Emira Kozarević[1]

Dženita Pirić[2]

EVALUATION OF THE REVISED Z'-SCORE MODEL AS A PREDICTOR OF A COMPANY'S FINANCIAL FAILURE

ABSTRACT

Under contemporary business conditions, there are numerous models used for the assessment of a company's financial situation and the prediction of the likelihood of its bankruptcy. These models have been mainly developed using the company's financial information. One of them is the Altman Z-score model. The model separates financially successful and stable companies from those having difficulties in business and headed for bankruptcy. This paper explains the importance of prudential information, basic financial statements and financial indicators and presents the research aimed at evaluating the applicability of the revised Altman Z'-score model in the Federation of Bosnia and Herzegovina (FBiH). Based on financial information, the paper analyzes the business activities of 50 large manufacturing companies in FBiH. The revised Z'-score model achieved a relatively good result in assessing the companies with business difficulties as it correctly classified 10 out of 20 companies; the other 10 companies were not incorrectly classified into the companies with the stable business but they were placed in the grey zone. The model proved completely reliable in the classification of all 30 companies with stable businesses. The research results indicate that the revised Altman Z'-score may be used as the predictor of the financial failure of manufacturing companies in FBiH. This model is definitely the tool that may assist while making business decisions. However, due to the specific business environment in FBiH, the model is recommended to be used as an additional rather than the basic indicator for predicting financial failure.

Keywords: *financial stability, financial failure, prediction, Altman Z-score model, revised Z'-score model*

JEL: *G33*

1   Professor, Faculty of Economics, Urfeta Vejzagića 8, 75 000 Tuzla, Bosnia and Herzegovina, email: emira.kozarevic@untz.ba

2   Expert associate for plan and analysis, Solana Tuzla, Inc., Ulica soli 3, 75 000 Tuzla, Bosnia and Herzegovina, email: dzenita.piric@solana.ba

1. INTRODUCTORY CONSIDERATIONS

In the 1950s, the imperative in corporate finance was the idea of predicting financial failure. Although very often the question is raised whether financial indicators can point to certain issues in business, historical data and theories on financial analysis and economic principles suggest huge importance of the applicability of these parameters.

In 1968, Edward Altman conducted the first multivariate research on the ratio between financial indicators and bankruptcy likelihood, with the Altman Z-score model as the result. The basic assumption of this model is that financial indicators of unsuccessful companies with problems in their business activities and settling their payments are different from financial indicators of successful and financially healthy companies.

As the original model was developed for public manufacturing companies traded on stock markets, in his later research Altman (2006, 2013a, 2013b), along with his associates, made two corrections. The first correction related to the adaptation of the model to the companies whose stocks were not publicly traded so as to make the score for such private companies and the model was named Z'-score. Another change was the consequence of the need to eliminate the influence of the industry activity on the model, which resulted in the development of the Z''-score model for non-manufacturing companies.

This paper focuses on a detailed analysis of the revised Z'-score model. The research described in this paper is the critical analysis of the efficiency of the revised Z'-score model in predicting the course of a company's business activity, based on financial indicators. The efficiency of the model will be analyzed over two dimensions - the efficiency of the model will be tested on the selected sample in the classification of companies into successful and unsuccessful, and the accuracy of the model will be tested in the identification of the emergence of business disruptions in companies.

A significant number of studies proved the efficiency of the Z' -score model in predicting a company's financial failure. However, there is much criticism by authors related to data generalization as the prediction of failure in Altman's model is limited to the companies functioning in the USA, a political and economic environment different than in less developed countries. This might be stated as one of the problems of the model, which is why the limitation needs to be considered when interpreting the results.

The question is raised on how various macroeconomic conditions, characteristics of a specific market, economic structure and business conditions affect the model in view of Altman's specific sample based on which the model parameters are defined.

Hence, a huge challenge is to establish the efficiency and accuracy of the results of the revised Z'-model in an emerging economy like the one in BiH, completely different from the USA, which belongs to the world's greatest economy by its power and the standard of living of its citizens.

