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Using Altman Z-Score Models for Predicting Financial Distress for Companies – The Case of Egypt panel data analysis

Abstract

This study seeks to identify the impact of applying Altman Z–Score models on the quality of financial distress predictability in the Egyptian registered non–financial institutions. The deductive research approach is used. A sample of 44 institutions is selected from the EGX 70 index during 2016–2020, that is corresponding to 220 firm year observations. The study is a panel data analysis. The selected study sample is characterized by continuation of operations, complete data, and currency recorded in Egyptian pound. The test tools used to forecast financial distress were the original Altman Z–Score model (1968) and the modified Altman Z–Score model (1993). The dependent variable is the firm financial distress represented by the sum of Z–Score. The independent variables are the ratios that are applied to the Altman Z–Score models. The logistic regression analysis was applied to examine the influence of the ratios used in the models. These ratios are net working capital/total assets NWC/TA, retained earnings/total assets RE/TA, earnings before interest and tax/total assets EBIT/TA, book value of equity/total liabilities BVE/TL, sales/total assets S/TA. The SPSS program was used. Findings indicate that applying Altman Z–Score models have a significant impact on the quality of financial distress predictability. Findings also indicate that the modified Altman Z–score (1993) model presents better results than the Altman Z–Score (1968) model for the prediction of the future financial distress of firms and the probable causes that might influence investor decisions and firm financial performance. The results of this study are expected to be beneficiary to external stakeholders like investors and regulatory bodies as well as to internal stakeholders like employees and managers.

Key Words: financial distress, bankruptcy, going concern, Altman Z–Score models

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إستخدام نماذج Altman Z-Score للتنبؤ بالتعثر المالي في مصر
panel data analysis

الملخص

تسعى هذه الدراسة إلى تحديد اثر استخدام نماذج Altman Z-Score على التنبؤ **بالتعثر المالي** في مصر. تم اختيار عينة مكونه من 44 وحده من مؤشر EGX 70 خلال الفترة 2016-2020 أي ما يعادل 220 مشاهده. يتم إجراء panel data analysis في هذه الدراسة. العينة المختاره من المنشئات غير المالية تعمل بدون توقف اثناء فترة الدراسة، وبينات الدراسه متوفره, ويستخدم عمله موحده وهي الجنيه المصري. نماذج Altman Z-Score المستخدمة للتنبؤ بالتعثر المالي هم –Altman Z Score (1968) وAltman Z-Score المعدل (1993). المتغير التابع هو التعثر المالي للمنشئه المالية المتمثله في مجموع Z-Score. المتغيرات المستقلة هي النسب التي يتم تطبيقها في نماذج Altman Z-Score. تم تطبيق تحليل الانحدار اللوجستي logistic regression analysis لفحص تأثير النسب المستخدمة في نماذج Altman Z-Score. هذه النسب هي صافي رأس المال العامل/ إجمالي الأصول NWC/TA، الأرباح المحتجزة / إجمالي الأصول RE/TA، الأرباح قبل الفوائد والضرائب / إجمالي الأصول EBIT / TA ، القيمة الدفترية لحقوق الملكية / إجمالي الخصوم /BVE TL، المبيعات / إجمالي الأصول Sales / TA. تم استخدام برنامج SPSS. تشير النتائج إلى: اولا استخدام نماذج Altman Z-Score لـه تـاثير هـام على جـودة التنبـؤ **بـالتعثر المـالي,** وثانيـا أن نموذج Altman Z-Score المعدل (1993) يقدم نتائج أفضل من نموذج Altman Z-Score (1968) للتنبؤ بالتعثر المالي للشركات. من المتوقع أن تكون نتائج هذه الدراسة مفيدة للمستثمرين وللمنشئات غير المالية والهيئات التنظيمية.

الكلمات المفتاحية: التعثر المالي، الإفلاس، استمرارية نشاط المنشئه، نماذج Altman Z-Score

1- Introduction

The business failure is not sudden as stated in Abdulkareem (2015). Failure is the condition when a business has to liquidate due to the hopelessness to success-fully carry on with its operations. There are many factors that lead to business failure. Excess debt burdens, the nature of businesses activities, high interest rates, government regulations, bad economic conditions, and uncontrolled pan-demics are among the leading factors to business failure .

The COVID-19 has caused excessive public agony and unfavorable financial disorder (OECD, 2020). However, there are great expectations for Egypt for a bright future. Egypt is the sole country in the middle east and north Africa to ex-perience positive economic growth of about 1.95% in (2020) from projections of the IMF`s World Economic Outlook. The study on hand evaluates the situation during the first wave of the pandemic only. It concentrates on the isolation peri-od. Public data issued by the Egyptian Ministry of Health and Population indi-cates that the first half of (2020) witnessed sharp increase in the numbers of death cases and confirmed cases of the virus. In February of that year, the number of confirmed cases was only 2. Within four months, this number exceeded 68 thousands. As for the number of death cases, it increased from zero to nearly three thousands during the same period .

Due to the difficulties that face creditors and investors in the process of pro-jecting financial crises, it is a necessity to use a tool that helps users to discover manipulation in the financial statements and accurately indicate how much. This will reduce the probability of a financial crisis from happening; in turn aid inves-tors escape extreme harm in the stock market. This tool benefits managers, po-tential investors, suppliers, customers, creditors, lenders, and others.

Investors and financial analysts depend on financial statements to rate credit risk. Predicting financial distress using Altman's Z-score is one of the popular methods used as indicated by (Toly et. al., 2020; Amanollahi, 2018; Abdul-kareem, 2015; Cho & Yu, 2012; Wu, 2010).

