Adapting Altman's model to predict the performance of the Palestinian industrial sector

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Abstract

Purpose – This study aims to adopt the Altman model in order to predict the performance of industrial companies listed on the Palestinian Stock Exchange during the period of time between 2013 and 2017.

Design/methodology/approach – The study sample consisted of 12 industrial companies listed on the Palestine Stock Exchange, and their financial disclosure period extended for 5 years. Multiple linear regression model was used in the analysis to determine the relationship between the independent variables and the dependent variable where the independent variables were (X_1, X_2, X_3). This study is based on one basic assumption, which is that the Altman's model cannot predict the performance of the Palestinian industrial sector.

Findings – The results of the analysis proved the negation of the zero main hypothesis. This means that Altman's model can predict the performance of the Palestinian industrial sector at the level of statistical significance ($a = 0.05$), as well as the existence of a statistically significant relationship between each of the independent variables (X_2, X_4, X_5) and the dependent variable (Log (Z-score)). Hence, the relationship of X_1 and X_3 with the dependent variable was not statistically significant.

Social implications – This paper highlights different challenges that face the adaption of Atman's model and performance prediction in the Palestinian industrial sector. The findings of the analysis have the potential to help future researchers in examining and dealing with new challenges.

Originality/value – This paper presents a vital review of adopting Altman's model in the Palestinian industrial sector. A number of recommendations have been made, the most important of which is that most of the companies are located in the red zone. The Altman's model must be adapted in order to fit the Palestinian environment according to the results of statistical analysis and according to a proposed model, which is Log $(Z) = -0.653 + 0.72X_2 + 0.18X_4 + 0.585X_5$.

Keywords Altman model, The Palestinian industrial sector, Financial faltering, Palestine Stock Exchange

Paper type Research paper

1. Introduction

As a result of the increasing importance of the financial statements, the need for financial indicators for the items of the financial statements arose and developed to extract the important measures and relationships that are useful in making decisions. These indicators can be used to assess the financial position of a facility and its performance during a certain period through making comparisons between the financial ratios of a specific establishment, similar establishments or successive time period comparisons and determination of their performance trends. Among the most prominent benefits of financial analysis and indicators, these can be utilised to predict possible distress by forming or building models and tools that give early warning of signs related distress. This has the potential to protect dealers, since

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financial ratios to be considered as an indicator of the strength or weakness of the financial position of the facility. It is also possible to observe the trends and behaviour of some financial ratios of a group of establishments before their distress and to identify the characteristics of these ratios. This makes it useful in distinguishing between non-performing and performing enterprises.

The issue of forecasting the financial failure of companies is one of the most important aspects that concerned many researchers, bodies and international organisations. This is because it causes negative effects on institutions, investors and the economy (Bzam, 2014; Razia *et al.*, 2017). To achieve more accuracy in predicting the future status of companies in terms of their ability to continue or liquidate, the indicators of creditworthiness and bankruptcy are used on the basis of assessing the institution's past situation and linking it to the future as well as measuring the company's ability to develop its resources. The creditworthiness indicators reflect the quality of the existing company's performance. As for the bankruptcy indicators, it refers to the company's ability to fulfil its obligations. Interest has increased in developing mathematical models that are capable of predicting companies' distress, including Altman's model, which is a statistical model for predicting financial distress using.

Multivariate linear discriminant analysis method to find the best financial ratios has the ability for predicting the distress of companies. This method divides into five different financial ratios which are liquidity ratios, profitability ratios, activity ratios, profit accumulation ratios and financial leverage.

2. Research problem

There are many companies that face difficulties in performance, which ultimately leads to their stumbling. This study assists in giving an indication for the management of industrial companies in the Palestine Stock Exchange, by using one of the most important models for forecasting faltering companies to help these departments and to give them sufficient information on evaluating their performance before reaching the stage of financial distress. Based on the previous discussion, this problem can be formulated through the following question: can the Altman model predict the performance of the Palestinian industrial sector?

3. The importance of the study and its objectives

Studying and analysing the Palestinian industrial sector contributes to clarifying the nature of its performance and the levels of operational and financial efficiency within it. This contributes to assessing the ability of this sector to face the challenges arising in light of the Palestinian political and economic environment. Therefore, providing decision-makers with important information helps in developing a perception about the financial performance of these companies, in addition to formulating appropriate policies for correction and early amendment. As a result, this study aims to apply the Altman model and its related aspects to predict the performance of the Palestinian industrial sector.

4. Literature review and previous studies

This part of the study presents the concept of financial distress and then reviews the most important existing studies on forecasting financial performance.

4.1 The concept of financial distress

The term financial distress is a broad term characterised by somewhat ambiguity, as there is no general agreement on its definition. Some studies defined it as a case of bankruptcy, such

as the Altman study, in 1968, while others see it as a failure or inability to pay obligations on the due date. However, Rose in 1996 linked the financial distress to insolvency and defined it as follows: "Inability to fulfil debts without any means of repaying them, such as insufficient assets to cover liabilities" (Arkan, 2015).

