International Journal of Research Publication and Reviews

Investigating the Relationship between Capital Ratios and Altman's Bankruptcy Prediction Model to Predict the Probability of Bankruptcy of Listed Companies

Ali Ahmadabadi

Department of Accounting and Finance, Payame Noor University (PNU), P.O. Box, 4818858565, sari, Iran
ORCID: 0000-0003-2268-8435

❖ *Reducing the possibility of capital loss by predicting the possibility of bankruptcy*
❖ *Correlation of investment ratios with the probability of bankruptcy in the following years*
❖ *appropriate use of investment opportunities, Preventing wastage of resources, advance and Helplessness or bankruptcy of the company.*

A B S T R A C T

1-1 Purpose: defaults in the financial statement often prevent the corporation from accurately reflecting its status in the fiscal year. It is very important to check whether the probability of bankruptcy in the next financial years can be predicted by using financial ratios such as the investment ratios. In this research, it will be investigated whether the investment ratios using 3 indicators ROA, ROE and GPM in the financial statements are correlated and have the ability to predict the level of bankruptcy of the company in the next financial year.

1-2 Result: ROA and GPM ratios in the base year have a positive correlation with the level of bankruptcy risk in the next fiscal year of listed companies and a negative or zero correlation with the ROE ratio. Also, the model used to predict the bankruptcy stage of 22 listed companies in a hypothetical portfolio in the next fiscal year in Iran, using GPM, ROA and ROE ratios of the base year, has been effective in at least half of the cases.

1-3 Enhancing knowledge: with the results obtained in this research market activists are easily able to build a model to predict the probability of bankruptcy of similar companies in a hypothetical portfolio in the next financial year.

1-4 Key words: Bankruptcy prediction, Altman model, equity, total assets, financial statements.

1-5 JEL Classification: G11, G17, G32, G33

2. Introduction:

Investors always want to avoid the risk of burning their capital by predicting the possibility of bankruptcy of a company. Because in case of bankruptcy, the price of securities will decrease drastically (Beaver 1966). Therefore, they are looking for ways to predict bankruptcy. Also, one of the important topics in financial management is investment and confidence in investment (Arash Arianpoor 2021). Given this, the appropriate tools and templates to assess the organization's financial circumstances help to make investment decisions (Mohammadzadeh 2009 n.3). Then, through these tools, investors can analyze the financial situation of organizations and by identifying their financial problems or their appropriate situation, they can make informed and confident decisions about investing in the right situation (Altman 2000). The financial crises in the world and due to the loss of large amounts of resources caused researches in the field of financial health and bankruptcy to become one of the most popular topics (Institute 2020), to the point where the prediction of company bankruptcy became one of the vital matters of the economy. (Mohammadzadeh 2009 n.3). In addition to that, bankruptcy prediction is also very important for investors so that they can invest in companies that have less risk. The problem is that there are companies that continue their outward life despite their poor financial situation and attract resources at the micro and macro levels, and in the end, the resources attracted are wasted due to various problems of these companies (Mohammadzadeh 2009 n.3).

3- Research Background:

Bankruptcy prediction and the concept of reporting quality have been a formal analytical topic since at least 1932.In 1932 Fitzpatrick conducted his study on 20 pairs of companies, one group of failed companies and the other group of active companies (FitzPatrick October, 1932). Although his study was not similar to today's common statistical analysis, he chose financial ratios in a very thoughtful way and was able to find the trend of these ratios. With the adoption of IFRS in a large number of countries in the world, the quality of financial reporting has become very important for economic decision makers, and the adopting countries claim to have improved the quality of financial reporting by applying the aforementioned standards (Rahmani).

Decision-makers use that information to assess the financial situation of the reporting unit. Consequently, all users of financial reports expect to receive accurate and appropriate information from businesses (Mbobo 2016 No. 4).