Considering the studies by the authors all over the world and the obtained results and bearing in mind the complexity of the scientific research problem and the topic of this research, the following main research hypothesis was postulated: "The revised Z'- score model can be the predictor of the financial failure of manufacturing companies operating in FBiH". For this research hypothesis to be scientifically provable, this research made use of revised financial reports only, which need to realistically and objectively show all the data they contain.

The rest of the paper is organized as follows: Section 2 contains a review of previous research, Section 3 specifies the data and methodology, Section 4 reports the results and discusses them, and Section 5 concludes and offers recommendations.

2. A review of previous research

Nowadays, the literature provides a large number of developed models for predicting financial failure applied in practice, following the implementation of statistical and mathematical methods and designed in such a way that the central place is given to financial indicators, each with a specific weight attached. It should be pointed out that a high-quality assessment of creditworthiness requires not only the knowledge of financial indicators and their meanings, financial analysis, etc., but also experience, the knowledge of the company and its business environment (Piljić, 2007).

Altman's paper in 1968 marked the beginning of the contemporary history of the models for predicting financial failure. His model is the best-known model in this field in the world. It served as an inspiration to many authors who, using the same statistical technique, later developed their own models. After 1968, huge popularization of this field occurred and a large number of researchers focused on the assessment of a company's financial situation and the likelihood of its bankruptcy.

Rodić (2016) analyzed the Z-score model for the evaluation of the creditworthiness of a company listed on the stock exchange, a production company that is not listed on the stock exchange, and the non-productive company. The model was tested on seven companies (four production and three non-productive). The main aim of the company is long-term survival and its unlimited long-term survival is subject to financial stability and indebtedness. The Z-score model takes into account indebtedness (X4) but not financial stability. The test showed that a more realistic Z-score is obtained in case X1 quantifies working capital/inventories than in the case quantifies working capital/operating assets.

The reason is that inventories are always lower than working capital. Quantification of X1 working capital/inventories indirectly takes financial stability that is essential for the creditworthiness (solvency) and the long-term survival of the company and for this reason, the author quantified X1 working capital/inventories.

Boda and Uradniček (2016) conducted research into the application of the Altman Z-score model in corporate practice in Slovakia, aimed to assess its implementation in the Slovak economic environment. The authors analyzed the applicability of the primary as well as revised Z-score models and assessed their ability to predict financial failure for the observed sample that included 2,414 companies in different economic activities over the period of five years (2009-2013). The results showed that the Z-score model is appropriate for the Slovak economy and can be used for predicting the financial failure of the companies in that country.

Stepanyan (2014) tested the Altman Z-score model to identify the course of business of the US airline companies. The motivation for this research was the vulnerability of the car industry to the changes in their business environment after September 11, 2001. One of the reasons was also the global financial crisis that brought the bankruptcy of many airline companies. The author used the original Z-score model. The sample included seven large airline companies and the research period spanned over five years (2007-2012). The research results showed that all companies were on the verge between the grey zone and the distress zone, meaning that they had a high probability of going bankrupt in the future period. Yet, the model did not reach Altman's accuracy percentage levels. One of the reasons may be the sensitivity of the airline industry to structural changes in the economy, especially in terms of competition regulation and fuel price instability.

In their study, Sherbo and Smith (2013) analyzed the applicability and accuracy of the Z-score model 45 years after it was developed. Modeled after the basic Z-score model, the sample included 33 bankrupt and 33 non-bankrupt companies in all business activities. The research period covered three years (2007-2009). The test results showed that in the group of bankrupt companies the model accurately identified 21 out of 33 companies, meaning that for 64% of the companies it predicted their bankruptcy within two years. In the group of non-bankrupt companies, the model correctly identified 18 out of 33 companies, meaning that for 55% of the companies it predicted their business stability within two years. The authors believe that based on these results, the Altman Z-score model can be considered a reliable tool for predicting financial failure even 45 years later.

Kaplinski (2008) tested the applicability of the Altman Z-score model in the construction industry in Poland. He believed that in its business activities the company should observe not only the factors leading to its development but also those that may lead to its failure.