To accommodate different industries and for wider acceptance of users like courts, auditors and in the loan evaluation process, the Z-score equations were

subject to adjustments. The Z–score is calculated based on accounting figures from the financial statements, as well as, stock market information. Thus, any change in the accounting figures has significant impact on the accuracy of the predictability of the Z–score.

If companies do not have sufficient resources, they will not be able to continue their operations and will eventually fail (Newton, 2009; Lo, 2008). In the early stages of the bankruptcy, the company management manipulates accounting profit to provide good news to the capital market, thus stopping corporate failure (Campbell et al., 2015; Burgstahler & Eames, 2006; Chan et al., 2001)

Financial distress is of extreme concern to accountants, investors, employees, managers, and creditors because they are influenced the most by this problem (Howe & Houston, 2015). Financial distress is the result of bad management choices of financing policies and their inability of implementing the company's operational plan (Platt, 2006). However, bankruptcy is the legal process by which the debts of firms, individuals, and occasionally governments in financial distress are resolved out of the court (White, 2011). Thus, it can be inferred that, if the financial distress of the company is not immediately detected, it will instantly go bankrupt and will be unable to pay its obligations.

The Altman's Z–score model has gone through many phases. First there is the original Altman's Z–score (1968) model that depended only on the data for publicly held manufacturing businesses. Next, the Z–score method is modified (Altman, 1983) to include other industrial segments like the private manufacturing companies. Consequently, the modified Altman Z–score (1983) model emerged. Further studies are undertaken and finally an even more accurate model is developed for predicting corporate failure (Altman, 1993). This new and improved Altman's Z–score (1993) modified equation can be applied via publicly held manufacturing companies, private manufacturing companies, developing market companies and non–manufacturing companies.

This study strives to confirm the significance of using Altman Z–Score models to maintain the availability of accurate information related to company business health in Egypt. Thus, maintaining quality predictions for company financial dis-

tress and bankruptcy. Accordingly, to protect investors from making harmful business decisions due to inaccurate predictions.

This study seeks to identify the outcome of using Altman Z–Score models for predicting financial distress in Egypt with a spot light on the first wave of the COVID-19. The paper goes on and presents the literature review and study question. Next the paper presents an explanation to the study methodology. After that the paper discloses the results and discussion. Finally is the conclusion.

2- Literature Review

The following starts off with a presentation of a couple of theories that explain why organizations exist and the logic behind the differences in their establishment and performance. These theories are the stakeholder theory and economies of scale. After that, comes the selected observations and findings of previous literature related to the subject matter that justify the concepts .

(Rampling, 2012) supports the stakeholder theory. (Mahoney, 2012) explains that the stakeholder theory assumes that corporate value is a fundamental aspect for doing business. This theory requires managers to clarify the corporate value they create, and identify the factors that bring its primary stakeholders together. The stakeholder theory also encourages managers to be honest about how they presume to carry on with their work. There is a variety of complex business challenges that face companies such as connecting ethics and capitalism, helping managers think about management, understanding how value is created and traded. (Freeman et. al., 2010) encourage stakeholder concept as a means for guidance for stakeholders to handle these business challenges, as well as, building good relations that initiate greater financial returns. The stakeholder theory supports the clear representation and transparency of the corporate value for accurate predictions of the company going concern .

The economy of scale concept confirms that big companies are capable of: negotiating with suppliers and customers, generating and withstanding strategic expansion, competing with their counterparts, and retaining better prices than the competitive level. This theory describes how highly influential big companies are over small companies. This implies that the bigger the company the

more reliable its public information. Accordingly, quality predictions for the company going concern are achieved.

This study is built on the foundations of the stakeholder theory and economies of scale. These theories support the importance of applying the appropriate tool for quality financial distress predictability of the company. Specifically, this study seeks to identify the impact of applying Altman Z–Score models.

Abdulkareem (2015) found studies undertaken in four countries Australia, the UK, Canada and the US to evaluate corporate failure prediction. These studies imply that evolving companies are exposed to financial distress along with private companies. Not only that, but small companies with ineffective supervisory and regulatory policies, as well as weak cash flow, are also significantly exposed to financial distress.

Wu (2010) argues Altman's Z–score (1968) original model is the pioneer to apply ratios in forecasting financial distress. From then on, failure prediction methods have become dependent on financial ratios. The Altman's Z–score (1968) original model is composed of five financial ratios that use the Multiple Discriminant Analysis MDA to evaluate the business performance. In the Altman study, a sample of 66 active and inactive manufacturing companies is tested. From this sample of manufacturing companies, 33 are bankrupt and 33 are well off. After composing a list of 22 financial ratios only five representing liquidity, profitability, leverage, solvency and activity have been taken based on their ability to predict company financial distress .

There are other studies like Ohlson (1980) that used Logistic Regression Analysis over Multiple Discriminant Analysis to predict company financial distress in United States companies. This study tries to define the likelihood of the individual firm failure. Lennox (1999) explored the motives behind corporate failure forecast via the Logistic Regression Analysis. A sample of UK registered companies during 1987 to 1994 was evaluated. Results indicate that fit logit and probit procedures are better for corporate failure forecast than the Multiple Discriminant Analysis. Ranjbar & Amanollahi (2018) use the panel data approach. The study inspects the influence of corporate financial distress on unforeseen net

earnings and corporate profits for businesses listed in the Tehran Stock Exchange during 2010–2015. The linear regression model is applied. Outcomes display that the coefficients of the firm fixed costs, ownership, financial distress, annual sales growth, size, loss, and market share are significant .