In 1967, William Beaver used the t-test to compare certain current financial ratios (Beaver 1966), after that Altman introduced his Z-rating analysis in 1968 (E. H. Altman 1977). In 1930 and 1935, Winakor & Raymond analyzed the changing financial ratios of bankrupt businesses. They analyzed the 10-year trend of financial ratios of these companies by using 21 financial ratios and concluded that the ratio of working capital to total assets is a good indicator for predicting bankruptcy. The problem of this study was the lack of a control group consisting of non-bankrupt companies (Mohammadzadeh 2009 n.3). Altman's Z-score model is a numerical measure used to forecast a company's exposure to bankruptcy for the next few years. This model was used by the American economist professor, Edward Altman, in 1968 as a measure to forecast the sustainability of companies. The Altman Z-score model is an effective method that can accurately predict financial risks over short periods by using companies financial statement information (Somaye Fathi Vol.3 / No.10 / Summer 2018). The idea of developing a bankruptcy forecasting model came about after the beginning of the Great Depression in the late 1920s, when the incidence of defaults increased. Altman's Z-score model is used as a metric to predict the probability of corporate collapse in the years ahead. According to studies, this model has shown 72% accuracy in predicting bankruptcy for the next 2 years (Mohammadzadeh 2009 n.3). In his model, Altman used a weighting system along with other ratios that were common to predict bankruptcy. In general, Altman introduced three different models for different types of business. His original model was unveiled in 1968 (E. H. Altman 1977). This model was created for public manufacturing enterprises with assets of more than $1 million. Under the initial model, private and non-manufacturing enterprises with assets of less than $1 million were excluded.

Also, recently theoretical articles in the field of economic literature state that fighting the impact of financial inefficiency and the possibility of company bankruptcy in competitive product markets is one of the regulating mechanisms of the financial reporting process (Balakrishnan 2011). According to Li, competition in the market will lead to the improvement of the quality of information disclosure by companies, which ultimately makes companies dependent on external competitive advantage, encourages owners to strengthen internal corporate governance mechanisms, and reduces the opportunistic behavior of managers (Li 2010). The fear of inefficiency in the competition in the product markets causes managers to be disciplined and encourages them to make financing and investment decisions that increase the value of the company (Mohammad Ali Sahmaniasl 2022).

4-Theoretical foundations and development of assumptions:

Financial statement researchers have conducted numerous researches to identify the effective factors that have contributed to the lack of correct reflection of the company's conditions in the financial statements of companies. Early studies related misleading to financial statements, such as the probability of bankruptcy, with business characteristics like company size (FitzPatrick October, 1932), capital structure (E. H. Altman 1977), profitability (Balakrishnan 2011) and the use of external income. With regard to business characteristics, particular attention has also been paid to the personal characteristics of managers (Arash Arianpoor 2021).

4-1 The first hypothesis:

There is a significant relationship between the major indicators of investment ratios including GPR, ROA and ROE at the end of one financial year, and the level of Altman bankruptcy model results of the same companies at the end of the next financial year.

4-1-1 Altman's Bankruptcy Model:

Considering that all the tested companies are Production companies, the modified model of Altman, which was introduced in 1983 under the title Z', was used. The reason for this choice is to reflect the book value of equity in the financial statements rather than the fair market value of equity.

$X_5 + 0.999\, Z' = 0.717 X_1 + 0.847 X_2 + 3.1 X_3 + 0.42 X_4$

X_1 = working capital / total assets

X_2 = retained earnings / total assets

X_3 = earnings before interest and taxes / total assets

X_4 = market value of equity / total liabilities

X_5 = sales / total assets

4-1-2 First model:

To investigate the first hypothesis in this research, in terms of arguments, it is deductive-inductive and in terms of data collection method, it is a descriptive regression research based on real information contained in the financial statements of companies. It is also developmental in terms of purpose. Independent and dependent variables are calculated for the selected companies at the end of the financial period and used in the multivariable regression model to test the hypotheses.

$Z'_{t+1} = \beta_0 + \beta_1 ROE_{(A-V)\,t} + \beta_2 ROA_{(A-V)\,t} + \beta_3 GPM_{(A-V)\,t} + \varepsilon_{(A-V)\,t}$

The above relationship is used to check hypothesis number one. variables GPR, ROA, and ROE are independent, the variable Z' is the dependent and T is the time monitoring parameter. Finally, ε is the error term of the regression model. The coefficients β_1 to β_p are also considered the coefficients of the regression model for the corresponding variables. Of course, note that β_0 means the constant or average value of Z' without considering any of the independent variables.

4-2 Second hypothesis:

By examining the correlation between GPR and ROA and ROE of the base year, with Altman's probability of bankruptcy, a conceptual model can be expressed. So that, investors can predict the companies that may include a higher probability of bankruptcy in the next fiscal year every year.

