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Using Discriminant Analysis for Building a Model to Predict Corporate Financial Failure

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Abstract:

Companies face the risk of financial failure, which led to the emergence of the need to constantly study the phenomenon of financial failure. Whereas, models of financial failure based on financial ratios circulated in financial analysis have been developed and reached remarkable results in predicting financial failure long before its occurrence, and the study was continued on the models to predict financial failure until the Edward Altman discriminatory model was reached in 1968, which is considered the best model so far.

In this research, a model was built to predict financial failure and compared it with Altman's model in terms of the strength of discrimination. Hence, the model that was built showed that it has a greater discrimination strength than the Altman model when applying them on the same data. In which the percentage of correct classification reached 94.12% of the proposed model, while the percentage of correct classification was 88% for the Altman model, and that the proposed model does not include a gray area in the classification as in the Altman model, but rather classifies all vocabulary into successful and failed.

Key words: Quantitative models, Financial failure, Discriminant Analysis, Classification, Altman model.

الملخص:

تواجه الشركات خطر الفشل المالي مما ادى الى ظهور الحاجة الى دراسة ظاهرة الفشل المالي باستمرار، حيث تم تطوير النماذج الخاصة بالفشل المالي المعتمدة على النسب المالية المتداولة في التحليل المالي وقد توصلت الى نتائج ملحوظة في التنبؤ بالفشل المالي قبل حدوثه بمدة زمنية، وتم الاستمرار في دراسة النماذج للتوقع بالفشل المالي حتى تم التوصل الى نموذج ادوارد التمان التمييزي، والذي يعتبر النموذج الافضل لحد الان.

من خلال بحثنا هذا تم بناء نموذج تمييزي للتنبؤ بالفشل المالي ومقارنته مع نموذج التمان من حيث قوة التمييز، وقد ظهر من خلال النموذج الذي تم بناؤه ان له قوة تمييز اكبر من قوة تمييز نموذج التمان عند تطبيقهما على نفس البيانات، حيث بلغت نسبة التصنيف الصحيح 94.12 %للنموذج المقترح، بينما بلغت نسبة التصنيف الصحيح 88 %لنموذج التمان، وان النموذج المقترح لا يتضمن منطقة رمادية في التصنيف كما في نموذج التمان وانما يصنف جميع المفردات الى ناجحة وفاشلة .

الكلمات المفتاحية: النماذج الكمية، الفشل المالي، التحليل التمييزي، التصنيف، نموذج التمان.

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پوختە:

کۆمپانیاکان ڕووبەڕووی مەترسی شکستی دارایی دەبنەوە، ئەمەش بووەتە هۆی ئەوەی کە پێویستی بە بەردەوامی لێکۆڵینەوە لە دیاردەی شکستی دارایی هەبێت، مۆدێل بۆ شکستی دارایی لەسەر بنەمای ڕێژەی دارایی کە لە شیکاری داراییدا بەکاردەهێنرێت پەرەی پێدراوە، و ئەنجامە سەرنجڕاکێشەکان لە پێشبینیکردنی شکستی داراییدا بەدەست هاتووە a توێژینەوەکە بەردەوام بووە مۆدێلەکان بۆ پێشبینیکردنی شکستی دارایی تاوەکو مۆدێلی جیاکاری ئێدوارد ئاڵتمان گەیشتوە، کە تا ئێستا بە باشترین مۆدێل دادەنرێت.

