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# Using Altman's Z-Score Model to Predict Corporate Failure: The Case of Iraqi Private Companies

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***Abstract***

This study examines the validity of Altman's Z-score model to predict corporate failure in the case of 10 Iraqi private companies between 2007 and 2016, using the Generalised Method of Moments system. The results show that the lagged Z-score has an insignificant negative effect on the contemporaneous firm Z-score. However, working capital to total assets (X1), retained earnings to total assets (X2), profit before interest and tax to total assets (X3), book value of equity to total liabilities (X4) and sales to total assets (X5) have a positive effect on a firm's Z-score. X1 and X4 are significant at 1%, X3 and X5 are significant at 5% and X2 is insignificant in determining the corporate failure in Iraqi private companies. This study therefore suggests, among many other recommendations, that Iraqi firms should apply financial analysis models to evaluate the results of their work in the event of corporate failure. The results of this research clearly show that this is likely to be important for these companies and for their shareholders and other individuals, such as investors.

***Keywords****: Corporate failure, bankruptcy, Z-score, Altman model.*

***JEL Codes****: G17; G30*

## 1.0 Introduction

There has recently been a significant increase in the number of firms established worldwide in general and in Iraq in particular. Moreover, whilst all firms attempt to make a profit and increase the value of their shares, companies will not always succeed in doing so and may sometimes incur losses. According to Altman et al. (2015), it is natural for firms to face both periods of success and failure. The majority of companies attempt to secure a safe position and find ways to reduce the possibility of failure by predicting financial failure in advance. In a study of energy corporations in Taiwan over a six-year period, Ko et al. (2016, cited in Apan et al., 2018) argue that profitability will be reduced when firms experience financial difficulties. Almamy et al. (2016) believe that forecasting financial difficulties is an important topic for several industries, individuals and the government. Similarly, Chavez and Hernandez (2018) point out that avoiding failure in firms can be done by making predictions regarding their financial status. In addition, firms facing financial difficulties might have a wider effect on the economy as a whole. For instance, Sulub (2014), Mohammed and Soon (2012) and Richardson et al. (1994) confirm that as the level of employment and the state of the economy are affected by the failure of firms, it is necessary to predict financial failure in advance.

A number of methods can be used to predict a company's potential for bankruptcy given the real risk it poses (Badea and Matei, 2016). One of the best methods to predict corporate failure may be financial analysis. As Tyagi (2014) notes, financial analysis requires knowledge of the financial conditions and wellbeing of companies. Maricica and Georgeta (2012) suggest that a good forecaster of corporate failure is financial ratios. Furthermore, Oz and Simga-Mugan (2018) confirm that the requirement for the initial detection of liquidation and financial loss is a perfect choice of financial ratios. Similarly, Prihadi (2011 cited in Mrthy et al., 2018) argues that an indicator of the financial failure of a company could be financial ratios. Alifiah and Tahir (2018) point out that there are four determinants of financial failure, namely liquidity ratios, profitability ratios, leverage ratios and the management of asset ratios. It is likely to be beneficial for companies to study their financial conditions if they are to avoid bankruptcy. As Ng et al. (2011) and Altman (1984) suggest, the recognition of possible failure from the start is necessary for the company.

The main aim of this paper is to use Altman's model to predict the risk of company failure in the industrial sector of Iraq. For this purpose, 10 companies were selected from 28 firms on the basis of the availability of data concerning their financial conditions from 2007 to 2016. The companies investigated in this study were Al Hilal Industries, Al-Kindi Veterinary Vaccines Drugs, Baghdad Soft Drinks, Iraqi Carton Manufactories, Iraqi Date Processing and Marketing, Iraqi Engineering Works, the Iraqi Company For Tufted Carpets and Floor Coverings, Modern Sewing, National Chemical and Plastic Industries and Ready Made Clothes.