Mohsen Ahmed Al-Khudairi defined the financial distress block as: "A financial imbalance facing the project as a result of the failure of its resources and capabilities to fulfil its obligations in the short-term". This potential imbalance between project resources (internal/external) and the obligation in the short-term needs to be paid or due for payment. This imbalance between self-resources and external liabilities ranges between the occasional temporary imbalance and the real permanent imbalance. The more this structural imbalance or close to the structural, the more difficult it is for the project to overcome the crisis caused by this imbalance.

Olivier Ferrier defined financial distress as: "a serious disorder affecting the ability to continue activities for various reasons". Numerous studies and statistics have proven that the failure of the institution does not necessarily mean its demise. According to a study conducted in France during the period between 1986 and 1990 that 4 out to 5 of the disappearance of 200,000 French enterprises is primarily caused by a change in the institution's structure (e.g. merger cases). As for the independent institutions, the reason for their disappearance is a change of ownership (for example, a change of possession or sale) and only 1 out of 5 of the vanishing institutions whose primary cause is financial failure (Ferrier, 2002).

Datta *et al.* (1995) believes that there is no single definition of distress, as a broad definition must be given that includes qualitative changes in the analysis of financial distress. This is because taking into account the qualitative variables in addition to the financial variables will provide a more rational and comprehensive analytical framework for predicting failure (Sami, 2014). According to (Lin and Liu, 2008), "If the institution carries more debt, coupled with its reduced ability to generate revenues with insufficient cash flow from operations, this will lead the institution to severe liquidity problems and thus the occurrence of financial distress" (Schmumuck, 2013; Razia *et al.*, 2019).

An attempt can be made to derive a comprehensive definition of financial distress as: "An imbalance that may affect the institution at a stage of its development, and may occur as a result of several reasons, which may be financial or administrative (structural) disturbances that precede the state of bankruptcy". The institution may overcome this imbalance through making the necessary changes in a timely manner, and you may fall into bankruptcy and thus disappear.

4.2 Related previous studies

Many studies in the Arab countries have sought to analyse the financial performance of companies and try to predict early financial distress using many models. The study of Leung and Zhang (2011), sought to find a way by which to predict failure before its occurrence by applying the Altman model to a number of Iraqi industrial companies. The model was applied to a sample consisting of 17 companies. The results of this study indicated the accuracy of the Altman model as one of the methods of financial analysis adopted in evaluating the performance of companies in predicting the failure of Iraqi joint-stock companies.

These results came in line with the results of the Al-Rifai study, 2017, which aimed to find out whether the Altman model has the ability to predict financial distress at least two years before the occurrence of distress. The test was performed on continuing companies whose financial data are available during the study period extending between 2011 and 2015. The study sample consisted of 61 industrial companies listed on the Amman Stock Exchange. The results of the study showed that the model has the ability to predict the distress of

companies within two years before the occurrence of distress for industrial companies listed on the Amman Stock Exchange. Altman represented by each of (X_1, X_2, X_3 and X_4) together and separately on the actual performance measured by the return on the shares of industrial companies listed on the Amman Stock Exchange. The study recommended the need to urge investors, financial analysts and auditors to use the Altman model to identify the financial position of industrial companies and take appropriate investment decisions. Ahmed and Saleh) 2016 (found that commercial banks in Sudan face a state of financial failure based on models of Mc Gough and Altman and Kind, operating cash flow indicators, and that the process of predicting financial distress before it occurs. This contributes to addressing the financial imbalance and contributes to the growth. The study recommended that managers of Sudanese commercial banks take advantage of the results of forecasting models of financial distress along with some indicators of cash flows for early warning of any distress cases. This should be conducted before exposing to any distress situations that may negatively affect and expose them to failure and liquidation.

It also helped providing commercial banks in Sudan with important information about what their future conditions will look like to take the necessary policies and measures. Alfarra (2017) aimed to know the extent of the possibility of predicting the financial distress of the Saudi shareholding companies for the cement industry by using the Altman model and the Springate model. The financial ratios extracted from the published financial statements and reports for the fiscal years 2013, 2014, 2015. The study concluded that the results obtained using the Altman model and the springate model to a large extent converge to predict the financial distress of the Saudi industrial joint-stock companies for the cement industry. The study recommended the necessity of making decisions related to directing capital by relying on scientific methods and accurate financial analysis based on financial and accounting data and information. It is also vital to pay attention to the accuracy and correctness of financial statements and reports. Al-Qaisi (2016) built a model from the financial ratios of joint-stock Jordanian industrial companies to distinguish between distressed and non-performing companies. This study was conducted using the linear discriminatory analysis of a sample of 38 companies, half of which are distressed and the other half are not, during the period between 2008 and 2011.