Cho & Yu (2012) follow the accruals approach to estimate the difference between actual earnings and estimated earnings that were subject to manipulation. The study recreates the Z–score according to the abnormal accruals adjustments to be able to confirm how much misrepresentation it displays. Results demonstrate that, adjustments for the income–increasing prevented the financial distress prediction from causing significant levels of type I error. This means that firms that are actually financially distressed are classified as no financial distress prediction. Thus, the Cho & Yu (2012) study confirms the importance of understanding and adapting to the changes that might happen in the accounting attributes that constitute the Z–score. Not only that, the study also proposes a way to adjust for such changes when applying the model. Results reveal biases in the financial distress prediction models.

Toly et. al., (2020) aim to project the likelihood for financial distress in a sample of 139 Indonesian publicly registered manufacturing companies during 2016–2018. This is achieved by tracking the effect of the four ratios (working capital / total asset, retained earnings / total assets, earnings before interest and tax / total assets, and book value of equity / total liabilities) that represent Z1, Z2, Z3, and Z4 respectively in the Altman Z–Score 1993 modified equation. This study also explains the influence of every ratio on the financial distress. Out of 139 companies, 55 companies experienced financial distress years 2016 and 2017, and 56 experienced financial distresses year 2018. Logistic Regression Analysis is applied. Results indicate that Z1, Z2, Z3, and Z4 in Altman Z–Score (1993) modified equation have positive impact on the financial distress. More specifically, Z2 that represents retained earnings / total assets and Z3 that represents earnings before interest and tax / total assets are the most significant.

Abdulkareem (2015) inspect the precision and soundness of the Altman Z-score 1983 modified model in forecasting financial distress of 24 private manu-

facturing companies in the UK. Out of these 24, only 12 of them are active and the rest are inactive. Data is obtained from the financial statements. Results show the precision of the Altman Z–score 1983 modified model concerning inactive companies reached 83.3% for one year before financial distress and 66.7% for two years before financial distress. However, results also convey the Z–score 1983 modified model precision for active companies reached 91.7% for one year before financial distress and 81.3% for two years before financial distress. Thus, the projecting capacity of the Altman Z–score 1983 modified model is considered an accurate predictor for company financial distress .

From the above studies presented it is evident that companies can face financial distress that can affect its going concern. The two tools most often used by companies to predict financial distress are the Ohlson and Altman models. Nevertheless, there is a unanimous agreement that the   Altman's Z–score (1968) original model is an appropriate tool, among others, that can be applied to forecast financial distress. However, Altman's Z–score (1968) original model has undertaken a couple of modifications to increase the validity of the financial distress prediction. Studies were made in the USA, Canada, UK, Australia, Indonesia, Iran, Jordan, Nigeria, Japan, India, Finland, Malaysia, Korea on emerging companies private companies small companies, public companies, and large well-established companies. No previous effort has been made to identify the impact of applying Altman's Z–score (1968) original model and its modifications in the Egyptian business environment to forecast financial distress, in turn, the company going concern. Similar work appears to be limited. This study is an effort to decrease this research gap. The purpose is to identify the impact of applying Altman Z–Score models on the quality of financial distress predictability in the Egyptian registered non–financial institutions with a spot light on the COVID–19 pandemic first wave .

Company failure is apparent in the Egyptian business environment during the study period 2016–2020 which was eye catching. From the above brief presentation of previous work done related to the topic on hand the following question arises :

Q1: What is the importance of using the Altman Z-score models for Predicting Financial Distress of Companies in Egypt?

3- Methodology

This study relies on panel data analysis to allow for differences in the form of unobserved individual country and firm effects. Panel data combines both time series and cross– sectional techniques. It is able to provide results that could not be estimated by the individual study of either cross–section or time–series data. This is due to a large number of observations which increase the degrees of freedom and decrease multicollinearity problems. As a result there is improvement in econometric estimations

Out of 18 sectors this study excludes the bank sector and the non–bank financial services sector. Secondary data is collected from the financial statements of nonfinancial institutions registered on the Egyptian stock exchange under the EGX 70 index. This index consists of 70 financial and nonfinancial institutions. The sample consists of 44 firms during the period 2016–2020 equivalent to 220 firm year observations. The sample chosen from this index are nonfinancial institutions that operate in Egyptian pound, have complete required data for the study and have not discontinued their activities for any reason during the study period .

The Altman (Z) score is the output of a credit strength test that evaluates a publicly traded manufacturing company's likelihood of financial distress ultimately leading to bankruptcy. For the Z–score model to be a helpful tool for creditors and investors for making sound credit–rating decisions, it is important that it reflects any changes in the underlying accounting attributes .

The Altman's Z–score (1968) original model is:

$Z= 0.012Z1+0.014Z2+0.033Z3+0.006Z4+0.999Z5$

Where:

Z=cumulative values

Z_1= net working capital/total assets NWC/TA

Z_2= retained earnings/total assets RE/TA

Z_3= earnings before interest and tax/total assets EBIT/TA

Z_4= book value of equity/total liabilities BVE/TL

Z_5= sales/total assets S/TA.

Based upon the original Altman's Z–score 1968 model, the firms are classified into three categories according to their sustainability known as distress zone, safe zone and grey zone. When the Z–score is lower than 1.8, this represents the distress zone. This is an implication of a strong probability of failures. When the Z–score exceeds 2.99, this signifies the safe zone. This infers a weak probability of company failure. When the Z–score is greater than 1.80 and less than 2.99, this suggests the grey area. In this case, the results cannot determine if the company is considered safe or distressed (Altman, 1968).