## 2.0 Literature review

### 2.1 The concept of corporate failure

There are many definitions of business failure. For instance, Mendes et al. (2014) defined a failure situation as a performance. Furthermore, Mohammed and Soon (2012) indicated that if a firm's current liabilities exceed its assets, insolvency will result. Likewise, Wu (2010), Beaver (1966) and Bunyaminu and Bashiru (2014) state that when firms are unable to cover their financial obligations to individuals, this situation is termed company failure.Gkouma et al. (2018) state that becoming insolvent and moving to liquidation is termed firm failure. Moreover, when a government loses income from different sources and the unemployment rate increases, this situation is termed bankruptcy. However, Sun et al. (2014) describe having a specific type of financial problem as financial distress. For example, when a firm's stock prices are 10% lower than pre-determined prices, this situation is called financial distress (Bose, 2006, cited in Sun et al.,2014). It should be noted that the simplest definition could be a situation in which an enterprise cannot afford its expenses and will cease operating.

### 2.1 The causes of business failure

The reasons why firms fail are many and varied (Arasti, 2011: 7490). One of the main reasons for corporate failure, as stated by Levratto (2013), is the internal and external circumstances of a firm, including managerial mistakes, competition, and loss of clients. In addition, according to Bradley and Rubach (2002), normal catastrophes and accidents could affect a firm's work. Arasti (2011) examined the main reasons for corporate failure in a sample of Iranian firms and found that absence

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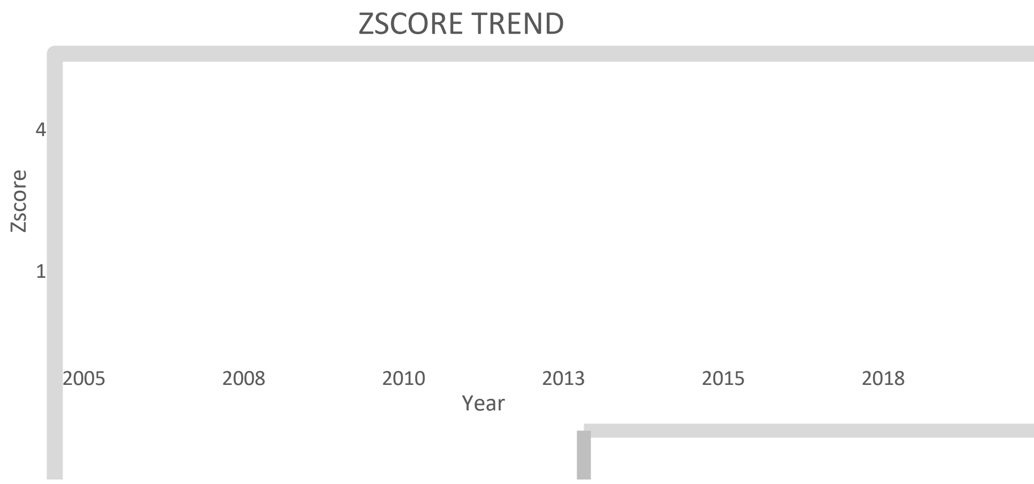
of good management is one of the main reasons why companies fail. According to Shepherd (2003), if a company has insufficient experience, this could lead to its failure. Finally, Ibrahim (2017) showed that some companies may keep less money in their accounts in order to increase profits, which could be an additional reason for company failure.

### 2.3 Corporate failure prediction models in Iraq

Predicting financial failure may have an important effect on managing the work of institutions and economic growth. However, few studies have investigated different industrial sectors in Iraq. Rammo and Al-Wattar (2010) applied the Altman model on 17 Iraqi industrial businesses quoted in the ISE and found it to be a good predictor of a company's failure. Moreover, the Altman model was applied by Al-Brifkani (2017) on a sample of 19 Iraqi private banks; it was recommended that banks should adopt models of financial analysis to ascertain their conditions. Alhamdani and Alqattan (2013) used the Sherrod model to predict company failure in a sample of pharmaceutical companies in Nineveh. Babela and Mohammed (2016) used the Sherrod and Kida models to predict corporate failure in a sample of 16 banks quoted in the ISE over a four-year period. They found the Sherrod model to be a better predictor of bankruptcy than the Kida model. It is important to note that it is still not clear which model is most suitable for the Iraqi economic environment; this is the main contribution of this study. The Z-score trend in Iraq is shown below to indicate changes in the stability of Iraqi corporate firms. The graph shows that there has been instability leading to corporate failure, and a suitable model therefore needs to be developed to predict this instability.




