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Estimating Re-Evaluation of the Risk Report Obtained Using the Altman Z-Score Model in Mergers with Neutrosophic Numbers

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Abstract: The Altman Z-Score model, introduced by Edward Altman in 1968, is one of the most common models used in financial risk analysis. However, although it is a widely used model, many theories against the growing uncertainty of our daily lives have been replaced by theories modeled by more complex sets of numbers that are nonlinear. Therefore, the necessity of evaluating the financial uncertainty situation with different and innovative methods has emerged for the models obtained. When looking at the studies in the literature with the use of the Altman Z-score model, it shows that the predictive power of the Z-score model is quite high. This model is a model that can be applied by using the data in the balance sheet and income statement, which are among the basic financial statements in accounting. In this study, the Altman Z-score model was arranged according to the neutrosophic numbers of some data from the balance sheet and income statement of the two companies, and a nonlinear study was compared with the classical Altman Z-score model. As a result of the study, it was predicted that the results obtained with the Altman Z-score and neutrosophic numbers have more positive results in company mergers than the formula found by the discriminant method, and the instability situations will decrease as a result of the merger of the company.

Keywords: Altman Z-score; Risk Analysis; Neutrosophic Numbers

1. Introduction

Neutrosophy is a branch of philosopy, introduced by Smarandache in 1980, which studies the origin, nature and scope of neutralities, as well as their interactions with different ideational spectra. Neutrosophy is the basis of neutrosophic logic, neutrosophic probability, neutrosophic set and neutrosophic statistics in [1]. Neutrosophic logic is a general framework for unification of many existing logics such as fuzzy logic which is introduced by Zadeh in [2] and intuitionistic fuzzy logic which is introduced by Atanassov in [3]. Fuzzy set has only degree of membership, intuitionistic fuzzy set has only degree of membership and degree of nonmembership. Thus; they do not explain the indeterminancy states. But neutrosophic set has degree of membership (t), degree of indeterminacy (i) and degree of nonmembership (f) and define the neutrosophic set on three components (t, i, f). A lot of researchers have been dealing with neutrosophic set theory in [4].

The main purpose of the establishment of businesses is to make a profit. However, over time, businesses may face the reality of failure and bankruptcy, which they consider as the last point, along with deterioration in their financial structures. Today, although there are companies that have

existed for years, there are companies that have to terminate their activities in a short time and go bankrupt. Edward I. Altman (1968) conducted a study on bankruptcy firms and created a model using financial ratios and discriminant analyzes to predict the insolvency of firms. In the literature, this model has been named as Altman Z-score model. Altman (1968) analyzed the financial ratios of 66 manufacturing enterprises with the method of multiple discriminant analysis and developed the Z-Score model consisting of five ratios that can be used in predicting financial failure. Altman classified the enterprises with a Z Score greater than 2,99 in the "safe zone" (Non-Bankupt). There is no failure for companies located in the safe zone. Businesses with a Z Score between 1,81 and 2,99 are classified in the gray area. Caution should be exercised when investing in businesses located in the gray zone. Businesses with a Z Score below 1,81 are determined as businesses with a high risk of financial failure. This study of Altman showed a successful classification performance of 95% for one year ago and 72% for two years ago in predicting financial failure. The Z-score has been developed over time for industry and service sectors and new models have been adapted to these sectors. Altman's Z-score model is one of the best known statistically derived models for predicting the upcoming bankruptcies of companies [5].

It is known that reasonable assurance mathematical and statistical methods are used in the establishment of audit systems and in auditing. Analysis with neutrosophic numbers can also be considered in this context. Especially when the continuity of businesses and bankruptcy risk are evaluated together, the auditor prepares the financial statements with the assumption that the enterprises have an indefinite life and can continue their activities in the foreseeable future. Financial statements are prepared to cover a period of at least 12 months. The concept of business continuity also refers to this. Within the scope of the auditor's responsibilities, it is necessary to obtain sufficient and appropriate audit evidence about the appropriateness of management's use of the going concern principle in preparing the financial statements. It is thought that whether there is a bankruptcy risk in business combinations can be measured with the concept of continuity [6].

In this study, the results obtained by adapting Altman's Z-score model, which is one of the accounting-based bankruptcy prediction models, to neutrosophic clusters in company mergers were compared with the classical Altman's Z-score model and a new perspective was tried to be gained to the literature.