4-2-1 model:

To prove or reject the second assumption; We delete Z'_{t+1} from model1 and rewrite the relation as follows:

$Z'\,t = A_0 + \beta_1 ROE_{(A\text{-}V)} + \beta_2 ROA_{(A\text{-}V)} + \beta_3 GPM_{(A\text{-}V)} + \varepsilon_{(A\text{-}V)}$

After checking the coefficient tables, the estimate of the coefficients and characteristics linked to their test can be seen. The constant value will appear in the template as C. It will also be clear whether the coefficients of each variable are positive or negative. Then, depending on whether the Sig of each variable is smaller or larger than 0.05, the null hypothesis is rejected or not. Therefore, GPM variable coefficient with X_1, ROA variable coefficient with X_2 and ROE variable coefficient with X_3 enter the model.

Pre $Z' = C_T + X_1 GPM + X_2 ROA + X_3 ROE$

Using GPM, ROA, ROE ratios of the base year on above relationship, Z' of the companies will be estimated and audited in the next year.

The Paired Sample T Test is used to compare two dependent variables ,with the same or different variance, including the estimation of Z' using GPM, ROA, ROE in the base year and the actual value of Z' in the next financial year.[1]

Table1- 'Z domain definition

'Z domain	The possibility of bankruptcy	The label
$Z' \leq 1/21$	Very much	1
$1/21 < Z' > 2/9$	Low	2
$Z' \geq 2/9$	None	3

This assumption is expressed as follows:

$H_0 = \mu_{Z'} \leq 1.21 < \mu_{Z'\,pre}$ **or** $\mu_{Z'\,pre} \leq 1.21 < \mu_{Z'} < 2.9 \leq \mu_{Z'\,pre}$ **or** $\mu_{Z'\,pre} < 2.9 \leq \mu_{Z'}$

$H_1: \mu_{Z'}, \mu_{Z'\,pre} \leq 1.21$ **or** $1.21 < \mu_{Z'}, \mu_{Z'\,pre} < 2.9$ **or** $2.9 \leq \mu_{Z'}, \mu_{Z'\,pre}$

$$T = \frac{\frac{1}{n}\sum_{i-1}^{n} x_{iA} - x_{iB}}{\frac{\frac{1}{n-1}\sum_{i=1}^{n}((x_{iA}+x_{iB}) - (\frac{1}{n}\sum_{i-1}^{n} x_{iA} - x_{iB}))}{\sqrt{n}}}$$

i=1,2,3,…,n

4-3 Methodology:

SSPS statistical software was used to fit the research model. The reason for using this software is the ability to adjust a model of various dimensions, the results are more reliable in panel data, etc. The error level is 0.01 or the test level is 0.99.

5- Population and statistical sample:

The search period extends from 2019 to 2022.The data includes the financial statements of companies admitted to the Tehran Stock Exchange. The statistical sample comes with systematic elimination and considering the following conditions:

5-1 extracted through the website of Tehran Stock Exchange Organization.

5-2 The data is related to 22 large listed companies in 7 industrial fields including (oil extraction, oil refining, automotive industry, other mines, production of basic metals, extraction of basic metals and agriculture).

---

[1] Considering that, the relationship between 3 indicators of financial leverage with Z' will be proven further, and according to the auditing standards of Iran, which usually independent auditors take significant financial actions that distort the financial statements (conditional clauses) In the next year's reporting paragraphs under the title of "other content", the statistics are assumed to be dependent and the Two Independent Sample T Test was not used.

5-3 The company was admitted to the stock exchange before 2019.

5-4 The end of the financial year of all companies is at the same time and according to the last day of the Iranian calendar. (March 20th)

5-5 During the entire period of research, they should not stop or change major activities in conflict with the statutes.

5-6 The required information should be available to everyone for verification.

5-7 Their shares should not have a trading break of more than 30 days

5-8 Except financial companies (such as banks and insurance institutions) as well as investment companies and holding companies.

5-9 the companies under investigation must pay taxes.

5-10 The owners of at least 49% of their shares are natural persons or private companies that are not affiliated with Official organizations or under the supervision of the Government.

5-11 The structure of their financial statements should be completely similar and based on the accounting standards of Iran (determined by the organization of certified accountants).