Source: Authors' calculation based on data from 10 Iraqi companies.

### 2.3.1 Altman's Z-score (1968) model

The Z-score model for predicting a firm's failure was developed by Edward Altman in 1968 and has been widely accepted since the mid-1980s. It is interesting to note that Al-Ali (2018) and Ko et al. (2017) consider Altman's model to have been widely used to estimate financial distress. Furthermore, it is not surprising to note that several authors believe that Altman's model is appropriate for predicting business failure. Anjum (2012) argues that over the past 40 years, Altman's revised Z-score model has been used as an effective form of multiple discriminant analysis in research. Similarly, Mohammed and Soon (2012) argue that the most beneficial tools for predicting business failure are the current ratio and Altman's model. In a study of Slovak firms over a five-year period, Boda and Úradníček (2016) show that Altman's model is useful for forecasting business failure. Hence, the failure to test this model in Iraq led to its testing in this study.

The equationbelow is a classical model of Altman's Z-score.

$Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 0.999X5.$

The revised model of Altman's Z-score is written as shown below.

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

**Where:**

**Z =** Z-score of a firm

**X1=** Working capital / total assets

**X2=** Retained earnings / total sales

**X3=** Earnings before interest and taxes / total assets

**X4=** Book value of equity / book value of total liabilities or reciprocal of debt-equity ratio

**X5=** Sales / total assets.

## 2.4 Empirical studies

Balcaen and Ooghe (2006) note that a considerable number of studies have attempted to find the best model for predicting business failure. It is important to note that many authors have used the Altman model for predicting corporate failure around the world, rather than focusing on a single country. As Laitinen and Kankaanpaa (1999) note, there has been extensive research into the prediction of business failure around the world. It is clear that these studies, carried out by a range of authors, have used different models for this purpose. However, the Altman model could be a good model for forecasting a firm's failure. Altman et al. (2015) stated that Altman's Z-score model could be appropriate for Italian firms with some exceptions. Similarly, a study of 40 quoted real estate firms in China by Yi (2012) found the Z-score model to be appropriate for the early cautioning of these companies.

In a study of 32 medium and small companies in Mexico, Chavez and Hernandez (2018) found that a high percentage of companies inhabit in a safe zone and about 3.1% of them have financial difficulties according to Altman's Z-Score. Hayes et al. (2010) examined the Z-score model in 17 companies over a two-year period and found that it predicted future financial distress in 94% of cases. Baranyi et al. (2018) found that the stability of 46% of companies not listed on Hungary's stock exchange could be identified using an adjusted Altman model. In another study, Soon et al. (2013) used the Altman Z-score to examine 52 firms registered in the Stock Exchange of Malaysia over an eight-year period and found it to have a positive effect on these enterprises. Moreover, they found that all these corporations were experiencing unfavourable financial conditions. Merkevicius et al. (2006) used two models to investigate companies listed on the NASDAQ and found Altman's z-score to offer a weak prediction of Lithuanian bankruptcy. Another study by Tyagi (2014) of the financial health of logistics industries in India over a seven-year period found that the Altman Z-score rose during this time. Stepanyan (2014) used the Altman Z-score to predict the financial failure of seven of the largest US airlines firms over six years and found that there was a risk that these corporations would fail. It is clear from the above that using Altman's model for the prediction of financial failure has mixed results.

However, some researchers have found the Altman model not to be effective. One reason for this might be because it only contains five variables, and some researchers have found better ones. Another factor that may have an effect, as suggested by Takahashi et al. (2018), is the size of the firm; choosing a larger sample may offer a greater power of explanation. For example, Fito et al. (2018) found the Amat et al.