The modified Altman's Z–score 1983 model is:

$$Z = 0.717Z_1 + 0.847Z_2 + 3.107Z_3 + 0.420Z_4 + 0.998Z_5.$$

The Altman Z–score 1983 modified model sorts firms into distress zone, safe zone, or grey zone according to their sustainability. When the Z–score is less than1.23, this signifies the distress zone. This suggests a strong probability of failures. When the Z–score surpasses 2.9, this implies the safe zone. This assumes a weak probability of company failure. When the Z–score is greater than 1.23 and less than 2.9, the firm is in the grey zone. In this case, the results cannot determine if the company is safe or distressed (Altman, 1983).

The modified Altman Z–score 1993 model is:

$$Z = 6.56\ Z_1 + 3.26\ Z_2 + 6.72\ Z_3 + 1.05\ Z_4.$$

Based on the modified Altman Z–score 1993 model, the firms are classified into three categories according to their sustainability known as distress zone, safe zone and grey zone. When the Z–score is under 1.10 this indicates the distress zone. This proposes a strong probability of failures. When the Z–score tops 2.60, this specifies the safe zone. This deduces a weak chance of company failure. When the Z–score is between 1.10 and 2.60, the firm is in the grey zone. In this case, the results cannot determine whether the company is in the safe zone or the distressed zone (Altman, 1993). It is worth noting that in the modified Altman

Z–score 1983 model the book value of equity is replaced by market value of equity in the Z_4. In the modified Altman Z–score 1993 model Z_5 is excluded.

The Altman Z–score 1968 model and the Altman Z–score 1993 model are applied to determine the firm financial distress. The dependent variable is the Z–score. The independent variables are the ratios in the equation. First, the Altman Z– score 1968 original model is applied. Then, the sum of the Z–score is obtained. Finally, the case of the company financial distress is identified for each business firm.

4- Results and Discussion

Table 1: Descriptive Statistics

Variables	N	Min	Max	Mean	Std. Deviation
Z1	220	-53.53	341.49	1.59	23.35
Z2	220	0.00	103.61	1.27	9.75
Z3	220	-32.85	30.07	0.00	3.02
Z4	220	0.03	45394.29	539.69	4194.59
Z5	220	-0.04	68.28	1.04	5.21
Valid N (listwise)	220				

Source: results of SPSS

Based on table 1 above, the following observations are worth noting. The total study sample was 220 firm year observations equivalent to 44 nonfinancial institutions for a period of 5 years during 2016–2020. The mean for each of Z_1, Z_2 and Z_5 are close in value 1.59, 1.27 and 1.04 respectively. The mean of Z_3 has the least value equal to 0, while the mean of Z_4 has the highest value equal to 540. The high value of the mean of Z_4 ratio give it more weight in calculating the Z–Score, and thus in determining the state of the company in terms of being in financial distress or not.

Table 2: Correlation between ratios

Variables	Z1	Z2	Z3	Z4	Z5
Z1	1				
Z2	.608**	1			
Z3	.782**	.300**	1		
Z4	-0.008	-0.004	-0.002	1	
Z5	.837**	.852**	.389**	-0.021	1

**. Correlation is significant at the 0.01 level
Source: results of SPSS

Based on table 2 above, the correlation between Z_1 and Z_5 is equal to (.837), and the correlation between Z_2 and Z_5 is equal to (.852). These two correlation coefficients are very high as it is higher than (0.8). This implies that by using Z_1, Z_2, and Z_5 in the same logistic regression analysis may cause a multi–collinear problem leading to inaccurate results. In the Altman Z–score 1968 model, Z_1, Z_2, Z_3, Z_4, and Z_5 represent the independent variables. In turn, when applying the logistic regression analysis the problem of multi–collinear exists leading to inaccurate results. However, in the Altman Z–score 1993 model, Z_1, Z_2, Z_3 and Z_4 represent the independent variables and the Z_5 is not included. This means that the problem of multi–collinear may not exist.

4-1 Logistic Regression Test for Altman Z-Score 1968 model

Table 3: Altman Z-Score 1968 model

Company name	2016	2017	2018	2019	2020
AJWA for food industries company Egypt	1.07	1.37	0.88	0.24	0.14
Alexandria spinning and weaving	-0.03	0.52	0.53	0.38	0.18
Amer group holding	0.74	0.73	0.58	0.41	0.32
Arab cotton ginning	27.7	2.21	6.44	9.13	23.9
Arab real estate investment co-ALICO	0.56	9.28	0.57	0.62	0.63
Arabian cement company	1.59	2.28	1.92	1.92	1.26
Asek company for mining (ascom)	-0.05	-0.55	-0.31	-0.11	0.32
Cairo poultry	1.69	1.69	2.14	0.61	0.79
Canal shipping agencies	1.25	1.53	1.99	1.93	2.15
Ceramic and porcelain	1.85	1.93	2.24	0.79	0.82
Delta construction and rebuilding	0.78	0.64	0.61	0.8	0.88
Development and engineering consultants	1.27	1.58	0.96	0.72	0.84
Dice sport and casual wear	-0.08	1.62	1.53	1.3	0.43
Edita food industries SAE	1.34	1.13	1.92	1.84	1.57
Egyptian chemical industries (kima)	701.04	3.47	59.06	207.12	-107.27
Egyptian financial and industrial	0.85	1.28	1.13	1.22	0.97
Egyptian media and production city	0.32	0.42	0.53	0.49	0.39
Electro cable Egypt	0.7	0.68	1.98	1.07	1.25
Elkahera housing	1.17	0.58	1.01	0.18	0.38
Elnasr clothes and textiles (kabo)	0.59	0.89	1.01	0.96	0.08
Elsaeed contracting and real estate investment company SCCD	1.92	1.79	1.73	1.45	1.47
Elwadi for international and investment development	0.38	0.34	0.46	0.41	0.17
Emaar misr for development	0.86	0.87	0.89	0.66	0.57
Giza general contracting	1.86	1.81	1.8	1.58	1.31
Ismailia development and real estate co	1.16	1.15	1.14	1.15	1.26
Ismailia misr poultry	0.85	0.92	1.07	1.02	0.71
Lecico Egypt	0.94	0.43	0.63	0.44	0.4