5-12 All financial statements have been approved by an independent auditor.

From the total financial statements extracted, ROA[2], ROE[3], and GPM[4] (a total of 264 ratios) and the Altman bankruptcy ratio for each financial statement (a total of 88 indicators) have been calculated by the researcher[5]. The criteria for selecting companies in this research is the list of 200 large companies that is published by Tehran Stock Exchange Organization every year. In the models and determination of the relevant indicators, the accuracy and error of each model has been calculated. (Appendix A)

6- Findings:

6-1 The first hypothesis:

6-1-1 Correlation check: The scatter diagram is one of the diagrams that is generally examined early. Using this diagram, we will see the dispersion of data, the distribution of data and their range based on scatter diagrams.

As can be seen, there is a strong positive correlation between GPM and ROA with Z' in the following year in all 3 years of the test, but considering ROE, we find that it does not have a strong correlation with Z'. However, we have kept the ROE factor in the equation due to the curvature towards the zero point of the coordinate axis. Most of the outlier data can be seen in the ROE correlation, and with the exception of GPM and ROA in 2019, which have created a cluster in their correlation with Z' 2020, the rest of the correlations have low outlier data and community in the center.
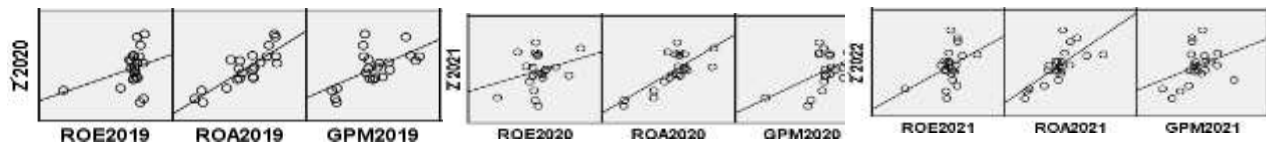
Figure-1: GPM, ROA, ROE Line correlation with Z'

6-1-2 Pearson's correlation analysis[6]:

If the value of the correlation coefficient between both variables is significant in the two-tailed test, they are marked with *. The output can be seen as below. In the subtitle of this table, the sign ** indicates the significance of the statistical test (rejecting the null hypothesis or the correlation coefficient

---

[2] $ROA = \dfrac{Net\ Income}{Average\ Total\ Assets}$

[3] $ROE = \dfrac{Net\ Income}{Equity}$

[4] $Gross\ Profit\ margin = \dfrac{Gross\ Profit}{Revenue}$

[5] According to the rules of Tehran Stock Exchange Organization, admitted companies are not required to disclose such ratios in their financial statements.

[6]) $(r = \dfrac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}$

being meaningless) at the error level of 0.01 or the test level of 0.99[7]. During this time, GPM and ROA showed a strong correlation with the Z' index of the following year, but ROE shows a moderate correlation with Z' of the following year.

Table 2 - Pearson's correlation analysis

		Z' 2020				Z' 2021				Z' 2022
Z' 2020	Pearson Correlation	1		**Z' 2021**	Pearson Correlation	1		**Z' 2022**	Pearson Correlation	1
	Sig. (2-tailed)				Sig. (2-tailed)				Sig. (2-tailed)	
	N	22			N	22			N	22
GPM2019	Pearson Correlation	.617**		**GPM2020**	Pearson Correlation	.470*		**GPM2021**	Pearson Correlation	.358
	Sig. (2-tailed)	.002			Sig. (2-tailed)	.027			Sig. (2-tailed)	.102
	N	22			N	22			N	22
ROA2019	Pearson Correlation	.840**		**ROA2020**	Pearson Correlation	.735**		**ROA2021**	Pearson Correlation	.728**
	Sig. (2-tailed)	.000			Sig. (2-tailed)	.000			Sig. (2-tailed)	.000
	N	22			N	22			N	22
ROE2019	Pearson Correlation	.318		**ROE2020**	Pearson Correlation	.280		**ROE2021**	Pearson Correlation	.413
	Sig. (2-tailed)	.150			Sig. (2-tailed)	.206			Sig. (2-tailed)	.056
	N	22			N	22			N	22
**. Correlation is significant at the 0.01 level (2-tailed).										
*. Correlation is significant at the 0.05 level (2-tailed).										