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model to be preferable to the Altman scoring model in their study of Spanish companies over a ten-year period. Likewise, Apan et al. (2018) compared the Altman and VIKOR methods in a study of 18 companies listed on the BIST-Food and Beverage Index over seven years. They suggested that the VIKOR method is a good method of analysing corporate failure.

Moreover, the environment might have an effect the use of a firm failure model. According to Alammar and Kousayri)2015), an appropriate model for predicting the failure of companies in Syria was developed by Shirata (2002).

## 3.0 Data and Methodology

The main aim of this study was to use the Altman model to predict corporate failure in Iraqi industrial firms. The sample used in this research consisted of 28 private industrial firms. Based on the availability of data on the variables of interest in this study, ten companies were selected for inclusion in the sample: Al Hilal Industries, Al-Kindi Veterinary Vaccines Drugs, Baghdad Soft Drinks, Iraqi Carton Manufactories, Iraqi Date Processing and Marketing, Iraqi Engineering Works, the Iraqi Company for Tufted Carpets and Floor Coverings, Modern Sewing, National Chemical & Plastic Industries and Ready Made Clothes. Secondary data were collected from the annual reports of these companies and all data were available on Iraqi Stock Exchange website. This study focused on the ten-year period from 2007 to 2016.

### 3.1 The Model

The Altman model is shown as:

$$Z'_{it} = \alpha + Q_{it}\beta + \varepsilon_{it} \quad \text{.........................(i)}$$

$$Z'_{it} = \alpha + \psi Z'_{i(t-n)} + Q_{it}\beta + \mu_i + \upsilon_{it} \quad \text{...........(ii)}$$

Where:

$Z'_{it}$ denotes the firm's current Z-score; that is the Z-score of the firm $i$ in period $t$.

$Z'_{i(t-n)}$ denotes the Z-score of the firm $i$ in the period $t-n$ and measures the effect of the firm's past Z-score on its current z-score. It also denotes the dynamic component of the relationship, which is meant to test how the firm's past failure contributes to present failure in Iraq private firms.

The vector $Q$ contains the independent variables (X1, X2, X3, X4 and X5) as postulated by the revised Altman model.

$\alpha, \psi$ and $\beta$ are the parameters to be estimated.

$u_i$ is the firm-specific effect and represents the permanent differences between firms that could not be observed but are likely to be correlated with explanatory variables.

$\upsilon_{it}$ is the remainder disturbance / error term.

Explicitly, the dynamic model will be:

$$Z' = \alpha_{it} + Z'_{i(t-1)} + \beta_1 X1_{it} + \beta_2 X2_{it} + \beta_3 X3_{it} + \beta_4 X4_{it} + \beta_5 X5_{it} + \varepsilon_{it} \quad \text{.........(iii)}$$

The dependent variable and independent variables are described in the figure below.