Mena touristic and real estate investment	1.2	0.89	0.13	0.64	-0.22
Misr cement (qena)	0.81	0.51	0.79	0.74	0.63
Natural gas and mining project (egypt gas)	1.47	1.1	1.03	0.8	0.62
Obour land for food industries	2.63	3.38	3.29	2.87	2.95
Paint and chemicals industries (pachin)	1.64	1.6	2.53	2.32	2.12
Porto group	0.34	0.75	0.26	0.52	0.32
Rakta paper manufacturing	-0.16	-0.41	-0.47	-1.39	-2.58
Reacap financial investments	0.92	0.62	0.77	0.11	0.1
Remco for touristic villages construction	0.24	0.52	0.55	0.61	-0.05
Rowad tourism (alrowad)	0.58	1.03	0.91	1.26	0.77
Six of october development and investment sodic	0.53	0.19	0.22	0.39	0.75
South valley cement	0.7	0.53	0.33	-0.1	0.13
The arab ceramic co ceramica remas	1.63	1.7	1.61	1.48	1.41
The arab dairy products co arab dairy-panda	1.1	1.59	2.03	1.64	1.12
The egyptian company for construction devel-opment-lift slab	0.87	0.26	0.14	0.37	0.53
United arab shipping	-0.87	-4.04	-3.71	-3.4	-4.71
Zahraa maadi investment and development	1.11	0.9	0.93	0.86	1.02

■ Financial Distress   □ Grey Area   □ Non-Financial Distress

Source: results of SPSS

In table 3 above, the Z–Score in the Altman Z–Score 1968 model was calculated for each company every year using the following formula:

$$Z \text{ score}=1.2Z_1+1.4Z_2+3.3Z_3+0.6Z_4+0.999Z_5$$

According to table 3 (Altman Z–Score 1968 original model), the number of non–financial firms facing financial distress out of a sample of 44 were: 38 year 2016, 37 year 2017, 33 year 2018, 37 year 2019, and 40 year 2020.

Table 4: Omnibus Tests of Model Coefficients

	Chi-square	Df	Sig.
Step	60.273	5	0.000
Block	60.273	5	0.000
Model	60.273	5	0.000

Source: results of SPSS

According to table 4 above, the Omnibus Tests of the Model Coefficients show the significance value is 0.000 which is less than 0.05 for the five independent variables that make up the Altman Z–Score 1968 model. Thus, this test estimates financial distress and the regression model is fit for use and the independent variables have a significant influence on the dependent variable.

Table 5: Model Summary

Step	-2 Log likelihood	Nagelkerke R Square
1	132.518	0.411

Source: results of SPSS

Nagelkerke R Square is a goodness of fit measure that describes how well the statistical model fits the data. According to table 5 above, the Model Summary show the Nagelkerke R Square value equals 0.411 suggesting only 41% of the cases of the financial distress variable are explained by the five $(Z_1, Z_2, Z_3, Z_4 \text{ and } Z_5)$ independent variables that make up the Altman Z–Score 1968 original model applied in this study. The rest (59% of the cases) are explained by other external factors.

Table 6: Hosmer and Lemeshow Test

Step	Chi-square	Df	Sig.
1	9.378	8	0.311

Source: results of SPSS

Hosmer and Lemeshow Test calculates if the observed values match the predicted values. If the significance value of the test is higher than 0.05 it means that expected values are nearly the perceived values. This indicates the goodness of fit for the model. According to table 6, the Hosmer and Lemeshow Test show the significance value is equal to 0.311. This suggests that the logistic regression approach can anticipate the value of observation since the significance value is greater than 0.05. Therefore, the Altman Z–Score 1968 is accepted because it matches the observational data.

Table 7: Classification Table

Observed		Predicted		
		Financial Distress		Percentage Correct
		Non-Financial Distress	Financial Distress	
Financial Distress	Non-Financial Distress	183	2	98.9
	Financial Distress	22	13	37.1
Overall Percentage				89.1

Source: result of SPSS

According to table 7 above, the Classification Table shows the Altmen Z-Score 1968 original model the overall Percentage Correct for logistic regression is 89.1%. This means that the model can predict 89.1% of financial distress values correctly. The proportion of 98.9% represents classification correctness for non-financial distress companies. There are 2 observation errors in the financial distress group and 183 observations that can be properly projected. The proportion of 37.1% exemplifies classification correctness financial distressed companies. There are 22 observation errors and 13 observations that can be accurately forecasted. This ratio is considered weak, as the model could not predict the financial distress situation correctly for the majority of the companies.

Table 8: Logistic Regression Analysis Results of Altman Z-score1968 model

Variables	B	S.E.	Wald	df	Sig.
Z1	-0.555	0.134	17.064	1	0.000
Z2	0.107	0.082	1.727	1	0.189
Z3	2.354	0.791	8.851	1	0.003
Z4	0.478	0.215	4.947	1	0.026
Z5	1.723	0.379	20.631	1	0.000
Constant	-2.917	0.360	65.617	1	0.000

Source: results of SPSS

The Effect of (Z_1) on Financial Distress

In line with table 8, the logistic regression test for the Altman Z-Score 1968 original model results convey that the significance level of Z_1 is equal to 0.00, which is less than 0.05. This implies that Z_1 has a substantial impact on the financial distress. The coefficient of Z_1 (Beta value) is equal –0.555. Thus, the Z_1 ratio is negatively related to financial distress. This means when the value of the Z_1 ratio increases/decreases, the likelihood of businesses experiencing financial distress decreases/increases.