In order to examine the efficiency of the Altman Z-score model in the Polish economy, Kaplinski decided to study the companies in the construction sector. In his paper, he used the original Z-score model. The research results showed that the model has the highest accuracy of prediction in the shortest period prior to bankruptcy. Kaplinski emphasized that the Z-score model can be of use to companies in recognizing the first symptoms of financial difficulties although it should be additionally adapted to the economic conditions of the country and the industry in which it is applied.

In their paper, Bogdan et al. (2019) tested the Altman Z-score model and identified the extent to which it is applicable in predicting bankruptcy in Croatia. The sample included a total of 52 companies traded on the Zagreb stock exchange, 26 that declared bankruptcy and 26 with stable business. The sample was observed from 2007 to 2016 and as it included the non-manufacturing companies, the revised Z''-score model was used in the research. Apart from testing the model efficacy, the authors attempted to adapt the weights of the revised Z''-score model by applying multiple discriminant analysis so as to get a model that would be more adapted to the Croatian market. Due to the presence of multicollinearity, not all the variables were kept in the model, which resulted in the model with an efficacy lower than the revised Z''-score model. The results of this research pointed out that the revised Z''-score model is applicable in the Croatian model but it is not recommended that the revised Z''-score model is used as the only or basic indicator while making business decisions.

Begović et al. (2014) analyzed credit solvency of Serbian companies in the process of restructuring and those that were not in that process, with the application of the revised Z''-score model. The sample included 123 companies, of which 33 in restructuring, for the period 2010-2012. The results revealed that the revised Z''-score model allows for the appropriate separation of financially healthy companies from those under the threat of bankruptcy.

El Khoury and Al Beaino (2013) tested the hypothesis that the classification of companies as successful and unsuccessful by the Z-score model is equal to the classification made by financial institutions. They used the revised Z'-score model for their study. The sample included 11 manufacturing companies that applied for credit approval from Lebanon banks. The time span of the research was the period from 2009 to 2011. The research results showed that the revised Z'-score model has a high level of accuracy as the predictor of financial failure. In addition, the classification of companies made by the application of the revised Z'-score model was very much similar to that made by the banks. The authors, however, emphasized that there are certain limitations of the research and the interpretation of its results, mainly related to structural differences between the two economies, the US economy on which Altman based his model and the Lebanese.

Also, one should not ignore a significant difference between the Generally Accepted Accounting Principles used by the US companies in the Altman model and International Financial Reporting Standards used by the companies in Lebanon.

Altman et al. (2013a) examined the applicability of the revised Z"- score model to Italian companies. The sample included 89 companies in the process of Extraordinary Administration (EA) in the period 2001 to 2009. The research results illuminated that the revised Z"- score model places 95% of the analyzed companies in the distress zone for the year prior to the company's bankruptcy. The authors concluded that the application of the revised Z"- score model is utterly for information purposes but also rather important for investors, regulatory bodies and even political policymakers.

Samkin et al. (2012) tested the applicability of the revised Z"-score model on 20 companies in New Zealand that went bankrupt. The results of their research revealed that the majority of these companies had results that pointed to inevitable failure. Bearing in mind the importance of the model for predicting financial difficulties, the authors suggested that such models be introduced as a part of financial reports or as a part of the announced review of the company's financial indicators.

In his paper, Wang (2012) tested the Altman Z-score model in the real-estate sector in China. The motivation for his research was linked to the need for predicting the future of this industry after the global financial crisis and for looking at the influence of government regulation on the real-estate sector. With the aim of predicting a potential financial failure of the real-estate companies, Wang used the revised Z"-score model for non-manufacturing companies. The observed sample included 40 companies traded on the Shanghai and Shenzhen stock exchanges. Ten companies had financial difficulties while the remaining 30 operated without problems. The research covered the period from 2008 to 2009. The results highlighted an 80%-accuracy in predicting the company's financial failure. Wang explained the lower accuracy level when compared to Altman's research, by territorial differentiation based on different macroeconomic conditions.