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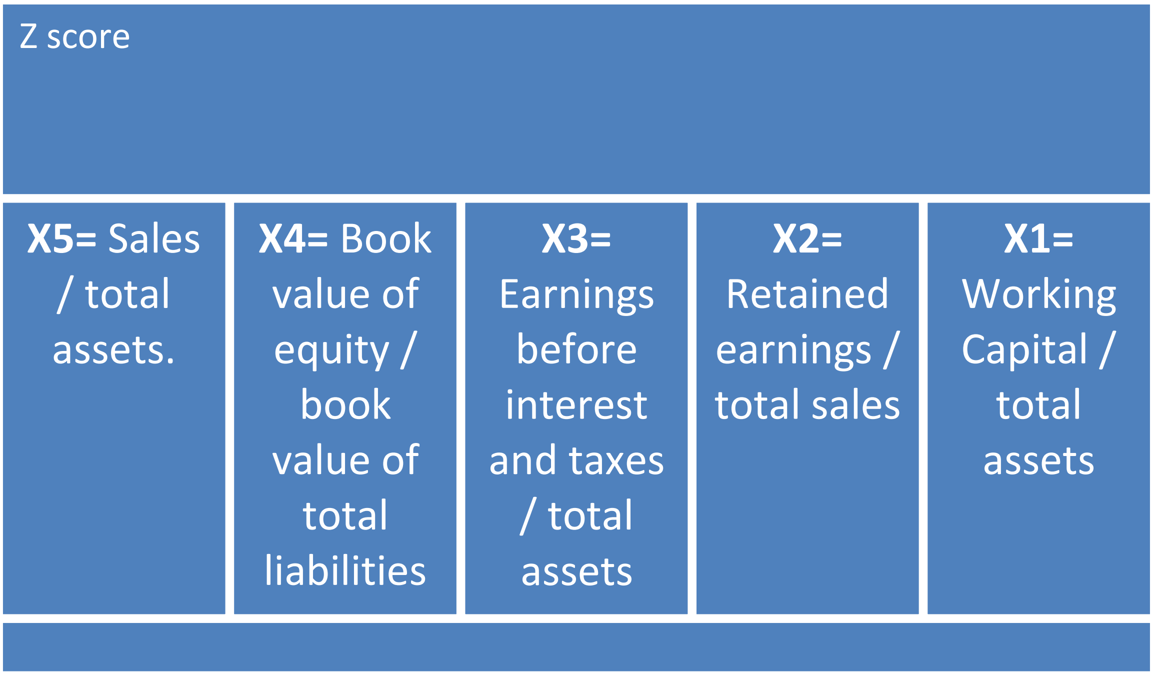


**Figure 1: Explanation of Independent and Dependent Variables.**

### 3.2 Estimating Technique

The choice of a dynamic model for this study is centred on its core persistence over time, as shown in Baltaghi (2008). This concerns the main effects that are specific to heterogeneity among firms as well as the autocorrelation resulting from the inclusion of the lagged dependent variable among the regressors and unobserved interaction effects. Therefore, the GMM approach was considered suitable to produce a consistent estimate in this study as the orthogonality condition might not have been met for a GLS, OLS or FE estimator. Generalised Method of Moments (GMM) is designed for a large or small sample, a sample with a small time-period and a large cross-section, a linear functional relationship and a dynamic model that has its dependent variable between its regressors(Boţoc&Pirtea, 2014).

According to Roodman (2009) and Nzimande and Ngalawa (2017), both differenced and System GMM estimators are designed for panel analysis based on the following assumptions:

a) The process is dynamic in that current realisations of the dependent variable are influenced by past realisations.

b) Arbitrary distributed fixed individual effects might exist in the dynamic model in that there is a constant and substantial change in the dependent variable across some observational units.

c) There are idiosyncratic disturbance terms across cross-sections (individuals).

d) Some regressors are predetermined although not strictly exogenous. It is possible to be independent of the white noise error term, but still influenced by past values, for instance the lagged dependent variable.

e) The panel is small, and some regressors may be endogenous in nature.

f) GMM estimators allow “internal” but not external instruments, chosen based on the sufficient and suitable lag structure of instrumental variables.

The model in iii above is estimated using the System GMM of Blundell and Bond (1998). The choice of the estimator is based on the fact that it has the capacity to eliminate any bias that may arise from dynamic endogeneity by providing more powerful instruments that solve

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the simultaneity bias problem, eliminate unobservable heterogeneity and improve efficiency. System GMM combines the regressions in the first difference with an estimation run in levels, using lagged levels and lagged difference as instruments. Its estimates build a system of two equations: the *transformed and* the *original* equations. For a very robust analysis in this study, the two-step SystemGMM was employed as it has been shown to be more asymptotically efficient than the one-step.