لە ڕێگەی لێکۆڵینەوەکانمانەوە مۆدێلێکی جیاکاری دروستکرا بۆ پێشبینیکردنی شکستی دارایی و بەراورد کرا لەگەڵ مۆدێلی ئاڵتمان لە ڕووی هێزی جیاکارییەوە، لە ڕێگەی ئەو مۆدێلەی کە دروستکرابوو دەرکەوت کە هێزێکی جیاکاریی زیاتری هەیە لە مۆدێلی ئاڵتمان کاتێک بۆ هەمان مۆدێل جێبەجێ دەکرێت داتاکان، بەو پێیەی ڕێژەی سەدی پۆلێنکردنی دروست گەیشتە 94.12 % بۆ مۆدێلی پێشنیارکراوی، لە کاتێکدا ڕێژەی سەدی پۆلێنکردنی دروست 88% بوو بۆ مۆدێلی ئاڵتمان، و مۆدێلی پێشنیارکراوی ناوچەیەکی خۆڵەمێشی لە پۆلێنکردندا وەک لە مۆدێلی ئاڵتماندا ناگرێتەوە، بەڵام بەڵکو هەموو بابەتەکان پۆلێن دەکات بۆ سەرکەوتوو و شکستخواردوو.

کلیلە وشە: مۆدێلی چەندایەتی، شکستی دارایی، شیکاری جیاکاری، پۆلێنکردن، مۆدێلی ئاڵتمان.

1-1 Introduction

The current business environment in general is characterized by being a complex and rapidly changing environment, in which political, economic, social and competitive factors overlap to a large extent. With the passage of time, the financial world is exposed to increasing and diversified risks, and companies face the risk of financial failure constantly, and thus have occupied many bodies and organizations International threats of financial failure to include additional institutions such as banks, investors and financial departments as well as government agencies.

The interest in financial failure was increased by the bankruptcy events that occurred in many companies and banks, especially what happened to American financial institutions, which caused severe damage to the global economy, and hence the need to study the phenomenon of financial failure. Since the sixties of the last century, a large group of studies and researches has emerged, those that have developed models for financial failure based on the financial ratios circulated in the financial analysis. And it has reached remarkable results in predicting financial failure well in advance of its occurrence. Then reducing the possibility of the risk occurrence and the possibility of taking the necessary corrective actions. And the possibility of taking the necessary corrective measures in the career of the company before its bankruptcy, as the financial failure does not happen suddenly. Accordingly, the institution must pass before it reaches the peak of financial failure in several passable stages, which distinguishes it from other non-failed institutions, and thus many researchers directed their attention to find models that helps to distinguish between failed and non-failed institutions according to the characteristics of failed and non-failed institutions. At least in the year preceding the failure, which must be clearly distinguished from non-failed institutions. Where the failure models currently used were reached after extensive studies until reaching the Edward Altman (Z -Score) discriminatory model in 1968. Although the multiplicity of models, the relevant opinions tended to Altman's model, being relatively close to accuracy. [3]

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This research aims to present the most important methods of predicting financial failure and to clarify the Altman model and then build a new special model for predicting financial failure. Where depends on the applying the foundations of statistical theory, in particular discriminant between two groups and comparing the model that is built with the Altman model in terms of the possibility of discrimination and predicting corporate failure by finding the correct rating ratio for the Altman model and the model to be built.

The research problem is that the financial risks to which the companies are exposed, and this may be as a weakness in the awareness of many companies of the risks of their exposure to future financial failure and the inability of the financial ratios individually to provide correct and accurate results for the company's financial position without comparison with other companies, especially Corresponding companies. Furthermore, single analysis may lead to shady information and results that cannot be relied on or used in judging the company's future. Still, with an increase in the number of companies that achieve successive losses and thus lead unequivocally to financial failure. On the other hand, there are many quantitative models specialized in predicting financial failure, but these models do not give accurate descriptions of the financial position of companies. Yet, there are successful companies within the description of a particular model, and the companies themselves are described as failures within another model, which raises many questions about the effectiveness of many models in describing the company's financial condition.