2. Altman Z-skor

In this model, Altman dividing 22 different ratios into 5 groups has created a discriminant model. This model;

$$Z = 0{,}012.X_1 + 0{,}014.X_2 + 0{,}033.X_3 + 0{,}006.X_4 + 0{,}999.X_5$$

- X_1 = Working Capital / Total Assets
- X_2 = Non-Distributed Profits / Total Assets
- X_3 = Profit Before Interest and Tax / Total Assets
- X_4 = Equity / Total Debts
- X_5 = Sales / Total Assets

According to some of the model included: Firms with a Z-score below 1,81 are classified as uncertain and companies within 2,99 are classified as safe in a distressed situation between 1,81 and 2,99. This model has been criticized in terms of predicting financial failure of private firms and non-production operating service sector for its construction for public companies. Altman (2000), with a number of regulations, introduced 2 new models for the private sector manufacturing and service sector.

Altman Z model for private sector manufacturing companies;

- $Z = 0{,}717.X_1 + 0{,}847.X_2 + 3{,}107.X_3 + 0{,}42.X_4 + 0{,}998.X_5$

Altman Z model for private sector service companies;

- $Z = 6{,}56.X_1 + 3{,}26.X_2 + 6{,}72.X_3 + 1{,}05.X_4$

The X_5 variable was removed from the new model, and the impact of the manufacturing sector was reduced. As a result of this situation, the coefficients of the new models have changed and as a result, the Z-score intervals have changed. The ranges of all created Z-score models are given in the table below. [7,8].

Z Score Ranges for Public Manufacturing Sector Firms (Altman, 1968)	**Altman Z Score Ranges for Private Sector Manufacturing Companies (Altman, 2000)**	**Altman Z Score Ranges for Private Sector Service Companies (Altman, 2000)**
Safe if Z score > 2,99	Safe if Z score > 2,90	Safe if Z score > 2,60
Uncertain if 1,81 ≤ Z score ≤ 2,99	Uncertain if 1,23 ≤ Z score ≤ 2,90	Uncertain if 1,1 ≤ Z score ≤ 2,60
Troubled if the Z score < 1,8	Troubled if the Z score < 1,23	Troubled if Z score < 1,1

3. Method and Modeling

Data on working capital, total assets, undistributed profits, profit before interest and tax, equity and debt belonging to companies A and B, whose names are kept confidential for modeling purposes, are given below.

For Company A;

- Working Capital = 21.552.520,00
- Total Assets = 29.147.026,00
- Non-Distributed Profits = 84.157,00
- Profit Before Interest and Tax = 11.517.421,00
- Equity = 24.581.236,00
- Debts = 4.565.790,00
- Sales = 18.413.971,00

In accordance with the information provided, for company A;

- X_1 = Working Capital / Total Assets = 0,7394414785
- X_2 = Non-Distributed Profits / Total Assets = 0,0028873272
- X_3 = Profit Before Interest and Tax / Total Assets = 0,3951490969
- X_4 = Equity / Total Debt = 5,3837859385
- X_5 = Net Sales / Total Assets = 0,6317615732

As a result, the Altman-Z Score obtained for company A;

$$Z = 0{,}717.X_1 + 0{,}847.X_2 + 3{,}107.X_3 + 0{,}42.X_4 + 0{,}998.X_5 = 4{,}652041494$$

For Company B;

- Working Capital = 23.519.164,00
- Total Assets = 47.405.811,00
- Non-Distributed Profits = 954.663,00
- Profit Before Interest and Tax = 12.244.001,00
- Equity = 36.727.311,00
- Debts = 10.678.500,00
- Sales = 41.524.596,00

In accordance with the information provided, for company B;

- X_1 = Working Capital / Total Assets = 0,35572096
- X_2 = Non-Distributed Profits / Total Assets = 0,017056971
- X_3 = Profit Before Interest and Tax / Total Assets = 0,802477804
- X_4 = Equity / Total Debt = 1,444535339
- X_5 = Net Sales / Total Assets = 0,874187066

As a result, the Altman-Z Score obtained for company B;

$$Z = 0{,}717.X_1 + 0{,}847.X_2 + 3{,}107.X_3 + 0{,}42.X_4 + 0{,}998.X_5 = 3{,}49397814$$

For company C obtained as a result of the merger of A and B companies;

- Working Capital = 45.071.684,00
- Total Assets = 76.552.837,00
- Non-Distributed Profits = 1.038.820,00
- Profit Before Interest and Tax = 23.761.422,00
- Equity = 61.308.547,00
- Debts = 15.244.290,00
- Sales = 59.938.567,00

In accordance with the information provided, for company C;