For the post-estimation tests, the Hansen Statistic developed by Hansen (1982) was used, rather than the Sargan statistic, in order to ascertain over-identifying restrictions. The Sargan statistic is not robust to autocorrelation r heteroscedasticity, whereas the Hansen J Statistic is. As a rule of thumb, the p-value of the Hansen statistic should be between 0.1 and 0.25. In addition, the number of instruments should either be less than or equal to the number of cross-sections (Roodman, 2009). More importantly, a necessary condition for System GMM is that the error term does not have second-order autocorrelation, as otherwise the standard error of the instrument estimates will grow exponentially (see Doytch and Uctum, 2011).

## 4.0 Analysing data and discussion

### 4.1 Preliminary Analysis

**Table 1: Description and Summary Statistics of variables**

| Variable | N | Mean | Std Dev | Min | Max |
|---|---|---|---|---|---|
| Z-score | 100 | 3.09577 | 3.3064 | 0.2574471 | 18.8612 |
| X1 | 100 | 0.5057867 | 0.3263312 | 0.0603629 | 2.710515 |
| X2 | 100 | 0.2474356 | 0.4051485 | 0.0000748 | 2.759236 |
| X3 | 100 | 0.3226509 | 0.7810118 | 0.0003438 | 6.155204 |
| X4 | 100 | 3.416979 | 5.681551 | 0.0112175 | 36.04478 |
| X5 | 100 | 0.4888979 | 1.110082 | 0 | 7.46201 |

Source: Author’s computation (2018).

Table 1 shows that the total number of observations is 100, while the mean, minimum, maximum and standard deviation of the respective variables are also shown in the table. From the analysis, X4 has the highest mean and the highest variability as shown by standard deviation. Moreover, X2 has the lowest mean (0.2474356) and X1 has the lowest standard

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deviation. This implies that the book value of equity over the book value of total liabilities ranges over a wider variety of values.

**Table 2: Correlation Analysis**

| Variable | Z-score | X1 | X2 | X3 | X4 | X5 |
|---|---|---|---|---|---|---|
| **Z-score** | **1.0000** | | | | | |
| **X1** | **-0.0002** | **1.0000** | | | | |
| **X2** | **0.3327** | **0.0245** | **1.0000** | | | |
| **X3** | **0.6079** | **-0.0520** | **0.3681** | **1.0000** | | |
| **X4** | **0.6060** | **-0.1194** | **-0.1657** | **-0.1190** | **1.0000** | |
| **X5** | **0.2633** | **0.1205** | **0.3014** | **-0.0237** | **-0.0528** | **1.0000** |

**Source: Author's computation (2018).**

Table 2 shows the degree and direction of association among the variables. All the signs, with the exception of X1, conform with Altman's Z-score. Specifically, X2, X3, X4, and X5 have a positive correlation with the firm's Z-score. On the other hand, X1 is inversely associated with the firm's Z-score. X3 and X4 had the strongest correlation with the Z-score (0.608 and 0.606 respectively) but no serious problem of multicollinearity exists, as the pairwise correlation coefficient did not exceed 0.80 for any of the variables (Gujarati, 2003).

### 4.2 Dynamic Panel Data Estimation: Blundell-Bond Two-Step System GMM

**Table 3: Estimate from System-GMM: Dependent variable, Z-score**

| Variables | Blundell-Bond (Two-step) |
|---|---|
| **L.zscore** | **[-0.004]**<br>**(0.018)**<br>**0.816** |
| **X1** | **[2.123]**<br>**(0.619)**<br>**0.008*** ** |

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| | |
|---|---|
| **X2** | **[1.355]**<br>**(0.895)**<br>**0.164** |
| **X3** | **[2.370]**<br>**(0.734)**<br>**0.010**** |
| **X4** | **[0.464]**<br>**(0.053)**<br>**0.000***** |
| **X5** | **[0.816]**<br>**(0.282)**<br>**0.018**** |
| **Constant** | **[-1.048]**<br>**(0.727)**<br>**0.183** |
| **Observation** | **90** |
| **No. of id (firms)** | **10** |
| **No. of Instruments** | **9** |
| **AR1** | **0.005** |
| **AR2** | **0.410** |
| **Hansen J Stats** | **0.21** |

Notes: Standard errors are in parentheses. Values in [ ] are the coefficients. *** denotes p<0.01 and ** denotes p<0.05. The values for Hansen J. stat, Arellano-Bond for first order serial correlation, AR (1) and Arellano-Bond for second order serial correlation and AR (2) are probability values.