This research can provide two types of benefits, the first benefit is a scientific benefit and the second is a practical benefit, so can say:

When observe the financial theory, find that its quantitative aspect is incomplete in construction. Despite the relatively large number of completed researches, and that many applications lead to different results, including models of financial failure, and based on that, the contradiction of research results always creates the need to continue research by giving great importance to any research conducted in this direction. Not to mention from the other practical point of view, which is the amount of interest obtained by the company itself by determining the possibility of relying on models for predicting financial failure. As well as, the other beneficiaries such as administrations, investors, banks, creditors, auditors, etc., all These and other stakeholders feel and perceive the importance of such research affecting the level of companies and the national and global economy, as through this it is possible to anticipate and predict economic crises as such research is a type of early warning.

Where the research hypotheses are that there are significant differences between the averages of the two groups, while they have one common covariance matrix, and that the studied discriminatory variables have significant effects in the discrimination model. The research follows the deductive analytical approach by applying the foundations of statistical theory in building a model or a linear discrimination function by which we can predict failed companies, or classify companies into failed and successful companies.

The research is based on positivist philosophy as it displays and compares an existing observable phenomenon, and the case in question (financial failure) is mostly controversial, as there was no agreement in previous studies on the results that were drawn in the applications of quantitative models to predict financial failure. {[1],[5] ,[11]}.

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Study by (Afraa, 2015) used multiple discriminant analysis to classify the stages of chronic renal failure disease through a study of a sample size (322), where discrimination functions were built that include the variables with moral influence and according to their importance in distinguishing. [2]

In (Edward, 1972) study, four models were built to predict failure for companies operating in Taiwan, multiple discriminant analysis (MDA), as well as artificial neural networks (ANNS) were used. Thus, the study recommended that the study models can be used to help investors, creditors, managers, auditors and regulators in Taiwan to predict the possibility of business failure. [9]

Study (Beaver, 1966) defined the financial failure in his study of financial ratios, and failure is the inability of the institution to meet its financial obligations on their due dates. Beaver relied on financial ratios in developing a model. He applied it to 79 failed companies and 79 other non-failed companies, testing 30 financial ratios to reach the best financial ratios in predicting financial failure. [4]

1-2 Theoretical framework

1-2-1 Financial failure

Financial failure occurs when there are operations for the institution followed by the assignment of the company's property in favor of the creditors, or a loss occurs after failed operations. Or the company's inability to recover the mortgaged property and capture its property before passing judgment on it, or that the company's property is placed under guard and settlement procedures take place between the company and its creditors. Thus, failure is the process in which the institution has begun to walk the path that leads to financial hardship. In addition, financial failure is the process that results from the interaction of many causes and factors and in a period of time not short to reach the state of inability to pay the existing financial obligations and the inability to obtain other new obligations accompanied by the loss of financial, monetary and operational balance. However, it is possible to classify the financial failure of companies into two categories: {[7], [9], [10]}.

The first category: economic failure, which measures success or failure based on the amount of return on capital. According to that, companies are considered failed if they fail to achieve the appropriate return in comparison to the invested capital in proportion to the expected risks.

The second one, is that financial failure in which the company is unable to pay its financial obligations when they become due.

The term financial failure cannot be considered accurate in providing a clear description of the financial situation that the company is going through, as it mixes the financial meanings and the legal meanings of bankruptcy and financial default.

Thus, the financial failure is directly related to the company's ability to meet its obligations represented by the inability of the company's returns to cover all costs, including the cost of capital financing, and the inability to achieve a return commensurate with the risks is also a form of financial failure or one of its many types.

There is almost agreement between the stakeholders on the results of the relevant financial indicators, which are: [8]

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- Excess current liabilities over assets or current assets.
- Inability to pay off long-term loans.
- The appearance of the basic financial ratios results with negative results.
- Delaying or not distributing profits at all.
- Inability to pay creditors on time.
- Inability to fund new or innovative product development projects.

This is in addition to the operational indicators represented by various financial phenomena, including but not limited to: [12]

- The loss of leading administrators without replacing them with others of the same level.
- Loss of a major or important market.
- Loss of a major resource without a replacement.
- Poor processing in general.

