies listed on the Amman Stock Exchange.

We conclude from the foregoing that Altman's second revised model was the best and the most capable of predicting the failure of joint stock companies listed on the Amman Stock Exchange among the original model, as it succeeded to some extent in predicting financial failure with greater accuracy, and this is an indication that the model reflects the financial difficulties or changes that the company is going through as acceptably threatening financial failure.

4. Conclusion

In this research, we have tried to identify the effectiveness of the Altman models for public shareholding companies listed on the Amman Stock Exchange in predicting the failure of a sample of these companies on this stock exchange, in addition to specifying the ability of the models to give an early warning of companies failure to make the necessary corrections to avoid the risk of bankruptcy and failure.

After applying the model to the study sample, we reached the following results:

- The results obtained by applying Altman's two financial failure prediction models to the studied joint-stock companies vary, although these models were applied to the data and the same period;
- The study showed the weakness of the original Altman model to predict the failure of joint stock companies listed on the Amman Stock Exchange during the years preceding the liquidation event, as the classification accuracy rate reached only 50%;
- The study demonstrated the ability of Altman's revised model (second model) to predict the failure of joint stock companies listed on the Amman Stock Exchange during the years preceding the liquidation event with a good and acceptable degree of confidence, as the classification accuracy ratio reached: 86.7%.
- The study found that Altman's second revised model is the best to predict the failure of companies during the three years preceding the reality of liquidation and failure, and this is an indication that the model reflects any financial difficulties or changes that the company is going through as threatening financial failure, and that it can be relied upon in judging The financial position of the companies with a good degree of confidence.

light of the above, the study recommends the following:

- The necessity to use Altman's second revised model in predicting financial failure, as it has proven successful and with a good degree of confidence as an indicator to predict financial failure, in addition to using another model of financial failure models to verify results;
- Conducting more studies and research in this field and trying to build a model to predict failure for companies listed on the Amman Stock Exchange.
- Preparing new studies that include other independent variables that have proven successful in predicting financial failure.
- The need to increase transparency and disclosure in the financial statements and reports, in order to communicate information to all interested parties;

- Pay attention to the topic of forecasting financial failure and complete the necessary research on this subject in order to protect companies that are annually exposed to financial failure and the specter of bankruptcy and liquidation.

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