This was followed by testing the predictive power of the discriminant model and comparing it with the predictive ability of Altman's model on the same sample. The study found that building a model consisting of financial ratios representing (profitability, liquidity and market) ratios, where the most important results indicated that the derived model was able to distinguish between distressed and non-distressed companies before occurring distress one, two and three years with a total accuracy of 97.74, 92.11 and 91.05%, respectively. In addition to average overall classification accuracy of (88.97%), while the overall classification accuracy of the Altman model for the same period was 73.68, 71.05 and 55.26%, with an average overall classification accuracy of 66.66%.

Many studies have shown the efficiency of applying Altman model in predicting the failure of companies. Niresh and Pratheepan (2015) indicated that estimating the probability of bankruptcy in the Sri Lankan trade sector through applying Altman's model. This has been conducted to a sample of seven commercial companies for a period of five years. It showed that 71% of these commercial companies fall within the red zone, which is the danger zone, and the remaining fall into the grey or foggy zone. It can be noticed that the entire commercial sector is in a dangerous phase. For this reason, rapid intervention must be made to save the Sri Lankan commercial sector from any potential distress.

Gunathilaka (2014) carried out a research in order to evaluate Altman's model through its application and examination. In addition to identify Altman's model suitability to emerging markets in Thailand and the extent of its reliability. The results clearly showed that they can predict bankruptcy and potential financial distress that may occur in the future. The model

proved to be effective and successful when used for more than one year. The result is commensurate with the stock market in Thailand.

Yasser and Al Mamun (2015) is related to several companies listed on the Malaysian Stock Exchange during the period between 2006 and 2010. The study confirmed that Altman's model was successful in predicting the distress of companies. There is also a need to use a unified international model to predict financial distress. This is because in the midst of the large number of models and the large number of their outputs, it will be difficult to compare companies, which contributes to hindering the decision-making process. Sajjan (2016) addressed that the application of Altman's model helps to understand the potential distress of selected companies from the industrial and non-industrial sectors listed on the Bahrain Stock Exchange and the New York Stock Exchange during the years (2011–2015). The results indicate that there are companies belonging to the risk zone (e.g. red zone), which has a high probability for stumbling and bankruptcy in the near future. Accordingly, the study recommended that these companies should review their strategies and develop them in line with their activities.

Gonzalez and Rodriguez (2013) introduced a model to predict corporate failure through a mathematical method using logarithms and algorithms. They also made a comparison between their designed model and Altman's model. The variables were chosen to build the special model from 32 financial ratios. The logarithmic model was used to predict bankruptcy and was compared to Altman's model. The study consists of two samples of the Spanish industrial construction companies, which were randomly selected during the periods from 2000 to 2004 and from 2005 to 2007. The results came to confirm that Altman's model had greater predictive power than the mathematical methods used in the first year, while Altman's model was observed to decline after the second year, unlike the proposed model.

4.3 Contribution of the current study

Given the importance of the industrial sector in Palestine, which is considered one of the major pillars of the Palestinian economy, it contributed 13% of the Palestinian GDP, which amounted to $13686.4 million (the annual report of the Palestinian Central Bureau of Statistics, 2017). Therefore, this study was conducted in order to predict the performance of the industrial sector by applying the Altman's model to the Palestinian industrial companies listed on the Palestine Stock Exchange during the period (2013–2017). It is expected that this study will contribute to raising important information for researchers, those interested and practitioners who deal with the Palestinian industrial sector.

5. Research methodology

5.1 Study design and sampling

The study population and sample consist of the Palestinian industrial companies listed on the Palestine Stock Exchange. These companies consist of different 12 companies (Palestine Securities Exchange, 2017).

5.2 The study hypothesis and test models

The research is based on one basic hypothesis as follows:

H0. Altman's model cannot predict the performance of the Palestinian industrial sector.

This study relied on examining the data collected from the financial statements of industrial companies published on the Palestine Stock Exchange website during the period 2013–2017. To develop the equation for predicting financial distress, Altman's default model was tested. This model relies on five independent variables. Each variable represents a financial

indicator from the recognised indicators and a dependent variable Z, known as Z-Score (Ramadan, 2011). The model form is produced as follows:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.99X_5$$

whereas:

Z: distress indicator that can be used to measure distressed or not distressed projects.

X_1: Net working capital/total assets. Liquidity Index.

X_2: Balance of retained earnings/total assets. Profit Accumulation Index.

X_3: Net profit before interest and taxes/total assets. Profitability Index.

X_4: Market value of shareholders' equity/total liabilities. Financial Leverage Index.

X_5: Sales/total assets. Activity Index.

The coefficients (1.2, 1.4, 3.3, 0.6, 0.99) represent the weights of the function variables and express the relative importance of each variable. According to this model, establishments are classified into three categories according to their continuity capacity and based on the value of "Z" as follows (Almajali *et al.*, 2012)

(1) If the value of Z is greater or equal to 2.99, firms are considered successful or viable.