- X_1 = Working Capital / Total Assets = 0,588765691
- X_2 = Non-Distributed Profits / Total Assets = 0,013569974
- X_3 = Profit Before Interest and Tax / Total Assets = 0,310392442
- X_4 = Equity / Total Debt = 4,021738435
- X_5 = Net Sales / Total Assets = 0,782969898

Altman-Z Score obtained as a result of the merger of A and B companies;

$$Z = 0{,}717.X_1 + 0{,}847.X_2 + 3{,}107.X_3 + 0{,}42.X_4 + 0{,}998.X_5 = 3{,}868562186$$

Normalization and adaptation to neutrosophic numbers for company A [9,10,11];

$$T_A: E \to]^-0, 1^+[$$
$$I_A: E \to]^-0, 1^+[$$
$$F_A: E \to]^-0, 1^+[$$

and

$T_A(x)$ $x \in E$, Accuracy Degree = 0,3766177702

$I_A(x)$ $x \in E$, Instability Degree = 0,3589821806

$F_A(x)$ $x \in E$, Inaccuracy Degree = 0,2644000492

- *T (x)= Safe Zone Z-Skore / Z-Skore, I(x)=Uncertain Zone Z-Skore / Z-Skore, F(x)= Troubled Zone Z-Skore / Z-Skore*

Normalization and adaptation to neutrosophic numbers for company B [9,10,11];

$$T_B: E \to]^-0, 1^+[$$
$$I_B: E \to]^-0, 1^+[$$
$$F_B: E \to]^-0, 1^+[$$

for;

$T_B(x)$ $x \in E$, Accuracy Degree = 0,170000531

$I_B(x)$ $x \in E$, Instability Degree = 0,477965211

$F_B(x)$ $x \in E$, Inaccuracy Degree = 0,352034257

Altman-Z Score for company C obtained as a result of the merger of A and B companies; results obtained as a result of normalization [4,5,6]

$$T_C: E \to]^-0, 1^+[$$
$$I_C: E \to]^-0, 1^+[$$
$$F_C: E \to]^-0, 1^+[$$

and

$T_C(x)$ $x \in E$, Accuracy Degree = 0,2503674853

$I_C(x)$ $x \in E$, Instability Degree = 0,4316849309

$F_C(x)$ $x \in E$, Inaccuracy Degree = 0,3179475838

- *T (x)= Safe Zone Z-Skore / Z-Skore, I(x)=Uncertain Zone Z-Skore / Z-Skore, F(x)= Troubled Zone Z-Skore / Z-Skore*

Adapting the results obtained as a result of normalizing the Altman-Z Score without merging of A and B companies to neutrosophic numbers and combining them with neutrosophic

numbers. Let's use the AB index to distinguish this combination from the classic Altman-Z Score [9,10,11];

$$T_{AB}: E \to]^{-}0, 1^{+}[$$
$$I_{AB}: E \to]^{-}0, 1^{+}[$$
$$F_{AB}: E \to]^{-}0, 1^{+}[$$

and

$T_{AB}(x)$ $x \in E$, Accuracy Degree = 0,6458237826

$I_{AB}(x)$ $x \in E$, Instability Degree = 0,2296159870

$F_{AB}(x)$ $x \in E$, Inaccuracy Degree = 0,1245602304

4. Conclusion

When the data obtained for A and B companies considered in our study were compared with the results obtained with the classical Altman-Z score and neutrosophic numbers;

- While the accuracy level is lower in the classical method, it is predicted that the company will become more secure as a result of the merger as the accuracy level increases in the data obtained by using non-linear neutrosophic numbers.
- Compared to the classical method, it is seen that the degree of instability decreases by almost half as the accuracy level increases.
- It has been observed that the same situation for the degree of indecision is also valid for the degree of inaccuracy, and the degree of inaccuracy is significantly reduced.

Along with all these results, the formula obtained from the discriminant method in the classical Altman-Z model is insufficient to calculate the positive benefit of company mergers, and when we look at the results obtained with neutrosophic numbers, it is predicted that mergers will make a more positive contribution in favor of the company and the situations of negativity and indecision within the company will decrease. Therefore, linear methods increase the accuracy rate of company financial data in company mergers, resulting in more positive results for the company. When the financial data of the company are evaluated, the possibility of making correct analysis according to the linear method also increases. It was concluded that this situation increases the possibility of making a more accurate decision in terms of decision data. In addition, it is considered that these studies can contribute to the field of audit, such as the continuity of the enterprises to be carried out in the field of audit, by evaluating the analytical procedures. Finally, it was predicted that in the future, more advanced number systems such as neutrosophic numbers will be used in risk analysis instead of classical number systems.

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