6-1-3 Regression analysis:

Since the correlation coefficient for the years 2020, 2021 and 2022 was above .750 (R= .852, .768 and .751), the coefficient of determination (R Square= .725, .589 and .565) and also "Adjusted coefficient of determination" (Adjusted R Square= .679, .521 and .492) has been calculated, it seems that the regression model is suitable[8]. Although the model shows more correlation in 2020 than the following years. At the end of the table, the Durbin-Watson column shows the relevant statistic with the value (1.63, 1.99 and 1.93). The value of this statistic is close to 2, this indicates that the residuals are independent. In this way, another condition of the related conditions It is satisfied by linear regression.

Table 3 - Regression analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.852ᵃ	0.73	0.68	1.63

a. Predictors: (Constant), ROE2019, GPM2019, ROA2019

1	.768ᵃ	0.59	0.52	1.99

a. Predictors: (Constant), ROE2020, GPM2020, ROA2020

1	.751ᵃ	0.57	0.49	1.94

a. Predictors: (Constant), ROE2021, GPM2021, ROA2021

The value of Constant is displayed in models with values (1.55 for 2020), (2.26 for 2021) and (1.81 for 2022). It is also clear that the coefficients of each of the variables are positive, but due to the fact that the Sig value is greater than 0.05 for each GPM and ROE variable, the assumption that they are zero cannot be rejected. The Unstandardize Coefficients column, which shows the actual coefficients, has been created according to the measurement unit of

---

[7] A coefficient between 0 and 0.29 indicates weak correlation

- The coefficient between 0.30 and 0.69 indicates moderate porrelation

- A coefficient between 0.70 and 1 indicates a strong correlation

[8] As these values approach 1, the model expresses the relationship between dependent and independent variables. Simply put, the regression model was able to cover or express a higher percentage of changes in the dependent variable.

each variable, so it is not possible to determine the importance of the corresponding variable in the regression model based on the magnitude of each coefficient. For this purpose, we use the Standardize Coefficients Beta column. Any coefficient of higher beta is more important in the regression model. Thus, the variable ROA (Beta =.798(2020), 731(2021), 864(2022)) is the best predictor for the dependent variable.

Table 4 - Regression analysis (Coefficients^a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.55	0.44		3.55	0.002
	GPM2019	1.08	1.14	0.15	0.95	0.356
	ROA2019	7.05	1.52	0.79	4.63	0
	ROE2019	-0.20	0.29	-0.10	-0.69	0.5

a. Dependent Variable: Z' 2020

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
2	(Constant)	2.26	1.03		2.21	0.041
	GPM2020	1.10	0.89	0.21	1.25	0.229
	ROA2020	7.64	1.95	0.73	3.92	0.001
	ROE2020	-1.83	1.96	-0.17	-0.93	0.364

a. Dependent Variable: Z' 2021

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
1	(Constant)	1.82	0.61		2.98	0.008
	GPM2021	0.53	0.93	0.10	0.57	0.576
	ROA2021	4.80	1.29	0.86	3.73	0.002
	ROE2021	-0.80	0.75	-0.24	-1.07	0.299

a. Dependent Variable: Z' 2022

In general, leverage ratios, especially ROA and GMP, are suitable for checking the probability of bankruptcy of a company or a group of companies in the stock exchange portfolio in the following years, but ROE cannot establish a strong relationship with Z' changes in the following year. Perhaps the reason can be seen as the Equity factor.

6-2 Second hypothesis:

6-2-1 Pre Z' and coefficients:

To investigate the second hypothesis, we investigated the regression relationship of z_{t-1}' as a dependent variable of GPM_{t-1} and ROA_{t-1} and ROE_{t-1} as independent variables. Then, 3 models were designed to predict the years 2021, 2022 and 2023[9] (Appendix B).