1-2-2 Discriminant between two groups

Discriminant analysis is one of the multivariate analysis methods that are concerned with separating different groups of observations into previously defined groups. However, the classification process is a subsequent process of building model or discriminative function. Where this function is relied upon to classify the new vocabulary of one of the groups under study with the lowest possible classification error.

There are several types of discriminant analysis models in this research will focus on the (Linear Discriminant Function-two groups), which is known as the (Fisher Function).

When two independent random samples are drawn, the first with a size (n_1) from a population with a normal distribution with (p) variables with a mean (μ_1) and the second with a size (n_2) from a population with a normal distribution with (p) from variables with a mean (μ_2) and a var-covariance matrix ($\sum$). If the goal is to find a structure, function, or linear model that represents the observations from the two groups, it is intended to discriminant between the two populations by using some scale, which gives the best discrimination or classification. [15]

Assuming that ($\bar{x}_1$) ($\bar{x}_2$) are the means of the first and second samples respectively, and that S is a pooled estimate (Σ) of the two samples, then we will determine the values of the coefficients vector for the indicator ($\underline{b}'$ x) and the distribution of ($\underline{b}' x_i$) will be:

$$\underline{b}'\,\underline{xi} \sim N\,(\underline{b}'\,\underline{\mu i},\ \underline{b}'\Sigma\underline{b})$$

Or

$\underline{b}'$ S $\underline{b}$ = I

By using the Lacrange multiplier in the function

$$\frac{n1n2}{n1n2}\,[\acute{b}(\bar{x}1 - \bar{x}\,2\,]2 - \lambda\ \acute{b}\ s\,b - 1) \quad \text{---------- (1)}$$

And by derivation with respect to ($\underline{b}$) can get:

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$$\frac{n1n2}{n1n2}](\bar{x}1 - \bar{x}2)(\bar{x}1 - \bar{x}2) - \lambda s)\, b = 0 \quad \text{----------(2)}$$

$$\lambda = \frac{n1n2(\bar{X}1-\bar{X}2)(\bar{X}1-\bar{X}2)'}{(n1+n2)\acute{b}\, s\, b} = \frac{n1n2}{n1+n2}\frac{[b\ (\bar{X}1-\bar{X}2)]2}{\grave{b}\, s\, b} \quad \text{-- ---------(3)}$$

Note that λ can be defined as the nonzero root of the characteristic equation

$$|s^{-1}(\bar{x}_1-\bar{x}_2)(\bar{x}_1-\bar{x}_2)'\, n_1\, n_2 / n_1+n_2 - \lambda I| = 0 \text{ ----------(4)}$$

$$\lambda = n_1n_2 / n_1+n_2\, (\bar{x}_1-\bar{x}_2)'\, s^{-1}(\bar{x}_1-\bar{x}_2) = T^2 \text{ ----------(5)}$$

$$F = n_1+n_2-P-1 / P(n_1+n_2-2)\, T^2 \sim F\, P, n_1+n_2-p-1 \text{ --- (Hoteling T)}$$

It is also noted that the only solution to $\underline{b}$ that satisfies the two equations

$$\underline{b} = s^{-1}(\bar{x}_1 - \bar{x}_2) \text{ ----------(6)}$$

And the linear discriminant function (Fisher function) is:

$$Z = \underline{\acute{b}}\ \underline{x} = (\bar{x}_1 - \bar{x}_2)\ '\ s^{-1}\underline{x} \text{ ----------(7)}$$

$$Z = b_1x_1 + b_2x_2 + b_3x_3 + \ldots\ldots + b_kx_k \text{ ----------(8)}$$

The discriminant function be:

$$D = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots\ldots + b_kx_k \text{ ----------(9)}$$