(2) If the value of Z is less than 1.81, the firms are considered distressed, as their performance is low.

(3) If the value of Z is greater than 1.81 and less than 2.99, this is known as the grey area. It is difficult to determine the status of the facility, and therefore it is subject to a detailed study, because it is difficult to predict decisively whether or not to distress.

The degree of accuracy in this model reaches 94% in the year before the establishment reaches bankruptcy. This degree reaches to 72% two years before bankruptcy and 84% three years before bankruptcy.

5.3 Methods of measuring study variables

X_1 refers to the index of net working capital/total assets: net working capital is the difference between current assets and current liabilities. This indicator measures the volume of surplus liquid assets after covering their liabilities or short-term liabilities, financial and vice versa if this indicator falls.

X_2 refers to the indicator of the balance of retained earnings/total assets: it measures the degree of the facility's dependence on financing its assets using part of its own resources represented in retained earnings. The higher this indicator, it indicates an increase in the establishment's dependence on its own resources in financing its assets. However, when this indicator is low, it indicates the increased dependence of the establishment on the funds of others to finance its needs of assets.

X_3 refers to the index of net profit before interest and taxes/total assets: this indicator measures the efficiency of the facility's management in operating its assets to achieve profits. The higher this index indicates the efficiency of the operational management in exploiting the assets and vice versa in the event of its decline.

X_4 relates to market value index for shareholders' equity/total liabilities: this indicator expresses the extent to which the assets of the enterprise can decrease, in terms of the total debt and the market value of its shares. The higher the trend of this index to the rise, this

indicates the facility's ability to fulfil its obligations and thus weakens its exposure to financial default and vice versa if this indicator is low.

X_5 link with sales/total assets: it is sometimes called the asset turnover ratio. It measures the efficiency of the management in using its assets in order to achieve revenues. If this indicator is high, it indicates the effective use of the available productive capacity. However, when it is low, it indicates that the fixed assets are not used efficiently. Therefore, it has potential for financial distress.

5.4 Descriptive results of the study

Descriptive analysis was carried out for each of the independent variables (X_1, X_2, X_3, X_4, X_5), in addition to the dependent variable which is known as *Z*-score. Table 1 shows the mean, standard error, SD and the highest and lowest value for each of the aforementioned variables. Table 2 shows the results of the Altman analysis procedure for the selected companies.

Table 2 shows different data that are related to the *z*-score analysis of the sample companies. This data indicates that their activity in most of the study years is located in the stability zone and the bankruptcy zone based on the function data. In other words, it locates within the grey area or the red zone.

6. Checking the conditions for linear regression

Building a multiple linear regression model requires examining a number of assumptions (conditions), in order to ensure the ability to generalise the regression results to the study population, which are as follows:

6.1 Dealing with outliers

Dealing with outliers is not a direct regression condition. However, linear regression is affected by outliers, as the relationship line moves towards these values, which affects the validity of the relationship between the variables. In order to determine these outliers, standard values of the dependent variable (*Z*-scores) were found to treat those with a standard value less than −3 or greater than 3. As a result, there were no outliers.

6.2 The existence of a linear relationship between the dependent variable and each of the independent variables

The relationship between the dependent variable and each other variables was examined by means of the scatter plot graph. The following figure shows that there is a quasi-linear relationship between the dependent variable and the independent variables X_2, X_4, X_5. This leads in difficulties to notice the linear pattern in both the relationship between the dependent variable and the independent variables X_1, X_3. However, the absence of a linear relationship between the dependent variable and the independent variables does not preclude the

Variables	Minimum	Maximum	Mean	Std. error	Std. deviation
X_1	−0.7463	0.5907	0.224	0.036	0.277
X_2	−5.3690	4.0967	0.0791	0.119	0.923
X_3	−0.6219	0.2677	0.0631	0.016	0.122
X_4	0.0000	5.7229	0.184	0.100	0.775
X_5	0.0317	3.4720	0.616	0.064	0.498
Z-score	−6.1217	4.3466	0.835	0.158	1.223