$Pre\ Z'_{2021} = 2.3_{2020} + .7GPM_{2020} + 8.7ROA_{2020} - 2.6ROE_{2020}$

$Pre\ Z'_{2022} = 1.4_{2021} + 1.06GPM_{2021} + 5.38ROA_{2021} - .77ROE_{2021}$

$Pre\ Z'_{2023} = 2.8_{2022} + 1.5GPM_{2022} + 7.6ROA_{2022} - 4.3ROE_{2022}$

After determining Per Z' (Appendix C), in this table, the correlation between two variables is displayed. Sig symbol shows the desired level of confidence, if it is greater than .05 the desired statistic is not significant (if it is smaller than .05 it is significant at the .05 level and if it is smaller than .01 it is significant at the 0.01 level)

Figure-5: Regression analysis (Coefficients^a)

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre Label 2021 - Z Label 2021	0.23	0.43	0.09	0.04	0.42	2.49	21.00	0.02

---

[9] Using the coefficients obtained from Table B Unstandardized Coefficients

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pre Label 2022 - Z Label 2022	0.18	0.39	0.08	0.01	0.36	2.16	21.00	0.04

In these tables, the value of t for the year 2021 is equal to 2.4 and for the year 2022 the value is 2.1 Then sigs were.021 and .042. Because the both of amount of sigs is less than .05 and more than .01, so it can be concluded that the pre Z' and Z' scores of the samples in both of years (2021 and 2022) do not have a statistically significant difference between 0.05 and 0.01.

7- Conclusion:

In this research, we have generally looked at the relationship between three investment ratios and the changes in the likelihood of bankruptcy of a portfolio of companies in Iran. The results of the first hypothesis of this research show that the changes in GPM and ROA ratios have a positive correlation with changes in the probability of bankruptcy in the next years, but the ROE ratio has shown a negative correlation. The results of the second hypothesis show us that if the financial statements of the companies of a stock exchange portfolio are available, a model like the model used in this research can be prepared every year and predict the probability of bankruptcy of the stock exchange portfolio companies in the next year. Comprehensively, these models, which can be prepared by preliminary investigation and proof of correlation by any other ratio, can replace the financial statement reading, which is a common and traditional procedure in most stock portfolio management companies. Because most of the classification of data in financial statements causes the external users of financial statements to deviate, and sections such as annual net profit and accumulated profit cannot reflect the possibility of bankruptcy of the company.

Bibliography

Altman. 2000. "Credit Risk Measarement." Journal of Banking and Finance no.3 3.

Altman, E. Haldman, R & Nara yana. 1977. "zeta analysis a new model to identify bankruptcy risk of corporations." Journal of Banking And Finance, no.12 11-13.

Arash Arianpoor, Saleh Orfizadeh. 2021. "The Relationship between Market Value, Capital Expenditures, Value ." Iranian Journal of Accounting, Auditing & Finance 2-4.

Arash Arianpoor, Saleh Orfizadeh. 2021. "The Relationship between Market Value, Capital Expenditures, Value." Iranian Journal of Accounting,Auditing & Finance 20.

Balakrishnan, K., & Cohen, D. A. 2011. "Product market competition and financial accounting misreporting." Retrieved from http://ssrn.com/abstract=1927427.

Beaver. 1966. "Financial Ratios as Predictors of Failure." Journal of Accounting research no.4 2-6.

FitzPatrick, Paul J., Ph.D. October, 1932. "A Comparison of the Ratios of Successful Industrial Enterprises With Those of Failed Companies." Journal of Accounting Research 598-605.

Institute, McKinsey Global. 2020. COVID-19: Implications for business. research, McKinsey & Company, 1.

Li, X. 2010. "The impact of product market competition on quantity and quality of voluntary disclosures." Review of Accounting Studies 663-711.

LLP, Bahman Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Bama Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Bandar Abbas oil refinery Company. 2019-2020. "Financial statement." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

—. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Casting development Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Charmelo Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Development of mines and metals Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Engineering and construction of oil industries company. 2019-2022. "financial statement." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Gol Gohar Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

—. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Hafari Shomal Company. 2019-2022. "financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Iran KhodrooCompany. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Khoozestan steel Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Kosar Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Magsal Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Mes Bahner Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

—. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Mobarake Steel Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, National Copper Industries of Iran Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Pars Khodroo Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Saipa Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Sepahan Oil Refinery Company. 2019-2022 . " Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Sepid Makian Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Tabriz oil refinery Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

LLP, Tehran oil refinery Company. 2019-2022. "Financial statements." Codal.ir. Tehran: Tehran Stock Exchange (TSE), March 20th.

Mbobo, M. E., & Ekpo, N. B. 2016 No. 4. "Operationalising the Qualitative Characteristics of Financial Reporting." International Journal of Finance and Accounting 184-192.