1-2-3 Classification

If there are two groups (G_1, G_2) and each of them has a probability density function (p. d. f) which is $f(X/G_2)$ $f(X/G_1)$, and that (P_1, P_2) are prior probability for the first and second set, respectively, and the trend of observations ($\underline{x}$) comes from the population (G_1, G_2) respectively. The posterior probability that ($\underline{X}$) belongs to (G1) is:{ [16] ,[4] }

$$P(G_1/x) = P_1*f(x/G_1) / \{p_1*f(x/G_1) + p_2*f(x/G_2)\} \text{ ----------(10)}$$

Assuming that f (x/G_1 , f (x/G_2)) are multivariate normal distribution functions and assuming that the covariance is equal ($\sum_1 = \sum_2 = \sum$):

$$(f(x/G_1) \sim NP(\mu_1, \Sigma)$$
$$(f(x/G_2) \sim NP(\mu_2, \Sigma)$$

Thus, the posterior probability for the observation (X) is to belong to the group (G_1) is:

$$\Pr(G_1/x) = e^z / 1+e^z \text{ ----------(11)}$$

And the posterior probability of the same observation if it belongs to the second group (G_2) is:

$$1-\Pr(G_1/x) \text{ ----------(12)}$$

Classified the observation as the highest probability.

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1-2-4 Altman model (Z-score)

The work done by Professor of Finance at New York University, Edward Altman in 1968, is one of the first and most important works among research and attempts that went beyond the old traditional method of financial analysis. The method used by previous scholars in their attempts to predict the failure of economic institutions, relying on simple statistical methods in analyzing financial ratios or choosing one ratio believed to be the best in distinguishing between failed and non-failed institutions.

In his research which titled (Discriminatory Analysis and Predicting Corporate Bankruptcy) where he defined bankrupt institutions as those that were declared bankrupt and placed under receivership or who were reorganized according to the terms of the applicable bankruptcy law.

What Altman did was characterized by using a more complex statistical model (discrimination between groups), which is a method of linear Multiple Discriminant Analysis (MDA). As Altman, after defining groups and identifying discriminative variables, by derives a linear discriminant equation consisting of independent discriminant variables, which considered the best in distinguishing between groups, and the importance of each of these variables in distinguishing between the two groups is shown through discriminatory coefficients. Where in this work can find two groups, which are bankrupt economic institutions and non-bankrupt economic institutions. As for the characteristics or independent discriminatory variables, they are the financial ratios. As well as, this model allows the use of a set of independent variables together, which are the financial ratios, to determine the extent of their ability to predict failure, The study included a randomly selected sample of economic institutions that were declared bankrupt between 1964 and 1965. Then another group of economic institutions was selected to compare with them, but they are not bankrupt. This selection was based on the quality of the industry and the size of the assets and the availability of data. The studied sample consists of 66 economic institutions divided into two groups, the first consisting of 33 non-failed institutions and the second group consisting of 33 failed institutions. Then Altman chose 22 financial ratios, which are the independent variables, and they deal with the most important financial dimensions, such as liquidity ratios, profitability, financial leverage and activity ratios. Thus, his choice of these financial ratios was built on the basis of their prevalence in the financial literature and their potential relationship to the subject of the study, as these financial ratios were classified into 5 categories: (Liquidity, Profitability, Financial leverage, The ability to pay off short-term obligations, and Activity). {[14] ,[9]}

The developed discriminatory equation that he reached was as follows:

$$Z = 1.2\ X_1 + 1.4\ X_2 + 3.3\ X_3 + 0.6\ X_4 + 1.0\ X_5 \text{ ----------(13)}$$

This model is known as the Z-Score model (Altman, 1968), which is a model that includes 5 basic variables, which are financial ratios that consist of the following:

X_1 Net working capital / Total assets
X_2 Retained Earnings / Total Assets
X_3 Earing before interest and taxes / total assets
X_4 Market value of quality / total liabilities

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X_5 Sales / Total Assets

When the Z value goes up, it indicates the safety of the company's financial position, while the low value of Z indicates the possibility of the company's financial failure. Based on the above, companies can be classified according to the results obtained from the Altman model: { [13] ,[3] }