Table 1.
Descriptive results of the study variables

Year	X_1	X_2	X_3	X_4	X_5	Z-score
Beit Jala pharmaceutical company						
2013	−0.223621683	0.530133199	0.267739077	0.028660689	0.221777508	1.59413556
2014	−0.193238864	0.58204936	0.242464437	0.012188384	0.241066379	1.62908386
2015	−0.734924828	0.625769569	0.22232329	0.018874972	0.206158086	0.60187318
2016	−0.746336889	0.67203389	0.218066685	0.035781609	0.187652312	0.63392439
2017	−0.111134272	0.503042398	0.154824056	0.007913182	0.124441269	0.45668889
Dar Al-Shifa pharmaceutical company						
2013	0.165417282	0.071732634	0.04330554	0.019085546	0.425746345	0.87477492
2014	0.111087042	0.076086166	0.027517887	1.787712042	0.409731645	1.80889566
2015	0.172840581	0.09261703	0.044496233	0.01589215	0.40722423	0.21083895
2016	0.226366613	0.095052781	0.013012998	0.009777569	0.406550281	0.21679268
2017	0.111376277	0.027574053	0.010284123	0.008397791	0.303381144	0.12668904
Birzeit pharmaceutical company						
2013	0.440984988	0.147106903	0.071696382	0.071167853	0.387991664	1.39854217
2014	0.425974615	0.150489554	0.067458202	0.043478221	0.357466156	1.32444541
2015	0.481557269	0.169875619	0.086604871	0.884551376	0.383016117	0.45511734
2016	0.529014376	0.188108405	0.109472274	0.088214772	0.437361882	0.42121734
2017	0.555139717	0.262767162	0.145054375	0.102272863	0.408978971	0.57164285
Jerusalem cigarette company						
2013	−0.121087514	0.017610688	0.015946604	0.046068866	1.911446797	1.85194739
2014	−0.106024104	−0.098263383	0.065491088	0.020818269	1.213300337	1.16498122
2015	0.024876639	0.047717161	0.002342689	0.744604488	0.974271834	1.8944373
2016	0.022680081	0.033712255	−0.009034661	0.014554146	0.913337643	1.10214686
2017	0.035703827	0.034773308	0.010050396	0.012399056	0.986195662	0.97262607
Al-Quds pharmaceuticals company						
2013	0.36994368	0.110017213	0.042966063	0.025251664	0.446015579	1.19645094
2014	0.351222758	0.116691988	0.034283865	0.037640525	0.491476616	1.20711901
2015	0.388240231	0.136365064	0.04545887	0.035936418	0.560382814	0.41142963
2016	0.42681708	0.157513297	0.060978043	0.04808299	0.539947911	0.43756062
2017	0.461533218	0.205669691	0.101673838	0.177044953	0.57044893	0.53788604
Palestine plastic industries company						
2013	0.134883025	−1.54691675	0.181467211	0.006775338	3.471967352	2.03633086
2014	0.064129796	0.198654589	0.18328566	0.005835215	0.333631976	1.29371164
2015	−0.042465783	4.096688801	−0.621924612	0.010239675	0.096218902	−6.1216851
2016	0.185757879	−5.368978845	−0.178824802	1.15277E-05	0.031715945	−1.0768542
2017	−0.128404435	−0.245613236	−0.04472513	0.001755435	0.058006619	−0.9673332
The national carton industry company						
2013	0.46764439	0.081993702	0.101681543	0.177667346	0.883994461	1.99326847
2014	0.441300057	0.081089291	0.076757011	0.148048876	1.019138767	1.99415992
2015	0.442667856	0.0806053	0.084506475	0.058769262	0.992358849	1.10989412
2016	0.417016672	0.062551596	0.056594385	0.063021876	0.937179307	1.15789184
2017	0.492748395	0.036280369	0.028673916	0.03234973	0.74552684	0.96520272
Vegetable oil industries company						
2013	−0.223621683	0.530133199	0.267739077	0.028660689	0.221777508	1.59413556
2014	−0.193238864	0.58204936	0.242464437	0.012188384	0.241066379	1.62908386
2015	−0.734924828	0.625769569	0.22232329	0.018874972	0.206158086	0.60187318
2016	−0.746336889	0.67203389	0.218066685	0.035781609	0.187652312	0.63392439
2017	−0.111134272	0.503042398	0.154824056	0.007913182	0.124441269	0.45668889

Table 2.
Altman's model analysis for sample selection companies

(*continued*)

Year	X_1	X_2	X_3	X_4	X_5	Z-score
Arabia for the manufacture of paints						
2013	0.494152138	0.212265516	0.18089327	0.038162745	0.836646877	2.33828013
2014	0.501357695	0.204267243	0.137293572	0.001454324	0.94831918	2.28038074
2015	0.522018796	0.250687853	0.215810518	0.164659611	1.065661609	1.24807408
2016	0.536799871	0.276347671	0.228803473	0.001841201	0.955751836	1.26335124
2017	0.590690972	0.318030575	0.200765398	0.00113933	0.873591584	1.36254609
Golden wheat mills						
2013	0.333019201	0.015929249	0.01333983	5.722877094	0.451417422	4.346575
2014	0.359700628	0.024104638	0.01172938	0.015654175	0.551836452	1.059805
2015	0.246206355	−0.053272704	−0.05958451	0.017825583	0.311900286	0.323159
2016	0.254417863	0.050838652	0.00266147	0.013627843	0.546507977	0.394567
2017	0.319236822	0.012979851	0.07315235	0.105962824	0.483963075	0.226385
Al Sharq electronics						
2013	0.30115317	0.026988755	0.034022424	0.00957074	0.404428244	0.91756847
2014	0.315138636	0.025138131	0.034127121	0.015060815	0.353524575	0.88500506
2015	0.320312078	0.00398947	0.033662664	0.01964377	0.288762942	0.21468785
2016	0.295052431	0.006003724	0.033253877	0.027079178	0.384561594	0.23062801
2017	0.292588647	0.018200578	0.023791508	0.014797748	0.291507837	0.17906052
National aluminium and profiles industry (NAPCO)						
2013	0.022169689	0.028273138	0.036714	0.0025096	0.695906505	0.877797
2014	0.050796387	0.057716844	0.034299	0.0071801	0.668113842	0.920685
2015	0.126076256	0.044752405	0.003143	0.0009861	0.634569233	0.445779
2016	0.038768495	0.058012537	0.01402	0.0012477	0.647230814	0.438231
2017	0.138968403	0.072060394	0.019112	0.0001475	0.690653033	0.459073