Table 3 contains the estimates from SYS-GMM. The coefficient of the one-year lagged Z-score had a negative but insignificant effect on the firm's current Z-score. Hence, the higher the corporate failure in the preceding year, the lower the failure tends to be in the current year. This also implies that higher failure in the past does not necessarily provide a basis for failure in the firm's future. X1, X2, X3, X4 and X5 had a positive effect on firms' Z-scores (2.123, 1.355, 2.370, 0.464, and 0.816 respectively). X1 and X4 were significant at 1%, and X3 and X5 were significant at 5%, while X2 was insignificant. This implies that X2 is not one of the significant determinants of the Z-scores of Iraq private firms. This confirms the findings of Takahashi et al. (2018), Fito et al. (2018), Apan et al. (2018), Alammar and Kousayri)2015), Alhamdani and Alqattan (2013), Range et al. (2018), and Babela and Mohammed (2016). Conversely, the findings of this study contradict those of Soon et al. (2013), Yi (2012), Soon et al.(2013), Altman et al.(2015), Tyagi (2014), Boda and Úradníček (2016), Rammo and Al-Wattar (2010), Beda and Matei (2016), Hayes et al. (2016) and Al-Ali (2018).

It may be concluded that the Altman Z-score predicts corporate failure in Iraq. In this study, the Z-score for Iraq private firms was $Z = 2.123X1 + 2.370X3 + 0.464X4 + 0.816X5$. This is based on the insignificance of X2.

The probability values of the Arellano-Bond tests for the first and second order autocorrelation (AR (1) and AR (2)) are 0.005 and 0.410 respectively. As was expected, whilst there was high first-order autocorrelation, there was no problem with second order autocorrelation, as it was insignificant. This indicates that the model was well-specified. The numbers of instruments used for System GMM was 9, slightly less than the number of the cross-sections (firms), which was 10. The probability value of the Hansen test is 0.21, which falls between 0.1 and 0.25. This finding conforms with the rule of thumb suggested by Roodman (2009) and confirms the validity of the instruments used in estimating the model.

## 5.0 Conclusion

This study examined the validity of Altman's Z-score model for predicting corporate failure in the case of 10 Iraqi private companies from 2007 to 2016. Whilst it was confirmed that the model holds for Iraqi firms, the modified model used in this study is $Z = 2.123X1 + 2.370X3 + 0.464X4 + 0.816X5$ because X2 is not significant in the case of Iraqi private companies. It is an undeniable fact that the financial position of the companies was weak and the probability of failure is high. This research corresponds with that of Altman et al. (2015), Yi (2012) and Soon et al. (2013) in that the Z-score is a good method of predicting corporate failure, but requires some changes, including adding or eliminating some variables, in order to obtain correct results.

## 6.0 Limitations of the Study and Suggestions for Further Study

There are several factors that might have affected economic growth in Iraq. It should be noted that one of the reasons for declining investment in Iraq is the weaknesses in the industrial sector; foreign investors look for a safe and sophisticated environment in which to facilitate their work and retain funds. In recent years, the war with ISIS has also been another factor that has affected economic growth in Iraq and deterred foreign investors. This study focused on just 10 companies in the industrial sector. However, this does not affect the validity of the findings, as the objective of the study was achieved with relevant data from the 10 companies. Annual reports from other firms were not available for the past ten years, which made the research sample small. It is therefore suggested that further studies on this subject to test the newly modified model described in this study to confirm its validity. Moreover, further research could examine the work of all companies in the Iraqi context in order to obtain clearer results. It should be noted that is necessary to apply more than one model to predict corporate failure and compare it with others in order to find an appropriate model suitable for the economic environment in which Iraqi firms operate.

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