Z > +2.99 ---safe zone
1.81 < Z < 2.99---gray zone
Z < 1.81 ---distress zone

1-3 The practical side

1-3-1 Research data

The data used in this research is a sample of size (34) companies consisting of two groups, the first group represents (17) successful companies, and the second one represents (17) failed companies and that the discriminatory variables are five variables which are as follows:

X_1 = Net working capital / Total assets
X_2 = Retained Earnings / Total Assets
X_3 = Earing before interest and taxes / total assets
X_4 = Market value of quality / total liabilities
X_5 = Sales / Total Assets

And the following table (1) shows the research data: [17]

Table 1. Research Data

First Group: Successful Companies

No.	X1	X2	X3	X4	X5
1	0.523	0.034	0.036	9.21	0.47
2	0.539	-0.07	0.024	19.2	0.52
3	0.799	-0.17	-0.09	8.69	0.29
4	0.626	-0.27	-0.04	3.94	0.65
5	0.733	-0.26	-0.17	8.94	0.33
6	0.72	0.095	0.047	9.3	0.42
7	0.723	0.128	0.136	6.29	1.03
8	0.321	0	-0.268	0.062	0.367
9	0.399	0.482	0.589	0.549	0.97
10	0.257	0.133	0.163	0.346	2.547
11	0.135	0.084	0.105	0.153	4.128
12	0.486	0.101	0.122	0.536	5.116
13	0.035	0.154	0.0003	25.477	0.026
14	0.057	-0.086	0.102	8.974	1.044
15	0.033	0.151	-0.001	19.34	0.0188
16	0.122	0.81	0.255	0.879	0.432
17	0.674	o.22	0.363	0.875	0.551

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Second Group: Failed Companies

N0.	X1	X2	X3	X4	X5
1	-0.118	-0.008	-0.12	0.566	0.64
2	0.053	0	0.006	1.207	0.078
3	-0.049	0	-0.048	0.814	0.126
4	0.176	0.032	0.011	0.048	0.035
5	0.191	0.029	0.009	0.034	0.028
6	-0.068	-0.265	-0.038	-0.201	1.217
7	-0.344	-0.777	-0.184	-0.484	1.636
8	0.011	0.223	0.046	0.384	0.607
9	-0.03	-0.61	-0.28	2.36	0.44
10	-0.13	-0.11	-0.11	1.86	0.34
11	-0.16	-0.91	-0.27	1.55	0.37
12	0.272	-0.17	-0.08	0.71	0.28
13	0.247	-0.3	-0.01	0.71	0.31
14	0.322	-0.1	-0.1	0.75	0.19
15	0.336	-0.57	-0.37	3.62	0.32
16	0.665	0.061	0.112	0.892	0.27
17	0.215	0.055	0.099	0.908	0.249

1-3-2 Statistical Analysis

The statistical analysis was carried out in two directions, the first using the Altman model, and the second by building a model for discrimination and comparison between the results of both models.

Altman Model

The Altman (z-score) model shown in equation (13) has been applied where:

$$Z=1.2X_1+1.4X_2+3.3X_3+0.6X_4+1.0X_5$$

After checking the independency between x,s .The data of the two groups were classified by finding (Z score) for the data as shown in the following table No. (2):

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Table 2. The value of (Z score) for the two groups by applying Altman's model

	Z score Group one		Z score Group two
1	6.78	1	0.414
2	12.7	2	0.641
3	5.92	3	0.282
4	3.27	4	0.241
5	5.65	5	0.230
6	7.16	6	0.739
7	6.31	7	-(0.047)
8	3.023	8	1.106
9	4.396	9	0.02
10	3.786	10	0.8
11	4.843	11	-(1.04)
12	6.564	12	0.55
13	15.510	13	0.57
14	6.713	14	0.56
15	11.870	15	0.89
16	2.2007	16	2.0582
17	1.5055	17	1.4555

The rate of classification was as shown in the following table (3):

Table 3. Classification of the two groups by using the Altman model

From / To	G_1	G_2	Total	% Correct
G_1	15	2	17	0.88
G_2	2	15	17	0.88
Total	**17**	**17**	**34**	**0.88**

Can noted that, the correct classification rate is (88%) for failed companies and successful companies, or in other words the model (Altman model) can predict the failure of companies with a probability of (0.88) for the data under consideration.