Table 2.

performance of linear regression, but rather necessitates that we be careful in generalising the results later (see Figure 1).

6.3 The normal distribution of the dependent variable

The normal distribution of the dependent variable is examined by means of the skewness and kurtosis tests, with the value of torsion (−4,330) and kurtosis (29,134) (see Table 3).

It is evident from the above table that the condition of normal distribution has been disturbed and therefore this problem must be resolved. In order to deal with this problem, the dependent variable was transformed using the logarithm function and re-examined again as shown in Table 4.

Depending on the above table, it can be noticed that the kurtosis and torsion values changed after the adjustment was made to be between −1 and 1. Therefore, the distribution of the dependent variable can be considered a normal distribution.

6.4 Absence of multicollinearity between independent variables

The existence of relationships between the independent variables was examined using the VIF coefficient of variance amplification. As shown in Table 5, the values of VIF are between 0.307 and 3.768, which shows a little multiplicity of linear relationships. However, the fact that the values did not exceed 5 is something that can be ignored. Therefore, it does not affect the results of linear regression.

6.4.1 Homoscedasticity. The homogeneity of the standard residues is checked by examining the point representation of the standard residues with the predicted values (see Figure 2).

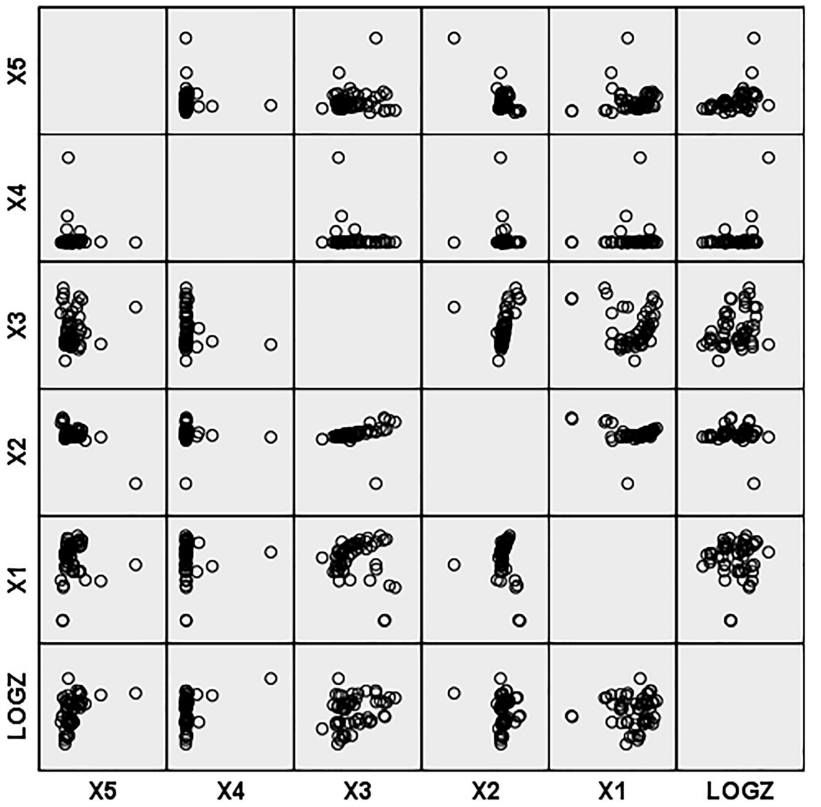

Figure 1.
Bitmap matrix of relationships between study variables

Table 3.
Examination of the normal distribution of the dependent variable

	Mean		Std. deviation	Skewness		Kurtosis	
	Statistic	Std. error	Statistic	Statistic	Std. error	Statistic	Std. error
Z-score	0.834992	0.1578679	1.2228397	−2.802	0.309	18.150	0.608
Valid *N* (listwise)	60						

Table 4.
Examining the normal distribution of the dependent variable after transformation

Descriptive statistics						
	Mean	Std. deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. error	Statistic	Std. error
LOGZ	−0.1030	0.33124	−0.315	0.316	−0.545	0.623
Valid *N* (listwise)	57					

6.5 Residual independence (no autocorrelation)

The independence of the residues is examined by calculating the Durbin–Watson constant. It can be found that it is 1.398 according to Table 6. In other words, between 1.5 and 2.5, confirms that the residues are independent and are not affected by each other to an acceptable extent.