Mohammad Ali Sahmaniasl, Hashem Nasirifar, Soraia Weysihesar. 2022. "Effects of Competition in the Product Market on the Relationship between Social Responsibility and Financial Leverage of Companies." Financial Accounting Research 2-5.

Mohammadzadeh, Dr. Amir. 2009 n.3. "Application model of Altman and Springgate models in bankruptcy prediction." Management research 2-8.

Rahmani, Ali. 12th year, number 4, consecutive (46), winter 1. "International Financial Reporting Standards (IFRS) and Quality of." Financial accounting research 2-3.

Somaye Fathi, Samira Saif, Zohre Heydari. Vol.3 / No.10 / Summer 2018. "Predicting Bankruptcy of Companies using Data Mining ." International Journal of Finance and Managerial Accounting 2-3.

Appendix

Appendix A

Total ratios

Context		Name	2019			2020				2021				2022			
			GPM	ROA	ROE	GPM	ROA	ROE	Z'	GPM	ROA	ROE	Z'	GPM	ROA	ROE	Z'
Oil and gas extraction		Hafari Shomal	0.25	0.09	0.34	0.82	0.21	0.6	1.48	1.53	0.43	0.96	2.37	0.16	0.05	0.1	1.24
		Engineering and construction of oil industries	0.33	-0.1	-0.7	0.14	0.01	0.5	0.1	0.07	0.05	1.25	0.19	1.1	0.04	0.69	0.34
	oil refining	Bandar Abbas oil refinery	0.09	0.52	0.98	0.04	0.28	0.6	7.01	0.17	0.76	1.3	6.27	2.16	0.64	0.9	7.38
		Tabriz oil refinery	0.12	0.59	1.3	0.05	0.31	0.5	8.82	0.16	0.94	1.27	8.25	3.16	0.63	0.9	7.95
		Sepahan Oil Refinery	0.35	0.63	1.2	0.24	0.4	0.7	4.13	0.29	0.47	0.77	3.79	4.16	0.39	0.55	3.36

Category	Company															
	Tehran oil refinery	0.15	0.61	0.85	0.05	0.34	0.5	5.23	0.14	1.65	2.55	6.53	5.16	0.63	0.84	5.34
Automobile manufacturing industry	Iran Khodroo	-0.4	-0.5	1.22	-0.2	-0.4	0.5	-1.6	-0.2	-0.4	0.51	-1.46	6.16	-0.22	0.28	-0.6
	Bahman	0.93	0.13	0.15	0.97	0.19	0.2	4.54	0.98	0.18	0.19	6.62	7.16	0.05	0.05	3.61
	Pars Khodroo	-0.4	-0.4	-5.6	-1.7	0.01	-0.1	-0.3	-0.8	-0.4	-2.1	-1	8.16	-0.1	-0.4	-0.2
	Saipa	-0.3	-0.4	0.93	-0.3	-0.4	0.6	-2.2	-0.5	-0.5	0.58	-2.3	9.16	-0.3	0.32	-1.7
Other mines	Casting development	0.17	0.12	0.17	0.26	0.34	0.5	3.27	0.28	0.41	0.64	2.71	10.2	0.29	0.36	4.14
Extraction of basic metals	Mes Bahner	0.14	0.17	0.5	0.25	0.35	1	2.59	0.25	0.38	1.1	2.75	11.2	0.37	1.14	2.61
	Khoozestan steel	0.28	0.31	0.72	0.25	0.24	0.6	1.75	0.37	0.53	0.95	2.83	12.2	0.4	0.65	2.72
	Mobarake Steel	0.5	0.4	0.66	0.38	0.34	0.5	4.21	0.51	0.55	0.84	6.06	13.2	0.58	0.79	9.23
	National Copper Industries of Iran	0.52	0.3	0.46	0.56	0.44	0.7	3.06	0.61	0.53	0.75	3.61	14.2	0.58	0.77	4.19
Minerals	Bama	0.78	0.61	0.68	0.44	0.76	0.8	8.35	0.6	0.4	0.46	4.15	15.2	0.12	0.14	2.9
	Development of mines and metals	0.99	0.49	0.37	0.99	0.32	0.4	5.22	0.99	0.6	0.71	4.24	16.2	0.53	0.62	5.58
	Charmelo	0.32	0.32	0.46	0.39	0.41	0.6	3.49	0.57	1.2	1.59	6.29	17.2	0.69	0.87	5.14
	Gol Gohar	0.41	0.31	0.61	0.4	0.36	0.6	1.9	0.47	0.49	0.86	2.92	18.2	0.39	0.67	2.3
Agriculture	Sepid Makian	0.18	0.01	0.03	0.2	0.78	1.2	4.68	0.23	0.74	1.17	7.26	19.2	3.06	4.73	3.67
	Kosar	0.85	0.35	0.35	0.83	0.41	0.5	5.37	0.79	0.37	0.43	4.06	20.2	0.36	0.43	4.3
	Magsal	0.23	0.13	0.38	0.2	0.14	0.4	1.65	0.09	0.16	0.47	1.73	21.2	0.31	0.81	2.78