Hayes et al. (2010) studied the efficiency of the Altman Z-score model on a sample of US retail companies. The rationale for their research was a high and increasing number of bankrupt companies. With the aim of establishing whether financial failure can be predicted for retail companies, the authors opted for the revised Z"-score model intended for non-manufacturing companies. The sample included 16 retail companies, half of which were financially healthy and the other half were bankrupt. The research period was 2007-2008. The research results point to the model efficacy of 94%. The authors suggest that the model formula might be further examined so as to include the effect of company size and the economy of the country in which the model is applied.

3. Data and methodology

The revised Z'-score model, as already mentioned, is applicable to manufacturing companies, therefore large manufacturing companies in FBiH were included in the sample. According to the data provided by the Agency for Statistics of BiH, a total of 80 large manufacturing companies operating on the territory of FBiH in 2019, and the database for conducting this research included a sample of 50 companies (62.5%). Given the non-transparency of the companies related to financial statement disclosure, the data used for this research were taken from the credit rating company LRC d.o.o. Sarajevo for the period 2015-2017. This period is chosen in order to check from the aspect of the time in which the research was conducted what happened to companies in the previous two years and more. In order to compare the results of the revised Z'-score model with the actual situation, as a benchmark was used the Central Credit Registry of the Central Bank of BiH, which provided insight into information on activities/blocking of companies' accounts and (in)ability to settle companies' obligations to creditors and, consequently, actual classification of companies into bankruptcy and non-bankruptcy.

Hence, the empirical research was conducted on a sample of 50 large manufacturing companies in FBiH. In order to identify the accuracy of the research results, the companies were classified into two groups as follows:

1. The first group included 30 companies with stable business activities, i.e., the companies:

- that regularly pay their credit obligations;
- that do not have their transaction accounts blocked, i.e., their accounts were not blocked in the observed period;
- that were given a positive assessment of their financial status, by the credit rating company LRC d.o.o. Sarajevo.

2. The second group included 20 companies with business difficulties, i.e., the companies:

- that are over 90 days late in paying their credit obligations;
- have their transaction accounts blocked, i.e., their accounts were blocked in the observed period;
- that were given a negative assessment of their financial status, by the credit rating company LRC d.o.o. Sarajevo.

The research methods used were the hypothetico-deductive method through the theoretical research and the definition of the subject, hypothesis and goals of the research based on the existing secondary sources on these issues.

Inductive reasoning was used during data collection and in the process of data analysis. As a method, analysis was used in the theoretical and empirical parts of the research. Unlike analysis, synthesis was used in discussion, conclusion, and recommendation. Other research methods used were: descriptive analysis, classification, generalization, and comparative analysis.

Based on the previously postulated hypothesis, we were able to identify the dependent and independent variables. The dependent variable was the revised Z'-score model, i.e., the formula of Altman's model for the prediction of financial failure. The independent variables were the input variables in the model or five financial ratios (selected values) used in the model formula as follows: X1, X2, X3, X4 and X5.

The revised Z'- score model, i.e.

$$Z' \text{ score} = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5, \qquad (1)$$

implies that five financial ratios identified for each company as follows:

- X1 = working capital / total assets,

- X2 = retained earnings / total assets,

- X3 = earnings before interest and taxes / total assets,

- X4 = book value of equity / total liabilities,

- X5 = sales / total assets.

Following the identification of the previously mentioned variables and their insertion into the model formula, the Z' values were obtained that served as the critical values for recognizing the distress zone, the grey zone and the safe zone of the company's business, as shown in Table 1.

Table 1: Critical values of the Z'-score with the corresponding financial stability rating

Value	Meaning
Z' < 1.23	Distress (or danger) zone - the company has difficulties in doing business and is in danger of initiating bankruptcy proceedings
1.23 < Z' < 2.90	Grey zone - financial stability is at stake, but there is a potential for recovery
Z' > 2.90	Safe zone - the company's business is financially stable

Source: *Authors' creation*

In this paper, the safe zone was identified as the zone of stable business while the bankruptcy zone was the one with the companies that had difficulties in doing business.