6.6 Data analysis and hypothesis testing

The multiple linear regression model was built as in Tables 7–9 as shown below. It is evident in Table 8, the model can predict a good portion of the dependent variable as the values of the three correlation coefficients reached (R) = 0.699, the coefficient of determination (R^2) = 0.489 and the adjusted determination coefficient (R^2) = 0.439. This means that the independent variables X_1 and X_5, were able to explain 43.9% of the changes in the dependent variable Log (Z-score). Therefore, and the rest is attributed to other factors.

As shown Table 8, the value of (p-value = 0.000), which is less than 0.05. This confirms that the model in general is able to predict the value of the dependent variable Log (Z-score) with a high explanatory strength at confidence level that is qual to 95%.

The table below shows the values of the regression coefficients for the estimators and the statistical significance tests for these parameters. It be concluded that there is a statistically significant relationship at a level of statistical significance of 0.05 between each of the independent variables X_2, X_4, X_5 and the dependent variable Log (Z-score). However, the relationship of X_1 and X_3 variables with the dependent variable was not statistically significant.

Therefore, the multiple linear regression model is

$$\text{Log}(Z) = -0.653 + 0.72X_2 + 0.18X_4 + 0.585X_5$$

Which means that Log (Z-score) is directly proportional to each of X_2 profit accumulation index, X_4 financial leverage index and X_5 activity index. These indexes are related with different transactions as follow (0.180, 0.720, 0.585) respectively.

7. Comparing models

Altman's model

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.99X_5$$

Predictor model

$$\text{Log}(Z) = -0.653 + 0.72X_2 + 0.18X_4 + 0.0.585X_5$$

Coefficients[a]

Model	Unstandardised coefficients		Standardised coefficients			Collinearity statistics	
	B	Std. error	Beta	t	Sig.	Tolerance	VIF
1 (Constant)	−0.653	0.101		−6.452	0.000		
X_5	0.585	0.121	0.872	4.824	0.000	0.307	3.258
X_4	0.180	0.042	0.432	4.246	0.000	0.970	1.031
X_3	0.384	0.548	0.088	0.701	0.486	0.633	1.580
X_2	0.720	0.233	0.600	3.089	0.003	0.265	3.768
X_1	0.118	0.124	0.099	0.953	0.345	0.929	1.076

Note(s): [a]Dependent variable: LOGZ

Table 5. Coefficient of variance amplification for the derivative variables

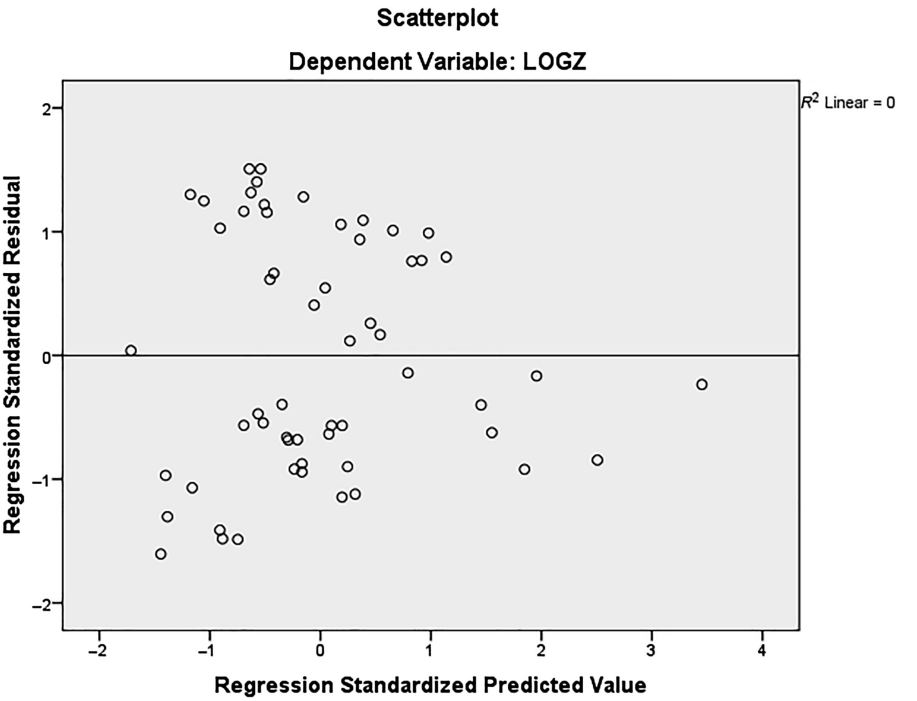

Figure 2.
Homogenisation of standard residues

Table 6.
Calculation of the Durban-Watson constant

Model summary					
Model	R	R square	Adjusted R square	Std. error of thsse estimate	Durbin–Watson
1	0.699[a]	0.489	0.439	0.24814	1.398