Appendix B

Tables for determining coefficients

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.327	.969		2.402	.027
	GPM2020	.700	.837	.133	.837	.414
	ROA2020	8.706	1.839	.833	4.735	.000
	ROE2020	-2.696	1.849	-.245	-1.458	.162
a. Dependent Variable: ABPm2020						

Coefficients[a]					
Model		Unstandardized Coefficients	Standardized Coefficients	t	Sig.

		B	Std. Error	Beta			
1	(Constant)	2.327	.969			2.402	.027
	GPM2020	.700	.837	.133		.837	.414
	ROA2020	8.706	1.839	.833		4.735	.000
	ROE2020	-2.696	1.849	-.245		-1.458	.162

a. Dependent Variable: ABPm2020

Coefficientsª

Model		Unstandardized Coefficients		Standardized Coefficients		t	Sig.
		B	Std. Error	Beta			
1	(Constant)	1.431	.504			2.839	.011
	GPM2021	1.060	.765	.183		1.385	.183
	ROA2021	5.384	1.065	.916		5.058	.000
	ROE2021	-.776	.617	-.221		-1.258	.224

a. Dependent Variable: ABPM2021

Coefficientsª

Model		Unstandardized Coefficients		Standardized Coefficients		t	Sig.
		B	Std. Error	Beta			
1	(Constant)	2.860	.857			3.338	.004
	GPM022	1.529	1.666	.182		.918	.371
	ROA2022	7.614	2.790	1.824		2.729	.014
	ROE2022	-4.318	1.880	-1.524		-2.296	.034

a.   Dependent Variable: ABPM2022

Appendix C

Pre Z' and Z'

CONTEXT		NAME	2021		2022		2023
			pre z'	Z'	pre z'	Z'	pre z'
Oil and gas extraction		Hafari Shomal	3.09	2.37	5.49	1.24	3.05
		Engineering and construction of oil industries	1.22	0.19	0.86	0.34	0.3
	oil refining	Bandar Abbas oil refinery	3.31	6.27	4.77	7.38	4.08
		Tabriz oil refinery	3.69	8.25	5.76	7.95	3.94
		Sepahan Oil Refinery	4.1	3.79	3.81	3.36	3.88
		Tehran oil refinery	3.97	6.53	8.56	5.34	4.18
Automobile manufacturing industry		Iran Khodroo	-2.39	-1.39	-1.56	-0.55	-0.07
		Bahman	4.09	6.62	3.81	3.61	4.44
		Pars Khodroo	1.51	-0.96	-0.06	-0.16	3.66
		Saipa	-2.65	-2.33	-2.32	-1.71	-0.85
Other mines		Casting development	4.24	2.71	3.6	4.14	4.32
Extraction of basic metals		Mes Bahner	2.7	2.75	3.06	2.61	1.24
		Khoozestan steel	3.13	2.83	4.12	2.72	3.63
		Mobarake Steel	4.1	6.06	4.56	9.23	4.63
		National Copper Industries of Iran	4.74	3.61	4.65	4.19	4.86
Minerals		Bama	7.02	4.15	4.19	2.9	3.58
		Development of mines and metals	4.87	4.24	5.72	5.58	5.79

	Charmelo	4.63	6.29	7.6	5.14	5.24
	Gol Gohar	3.56	2.92	4.17	2.3	3.59
Agriculture	**Sepid Makian**	5.92	7.26	4.9	3.67	3.26
	Kosar	5.23	4.06	4.35	4.3	5.13
	Magsal	2.61	1.73	2.08	2.78	2