4. Results and discussion

The manufacturing industry in BiH is one of the most important pillars of the economic system in BiH. This is supported by the fact that the manufacturing industry makes around 11% of the total gross added value, some 20% of the total employment in BiH, one-quarter of all company generated revenue and around 70% of BiH's export. As a consequence, this industry takes the central position in the structure of economic growth in BiH

Taking into consideration the importance of the manufacturing industry for BiH and the conditions under which business subjects operate, it would be rather useful to identify the accuracy of the revised Z'-score model. The model would allow for the timely recognition of business problems and timely commencement of corrective measures.

Based on the financial reports in the form of balance sheets and income statements of the companies in the sample, we calculated the financial indicators included in the Altman model and they were inserted in the formula of the revised Z'-score. In the survey of the value of the calculated Z' indicators, 50 companies in the sample were classified into three groups as follows:

- 10 companies in the bankruptcy zone (Z' under 1.23),

- 29 companies in the grey zone (Z' between 1.23 and 2.90),

- 11 companies in the zone of stable business (Z' over 2.90).

Out of the ten companies heading for bankruptcy as predicted by the revised Z' model, in reality, all ten were assessed as the companies with business difficulties. This points to 100% accuracy and 0% error of the model, which means that the model did not make errors while classifying companies compared to the actual situation, as evident in Table 2.

Table 2: Companies whose Z' is less than 1.23

No.	Z'			MEASURE FOR COMPARISON			Assessment of the company in the reality
	2015	2016	2017	ACCOUNT ACTIVE (A)/ BLOCKED (B)	LRC'S ASSE-SSMENT OF FINANCIAL STATUS	Companies are orderly in repaying credit obliga-tions for up to 90 days	
1	1.18	0.70	1.17	B	1	NO	business difficulties
2	-0.50	-0.17	0.37	B	1	NO	business difficulties
3	0.58	0.59	-0.25	A	1	NO	business difficulties
4	0.82	0.68	1.15	B	1	NO	business difficulties
5	0.33	0.51	0.65	B	2	NO	business difficulties
6	-0.41	0.48	0.26	A	1	NO	business difficulties
7	1.03	0.91	0.04	A	1	NO	business difficulties
8	0.46	0.49	0.86	B	2	NO	business difficulties
9	0.57	0.53	0.48	A	1	NO	business difficulties
10	0.72	0.87	1.00	A	3	NO	business difficulties

Source: *Authors' calculation*

Out of the 29 companies for which the revised Z' model predicted doing business in "the grey zone", in reality, 17 were assessed as the companies with stable business and 12 as the companies with business difficulties, which is evident in Table 3. Generally, "the grey zone" is difficult for determining the level of prediction accuracy, as by its definition this zone is insufficiently determined. Hence, nothing particular is predicted for this group and at the same time, nothing is excluded, which means that anything is possible. According to Altman, "the grey zone" is the state of insecurity and lack of knowledge, which means that it is not known if the company is to file for bankruptcy or not.

Table 3: Companies whose Z' is between 1.23 and 2.90

No.	Z'			MEASURE FOR COMPARISON				Assessment of the company in the reality
	2015	2016	2017	ACCOUNT ACTIVE (A)/ BLOCKED (B)	LRC'S ASSE-SSMENT OF FINANCIAL STATUS	Companies are orderly in repaying credit obligations for up to 90 days		
1	3.26	2.58	2.68	A	4	YES		stable business
2	1.91	1.54	3.76	A	3	YES		stable business
3	1.97	2.02	1.78	A	2	NO		business difficulties
4	2.45	1.57	1.59	A	3	NO		business difficulties
5	1.66	1.55	1.82	A	4	YES		stable business
6	1.81	1.84	1.73	A	3	YES		stable business
7	2.60	2.27	2.74	A	5	YES		stable business
8	1.68	1.89	2.21	A	4	YES		stable business
9	1.27	1.46	1.11	B	2	NO		business difficulties
10	2.03	1.59	2.16	A	4	YES		stable business
11	1.57	2.04	2.21	A	5	YES		stable business
12	2.11	1.81	2.00	A	4	YES		stable business
13	1.63	1.78	1.76	A	3	YES		stable business
14	1.23	1.39	1.45	B	3	NO		business difficulties
15	1.58	0.98	1.38	A	2	YES		stable business
16	1.95	1.36	1.22	B	3	NO		business difficulties
17	1.76	1.79	2.13	A	4	YES		stable business
18	1.71	1.81	1.70	A	3	YES		stable business
19	1.41	1.57	1.71	A	3	NO		business difficulties
20	3.50	2.45	1.65	A	3	YES		stable business
21	1.27	1.57	0.81	A	2	NO		business difficulties
22	3.78	1.34	2.04	B	1	NO		business difficulties
23	2.16	2.29	2.46	A	4	YES		stable business
24	1.56	1.97	2.33	B	2	NO		business difficulties
25	2.07	2.40	2.59	B	1	NO		business difficulties
26	1.76	2.26	1.71	A	5	YES		stable business
27	1.17	1.26	1.23	A	2	NO		business difficulties
28	1.83	1.96	2.21	A	5	YES		stable business
29	1.28	1.48	1.45	B	2	NO		business difficulties