Note(s): [a]Predictors: (Constant), X_1, X_4, X_5, X_3, X_2

Table 7.
Summary of the multiple linear regression model

Model summary				
Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.699[a]	0.489	0.439	0.24814

Note(s): [a]Predictors: (Constant), X_1, X_4, X_5, X_3, X_2

Table 8.
Analysis of variance for multiple linear regression

ANOVA[a]						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	3.004	5	0.601	9.757	0.000[b]
	Residual	3.140	51	0.062		
	Total	6.144	56			

Note(s): [a]Dependent variable: LOGZ
[b]Predictors: (Constant), X_1, X_4, X_5, X_3, X_2

Models were compared by examining the two null hypotheses as follows:

(1) Standard mean residuals of the predicted model = 0

(2) Altman's standardised mean residual = 0

By *T*-test, and below are the results of the examination:

It is clear from Table 10 that the value of (p value = 1) is greater than 0.05. This means that the null hypothesis must be accepted. This also indicates that the rate of the remainder of the model is equal to zero, meaning that the rate of error in the prediction is equal to zero in statistical terms at the confidence level 95%. In contrast to the results in Table 11, where the null hypothesis must be rejected, which confirms that the residual rate is not equal to zero when applying Altman's model. Therefore, it can be concluded that the predictive model for the Palestinian environment is more suitable for estimating the value of the dependent variable compared to Altman's model.

Coefficients[a]

Model	Unstandardised coefficients		Standardised coefficients		
	B	Std. error	Beta	*t*	Sig.
1 (Constant)	−0.653	0.101		−6.452	0.000
X_5	0.585	0.121	0.872	4.824	0.000
X_4	0.180	0.042	0.432	4.246	0.000
X_3	0.384	0.548	0.088	0.701	0.486
X_2	0.720	0.233	0.600	3.089	0.003
X_1	0.118	0.124	0.099	0.953	0.345

Note(s): [a]Dependent variable: LOGZ

Table 9. Coefficients of multiple linear regression model

One–sample test

	Test value = 0					
					95% Confidence interval of the difference	
	t	Df	Sig. (2-tailed)	Mean difference	Lower	Upper
DIFF2	0.000	56	1.000	0.00000	−0.0628	0.0628

Table 10. *T*-test results on the rest of the predicted model

One–sample test

	Test value = 0					
					95% Confidence interval of the difference	
	t	df	Sig. (2-tailed)	Mean difference	Lower	Upper
DIFF	−6.673	56	0.000	−0.22532	−0.2930	−0.1577

Table 11. Results of *T*-test on the remainder of Altman's model

8. Discussion of conclusions and recommendations

This study aimed to adapt Altman's model to predict the performance of the Palestinian industrial sector. Based on the statistical analysis, it can be noted that Altman's model can predict the performance of the Palestinian industrial sector at a level of statistical significance (0.05a) and becomes more effective and efficient if the modification of its parameters which is done by rebuilding the linear regression model. This leads the same independent variables to be closer to the economic environment in Palestine. This is because the effect of the two factors X_1 and X_3 did not have an effect in Altman's model. There was a clear difference in the values of the transactions between the two models as this appeared when calculating the averages of the standard residues and comparing them to zero. Depending on the results, the study recommends the following:

(1) By analysing the companies according to Altman's model. It can be noticed that most of the companies are located in the grey or red area. This means before distress or distressed. This leads that there is a need to amend the model to suit the Palestinian environment as indicated by the results of the statistical analysis.

$$\mathrm{Log}(Z) = -0.653 + 0.72X_2 + 0.18X_4 + 0.585X_5$$

(2) Industrial companies listed on the Palestine Stock Exchange must also apply the proposed model appropriate to the Palestinian environment before falling into distress. This is because of the ability of this model to predict the possibility of financial distress in a timely manner before the occurrence of failure and liquidation.

(3) Conducting further studies to apply Altman's model for different periods to help generalise the results.

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Appendix

Number	Company name
1	Dar Al-Shifa pharmaceutical company
2	Beit Jala pharmaceutical company
3	Birzeit pharmaceutical company
4	Jerusalem cigarette company
5	Al-Quds pharmaceuticals company
6	Palestine plastic industries company
7	The national carton industry company
8	Vegetable oil industries company
9	Arabia for the manufacture of paints
10	Golden wheat mills
11	Al Sharq electronics
12	National aluminium and profiles industry (NAPCO)

Note(s): Palestine Stock Exchange

Table A1.
Study population and sample

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