The Effect of (Z_2) on Financial Distress

In table 8, the logistic regression examination for the Altman Z-Score 1968 model results convey that the significance level of Z_2 is equal to 0.189, which is higher than 0.05. This implies the coefficient of Z_2 is insignificant, which means that Z_2 has no significant impact on the financial distress.

The Effect of (Z_3) on Financial Distress

In table 8, the logistic regression examination for the Altmen Z–Score 1968 model results convey that the significance level of Z_3 is equal to 0.003, which is less than 0.05. This implies that Z_3 has a significant impact on the financial distress. The coefficient of Z_3 (Beta value) is equal 2.354. Thus, the Z_3 ratio is positively connected to financial distress. This indicates that when the value of the Z_3 ratio increases/decreases, the likelihood of businesses experiencing financial distress increases/decreases.

The Effect of (Z_4) on Financial Distress

In table 8, the logistic regression examination for the Altman Z–Score 1968 model results convey that the significance level of Z_4 is equal to 0.026, which is less than 0.05. It implies that Z_4 has a significant impact on the financial distress. The coefficient of Z_4 (Beta value) is equal 0.478. Thus, the Z_4 ratio is positively associated to financial distress. This infers that when the value of the Z_4 ratio increases/decreases, the likelihood of businesses experiencing financial distress increases/decreases.

The Effect of (Z_5) on Financial Distress

In table 8, the logistic regression examination for the Altman Z–Score 1968 model results convey that the significance level of Z_5 is equal to 0.00, which is less than 0.05. This implies that Z_5 has a significant impact on the financial distress. The coefficient of Z_5 (Beta value) is equal 1.723. Thus, the Z_5 ratio is positively related to financial distress. This proposes that when the value of the Z_5 ratio increases/decreases, the likelihood of businesses experiencing financial distress increases/decreases.

4-2 Logistic Regression Test for Altman Z-Score 1993 model

Table 9: Altman Z-Score 1993 model

Company name	2016	2017	2018	2019	2020
AJWA for food industries company Egypt	-1.13	-1.48	-2.18	-3.24	-4.08
Alexandria spinning and weaving	-0.83	0.64	0.65	0.43	0.85
Amer group holding	1.29	1.56	1.33	0.98	0.77
Arab cotton ginning	49.29	4.02	12.26	16.85	42.7
Arab real estate investment co–ALICO	1.87	50.05	2.55	2.83	2.82

Arabian cement company	5.53	6.48	5.31	5.4	4.2
Asek company for mining (ascom)	-1.48	-4.28	-4.2	-3.89	-1.27
Cairo poultry	1.06	3.35	0.77	0.49	1.16
canal shipping agencies	3.98	5.09	6.38	6.28	6.92
ceramic and porcelain	3.95	3.59	3.94	0.82	0.1
delta construction and rebuilding	2.95	2.61	2.14	2.16	2.86
development and engineering consultants	4.41	3.59	2.8	2.12	3.14
dice sport and casual wear	-2.77	1.09	1.35	0.86	-0.91
Edita food industries SAE	0.99	-0.04	1.32	1.83	1.33
Egyptian chemical industries (kima)	2730.54	5.88	136.84	490.61	-475.29
Egyptian financial and industrial	0.47	1.34	0.92	1.4	1.26
Egyptian media and production city	0.68	1.13	1.52	1.25	0.72
electro cable Egypt	-0.22	-0.17	2.26	0.96	1.95
Elkahera housing	3.39	1.13	2.52	0.99	1.57
Elnasr clothes and textiles (kabo)	0.75	1.7	1.81	1.54	-0.38
Elsaeed contracting and real estate investment company SCCD	5.09	4.94	5.05	4.17	4.06
Elwadi for international and investment development	1.29	1.13	0.89	0.42	-0.18
Emaar misr for development	2.8	2.83	2.72	2.25	2.05
Giza general contracting	3.1	3.46	2.93	2.47	2.5
Ismailia development and real estate co	6.32	6.28	6.23	6.25	6.45
Ismailia misr poultry	0.89	0.96	0.95	0.38	-0.14
lecico egypt	1.4	-0.09	-0.01	-0.52	-0.65
Mena touristic and real estate investment	2.55	4.19	1.03	1.87	0.09
Misr cement (qena)	0.39	0.15	-0.33	0.21	-0.4
Natural gas and mining project (egypt gas)	2.76	1.92	1.19	0.7	0.26
Obour land for food industries	2.43	3.34	3.58	2.82	2.98
Paint and chemicals industries (pachin)	4.44	4.47	4.85	4.37	4.02
Porto group	0.22	0.85	1.45	2.2	1.78
Rakta paper manufacturing	-1.62	-4.04	-4.7	-5.86	-8.48
Reacap financial investments	3.59	2.76	2.89	0.31	0.28
Remco for touristic villages construction	0.55	1.16	1.57	1.85	-0.44
Rowad tourism (alrowad)	2.14	3.36	3	4.02	2.94
Six of october development and investment sodic	1	-0.14	-0.1	0.71	3
South valley cement	1.77	1.41	0.86	-0.49	0.42
The arab ceramic co ceramica remas	1.53	1.11	1.65	1.2	1.46
The arab dairy products co arab dairy-panda	-0.82	-1.35	1.51	1.15	-0.05
The egyptian company for construction development-lift slab	4.15	0.59	-0.04	0.93	2.11
United arab shipping	-1.28	-11.37	-12.23	-11.09	-13
Zahraa maadi investment and development	3.14	2.95	2.95	3.16	3.17

☐ Financial Distress   ☐ Grey Area   ☐ Non-Financial Distress

Source: results of SPSS

The Z–Score in this model was calculated for each company every year using the   following

formula:

$$Z - Score = 6.56Z_1 + 3.26Z_2 + 6.72Z_3 + 1.05Z_4$$

According to table 9 (Altman Z–Score 1993 modified model), the number of non–financial companies experiencing financial distress out of 44 companies were: 18 year 2016, 15 year 2017, 15 year 2018, 20 companies in 2019, and 21 companies in 2020.