The Built Model

The data was analyzed by using the principles of discriminant analysis, the discriminant analysis of two groups, using the equations (1-9), and using the following applications (XL STAT, SPSSIBM 24).

The significance of the discriminatory function was first tested about significance of the differences between the averages of the two groups in question, based on the following hypothesis:

H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$

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Among the criteria for testing the above hypothesis is the Willks Scale, which has been formulated:

$\lambda=|w| / |T|$

Where:

(W) is the covariance matrix and the covariance within groups.
(T) Matrix of covariance and total covariance of totals.

The above formula follows a chi-square distribution with a degree of freedom (p (k-1)) and a level of significance (α). When conducting this test, the results were as in the following table (4):

Table 4. Test the significance of the discriminatory function

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.285	37.058	5	.000

The results of the above table indicate that there are significant differences between the averages of failed companies and successful companies, and this means that the discriminant function has the ability to distinguish, that is, it can be used to classify observations into any of the two groups.

The homogeneity of the variances between the two groups was tested. To apply the linear discrimination function, the variance and covariance matrices must be equal. Bartlett's test is one of the tests that are applied to verify the conditions of homogeneity of variance, and the hypothesis:

$H_0:\Sigma_1=\Sigma_2$
$H_1:\Sigma_1\neq\Sigma_2$

And the test by approval of the development of (Box) will be:

$$\mu\, C^{-1} - X^2\,[1/2(k-1)\,p(p+1)]$$

$$C^{-1} = 1 - (2P_2-3P-1)/(6(P+1)\,(K-1))\,[\sum 1/V_i - 1/\sum V_i]$$

$$\mu = (\sum vi)\,Ln|S| - \sum(ViLn|S|)$$

$$S = (1/\sum Vi)\,\sum ViSi$$

Where:

P number of variables = 5
Vi degree of freedom of the sample (i) = $n_i - 1 = 16$
K number of groups = 2
S matrix of variance and pooled covariance.
Si matrix of variance and covariance of the group (i)

According to this test, the results were reached in the following table (5):

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Table 5. Test for homogeneity of variance and covariance of the two groups

Box s	M
F Approx	3.577
DF1	15
Sig	0.61

According to the table above, the results showed the homogeneity of the variances between the two groups, and this means that the condition for using the discriminant function was met.

First, the discrimination parameters were found, and the discrimination model is as follows:

$$D = 2.611X_1 + 1.496X_2 + 0.909X_3 + 0.175X_4 + 0.771X_5 - 1.896$$

This model was used to classify the items of the two groups by finding the value of the posterior probability, as in the equations (11,12), where a value of (D) is found for each item of the sample, then we find:

$$P(G_1/X) = e^D/(1+e^D)$$

Or

$$P(G_1/X) = 1/(1+e^D)$$

$$P(G_2/X) = 1-P(G_1/X)$$

The item is classified into the group that corresponds to the greatest probability, as shown in Table (6) below:

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Table 6. Classification of the sample items using the proposed model
Prior and posterior classification, membership probabilities, scores