Table 10: Omnibus Tests of Model Coefficients

	Chi-square	Df	Sig.
Step	268.950	4	0.000
Block	268.950	4	0.000
Model	268.950	4	0.000

Source: results of SPSS

According to table 10 above, Omnibus Tests of the Model Coefficients show significance value is 0.000 for the four $(Z_1, Z_2, Z_3 \text{and} Z_4)$ independent variables that is less than 0.05. This confirms the Altman Z–Score 1993 modified model can accurately estimate financial distress. In addition, the logistic regression analysis is considered viable to apply. The independent variables have a vital in–fluence on the dependent variable.

Table 11: Model Summary

Step	-2 Log likelihood	Nagelkerke R Square
1	27.967	0.953

Source: results of SPSS

Nagelkerke R Square is a goodness of fit measure that describes how well the statistical model fits the data. According to table 11 above, Model Summary show the Nagelkerke R Square value is 0.953. Thus, 95.3% of the cases of the financial distress variable are explained by the four $(Z_1, Z_2, Z_3 \text{and} Z_4)$ independ–ent variables that make up the Altman Z–Score 1993 model applied in this study, while the rest (4.7% of the cases) are explained by other external factors.

Table 12: Hosmer and Lemeshow Test

Step	Chi-square	Df	Sig.
1	12.928	8	0.114

Source: results of SPSS

Hosmer and Lemeshow Test calculates if the observed values match the predicted values. When the significance value is higher than 0.05 then, predicted values are close to observed values. This indicates the goodness of fit for the model. According to table 12, the Hosmer and Lemeshow Test show the significance value is equal to 0.114. This implies that the logistic regression analysis is able to forecast the value of observation since the significance value is greater than 0.05. Therefore, the Altman Z–Score 1993 modified model is accepted because it matches the observed data.

Table 13: Classification Table

Observed		Predicted		
		Financial Distress		Percentage Correct
		Non-Financial Distress	Financial Distress	
Financial Distress	Non-Financial Distress	131	0	100.0
	Financial Distress	2	87	97.8
Overall Percentage				99.1

Source: results of SPSS

According to table 13 above, the classification table shows that for the Altman Z–Score 1993 modified model the whole Percentage Correct for logistic regression is 99.1%. This means that the Altman Z–Score 1993 modified predicts 99.1% of financial distress values correctly. The full 100% represents the classification correctness for non–financial distressed companies. It implies there are no errors in the financial distress group. Thus Altman Z–Score 1993 model can predict 100% of companies experiencing non–financial distress correctly. The portion of 97.7% represents the classification correctness for companies experiencing financial distress. There are only 2 errors and 87 correct estimations. This means that Altman Z–Score 1993 model can predict 97.8% of companies that experiencing financial distress correctly, while only 2 values were incorrect. This high

ratio is considered very good, as the Altman Z–Score 1993 model could predict the financial distress situation correctly for most companies.

Table 14: Logistic Regression Analysis Results for Altman Z-Score 1993 model

Variables	B	S.E.	Wald	Df	Sig.
Z1	-46.582	10.435	19.926	1	0.000
Z2	-24.808	7.174	11.957	1	0.001
Z3	-47.818	11.065	18.674	1	0.000
Z4	-2.166	4.671	0.215	1	0.643
Constant	7.851	1.747	20.196	1	0.000

Source: result of SPSS

The Effect of (Z_1) on Financial Distress

In table 14, the logistic regression examination for the Altman Z–Score 1993 modified model results convey that the significance level of Z_1 is equal to 0.00, which is less than 0.05. This implies that Z_1 has a significant impact on the financial distress. The coefficient of Z_1 (Beta value) is equal –46.582. So, a negative relationship exists. This means that when the value of the Z_1 ratio increases/decreases, the likelihood of businesses experiencing financial distress decreases/increases.

The Effect of (Z_2) on Financial Distress

In table 14, the logistic regression examination for the Altman Z–Score 1993 modified model results convey that the significance level of Z_2 is equal to 0.00, which is less than 0.05. This implies that Z_2 has a significant impact on the financial distress. The coefficient of Z_1 (Beta value) is equal –24.808. Thus, a negative relationship exists. This negative relation suggests that when the value of the Z_2 ratio increases/decreases, the likelihood of businesses experiencing financial distress decreases/increases.

The Effect of (Z_3) on Financial Distress

In table 14, the logistic regression analysis for the Altman Z–Score 1993 modified model results convey that the significance level of Z_3 is equal to 0.00, which is less than 0.05. This implies that Z_3 has a significant impact on the financial distress. The coefficient of Z_3 (Beta value) is equal –47.818. Consequently, a

negative relationship exists. This negative relation proposes that when the value of the Z_3 ratio increases/decreases, the likelihood of businesses experiencing financial distress decreases/increases.

The Effect of (Z_4) on Financial Distress

In table 14, the logistic regression examination for the Altman Z–Score 1993 modified model results convey that the significance level of Z_4 is equal to 0.643, which is higher than 0.05. This implies the coefficient of Z_4 is insignificant, which means that Z_4 has no significant impact on the financial distress.