Observation	Prior	Posterior	Pr(G1)	Pr(G2)	F1	D^2(G1)	D^2(G2)
Obs1	G1	G1	0.991	0.009	1.528	1.891	11.287
Obs2	G1	G1	1.000	0.000	3.189	7.436	27.052
Obs3	G1	G1	0.993	0.007	1.599	4.933	14.765
Obs4	G1	G1	0.818	0.182	0.490	4.927	7.938
Obs5	G1	G1	0.982	0.018	1.294	5.466	13.423
Obs6	G1	G1	0.999	0.001	2.120	3.071	16.112
Obs7	G1	G1	0.999	0.001	2.202	2.832	16.377
Obs8	G1	G2	0.043	0.957	-1.007	15.301	9.107
Obs9	G1	G1	0.979	0.021	1.247	13.315	20.983
Obs10	G1	G1	0.972	0.028	1.148	3.998	11.057
Obs11	G1	G1	0.997	0.003	1.889	9.898	21.517
Obs12	G1	G1	1.000	0.000	3.676	18.153	40.760
Obs13	G1	G1	1.000	0.000	2.904	14.380	32.242
Obs14	G1	G1	0.861	0.139	0.593	5.011	8.658
Obs15	G1	G1	0.996	0.004	1.814	8.205	19.363
Obs16	G1	G1	0.748	0.252	0.353	12.363	14.535
Obs17	G1	G1	0.967	0.033	1.101	7.831	14.605
Obs18	G2	G2	0.005	0.995	-1.732	14.233	3.581
Obs19	G2	G2	0.010	0.990	-1.480	11.091	1.986
Obs20	G2	G2	0.004	0.996	-1.827	13.670	2.430
Obs21	G2	G2	0.016	0.984	-1.343	10.437	2.178
Obs22	G2	G2	0.017	0.983	-1.318	10.303	2.199
Obs23	G2	G2	0.007	0.993	-1.600	12.264	2.421
Obs24	G2	G2	0.000	1.000	-2.946	27.861	9.744
Obs25	G2	G2	0.050	0.950	-0.956	9.772	3.891
Obs26	G2	G2	0.001	0.999	-2.388	18.314	3.625
Obs27	G2	G2	0.003	0.997	-1.912	14.273	2.515
Obs28	G2	G2	0.000	1.000	-3.363	30.478	9.794
Obs29	G2	G2	0.026	0.974	-1.172	9.122	1.913
Obs30	G2	G2	0.016	0.984	-1.345	10.966	2.693
Obs31	G2	G2	0.042	0.958	-1.017	8.938	2.680
Obs32	G2	G2	0.017	0.983	-1.327	13.846	5.685
Obs33	G2	**G1**	0.773	0.227	0.398	5.522	7.970
Obs34	G2	G2	0.076	0.924	-0.811	7.807	2.819

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The correct classification is as shown in the following table (7):

Table 7. Classify the items of the two groups using the proposed model

From/to	G1	G2	Total	%correct
G1	16	1	17	94.12%
G2	1	16	17	94.12%
Total	17	17	34	94.12%

Can note from Table No. (7) above that the correct rating ratio is (94.12%) for failed companies and successful companies, or that the model that was built can predict the failure of companies with a probability of (0.9412) and that the correct rating percentage of the proposed model gives it an advantage in application compared to the Altman model, which achieved a correct classification rate of (88%) only.

1-4 Conclusions and Recommendations:

1- It appeared through the results (model or function of discrimination that was built) that all the variables studied have an impact and importance in building the discriminatory function.
2- As for the built model, it is clear that the variable (X_1) has the largest discrimination coefficient, which is equal to (2.611), followed by the variable (X_2) with a discrimination coefficient (1.496), then (X_3) and (X_5) and finally (X_4) with a discrimination coefficient (0.175).
3- The model that was built has a high discrimination power of (94.12%), while the discrimination power of Altman model reached (88%), which gives a clear preference for the proposed model compared to Altman model.
4- The model that was built does not include a gray area in the classification (as in the Altman model), but rather categorizes all cases as either successful or failed.
5- The model that was built can be developed if other data is available, and we expect that building a model for groups with a larger size than the studied sample will give better results

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