The findings are summarized as follows:

According to table 3 (Altman Z-Score 1968 original model), the number of non–financial companies facing financial distress out of a sample of 44 were: 38 year 2016, 37 year 2017, 33 year 2018, 37 companies in 2019, and 40 companies in 2020.

According to table 9 (Altman Z–Score 1993 modified model), the number of non–financial companies experiencing financial distress out of 44 companies were: 18 year 2016, 15 year 2017, 15 year 2018, 20 companies in 2019, and 21 companies in 2020.

The first (Altman Z–Score 1968 original) model is estimated using the five ($Z_1, Z_2, Z_3, Z_4,$ and Z_5) ratios as independent variables. The second (Altman Z–Score 1993 modified) model is estimated using the four ratios ($Z_1, Z_2, Z_3,$ and Z_4) as independent variables excluding Z_5 ratio.

When comparing the Nagelkerke R square goodness–of–fit measure of the two models, findings indicate Nagelkerke R square of the Altman Z–Score 1968 model is equal 0.411 and 0.953 for Altman Z–Score 1993 model. That is to say that the Nagelkerke R square of the Altman Z–Score 1968 model is less than Altman Z–Score 1993 model. This implies that the Altman Z–Score 1993 model is better than the Altman Z–Score 1968 model in terms of fitting the data.

When comparing the correctness of the prediction between the two models, it was found that Altman Z–Score 1968 model can correctly predict 89.1% of

financial distress values, while Altman Z–Score 1993 model can correctly predict 99.1% of financial distress values. Thus, the Altman Z–Score 1993 model has better predictions validity than the Altman Z–Score 1968 model.

All these differences between the two (Altman Z–Score 1968 and Altman Z–Score 1993) models led to different estimated values of the model coefficients. The coefficient of (Z_1) was significant and negative in both models, which means that the Z_1 ratio is negatively related to financial distress. The coefficient of (Z_2) was significant and negative in only the Altman Z–Score 1993 model, while it was insignificant in the Altman Z–Score 1968 model. The coefficient of (Z_3) was significant in both models. However, it was positive in the Altman Z–Score 1968 model and negative in the Altman Z–Score 1993 model. The coefficient of (Z_4) was significant and positive in only the Altman Z–Score 1968 model, while it was insignificant in the Altman Z–Score 1993 model.

The most obvious reason for these differences among the coefficients of the (Altman Z–Score 1968 and Altman Z–Score 1993) models is the presence of the Z_5 in the first model, and its absence in the second model respectively. According to table 2, Z_5 ratio is highly correlated with Z_1 and Z_2. This means that Altman Z–Score 1968 original model suffers from multicollinearity, which leads to inaccurate results. However, the Altman Z–score 1993 modified model excludes Z_5 as an independent variable, which means that the problem of multicollinearity may not exist. Therefore, the results of the Altman Z–score 1993 modified model has higher precision over the Altman Z–Score 1968 original model.

5- Conclusions

Failure is a common problem that faces small and big institutions in established and evolving economies. Therefore, a country's economy and people may experience substantial harm and massive costs from financial distress that ultimately leads to the bankruptcy.

There are many reasons that lead a company to failure such as the weakness and inefficiency of the company's directors and various surrounding external environmental conditions. The sample data was evaluated by the Altman Z–score 1968 original model then reevaluated by the Altman Z–score 1993 modified

model. Results imply there is deficiency and inaccuracy in the financial information of listed Egyptian non-financial firms before and during the COVID19 pandemic. The Ministry of Health and Population of Egypt, table 15, announced from January 2020 till June 2020 there is a sharp monthly escalation in the COVID-19 confirmed cases and a sharp monthly rise in the COVID-19 death cases that are still proceeding till now.

Table 15: confirmed cases and death cases of COVID-19

Year 2020	January	February	March	April	May	June
Confirmed Cases	0	2	710	5537	24985	68311
Death Cases	0	0	46	392	959	2953

Source: Ministry of Health and Population of Egypt announcement 2020

According to table 4 Altman Z-Score 1968 original model the number of non-financial companies facing financial distress out of a sample of 44 were: 38 year 2016, 37 year 2017, 33 year 2018, 37 year 2019, and 40 year 2020.

According to table 10 Altman Z-Score 1993 modified model the number of non-financial companies experiencing financial distress out of 44 companies were: 18 year 2016, 15 year 2017, 15 year 2018, 20 year 2019, and 21 year 2020.

The Altman Z-Score 1968 original model is estimated using the five (Z_1, Z_2, Z_3, Z_4, and Z_5) ratios as independent variables. The Altman Z-Score 1993 modified model is estimated using the four ratios (Z_1, Z_2, Z_3, and Z_4) as independent variables excluding Z_5 ratio. This implies that the Altman Z-Score 1993 modified model is better than the Altman Z-Score 1968 original model in terms of fitting the data. Also, the Altman Z-Score 1993 modified model has improved predictions validity than the Altman Z-Score 1968 original model.

The most obvious reason for these differences among the coefficients of the (Altman Z-Score 1968 and Altman Z-Score 1993) models is the presence of the Z_5 in the first model, and its absence in the second model respectively. Therefore, the results of the Altman Z-score 1993 model were better than the Altman Z-Score 1968 model.

The paper studies five years during 2016-2020 representing a snapshot that is enough to capture the changes that took place leading to financial distress. Find-

ings indicate that applying Altman Z–Score models have a significant impact on the quality of financial distress predictability. Findings also indicate that the modified Altman Z–score (1993) model presents better results than the Altman Z–Score (1968) model for the prediction of the future financial distress of firms and the probable causes that might influence investor decisions and firm financial performance. In future studies this sample can be increased for more accuracy. In addition, further studies can be made to test the influence of the quality of cor–porate governance structures on the level of financial distress.

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