Source: *Authors' calculation*

Out of the 11 companies for which the revised Z' model predicted doing business in the stable business zone, in reality, all of them were assessed as the companies with stable business. This points to 100% accuracy and 0% error of the model. This means that the model did not make errors while classifying companies compared to the actual situation, as evident in Table 4.

Table 4: Companies whose Z' is above 2.90

No.	Z'			MEASURE FOR COMPARISON			Assessment of the company in the reality
	2015	2016	2017	ACCOUNT ACTIVE (A)/ BLOCKED (B)	LRC'S ASSE- SSMENT OF FINANCIAL STATUS	Companies are orderly in repaying credit obliga- tions for up to 90 days	
1	3.11	3.33	2.88	A	4	YES	stable business
2	4.01	4.76	3.40	A	5	YES	stable business
3	3.75	4.54	3.69	A	5	YES	stable business
4	5.45	5.79	6.78	A	3	YES	stable business
5	3.51	3.98	3.73	A	4	YES	stable business
6	3.64	3.96	3.99	A	4	YES	stable business
7	4.10	3.12	2.48	A	5	YES	stable business
8	3.70	3.35	3.54	A	5	YES	stable business
9	4.45	4.72	4.08	A	5	YES	stable business
10	3.26	3.51	3.44	A	5	YES	stable business
11	3.70	3.66	3.71	A	5	YES	stable business

Source: *Authors' calculation*

The accuracy in predicting the business stability of the sampled companies was ca-lculated using the revised Z' model. The accuracy was analyzed by comparing the company classification into one of the previously mentioned groups formed in the range of the revised Z'-score model to the actual position of the companies. The results are interpreted in Table 5.

Table 5: Test results according to the value ranges of the Z' model

Description	Z'	Actual situation		%	
		Business difficulties	Stable business	Accuracy	Error
Distress zone	10	10	0	100%	0%
Safe zone	11	0	11	100%	0%
Grey zone	29	12	17	-	-
Total	**50**	**22**	**28**	-	-

Source: *Authors' calculation*

The following part of the paper brings the results interpreted from the aspect of the group to which the company belongs in reality, as presented in Table 6.

The results of the application of the revised Z'-score model for the companies cha-racterized by stable business are the following:

- Out of the 30 companies with stable business, the value of Z' above the lower threshold of 1.23 was registered for all 30 companies, which is 100%.

- Eleven companies (37%) were registered in the zone of stable business, with the Z' value above 2.90.

- Nineteen companies or 63% were registered in the grey zone, with the Z' value between 1.23 and 2.90.

- As no companies were registered with the Z' value below 1.23, there were no companies classified in the bankruptcy zone.

The results of the application of the revised Z'-score model for the companies with business difficulties are the following

- Out of the 20 companies with business difficulties, 10 companies (50%) were classified into the bankruptcy group, with the Z' value below 1.23

- Ten companies (50%) were classified into the grey zone, with the Z' value between 1.23 and 2.90.

- There were no companies with a Z' value above 2.90, which is why there were no companies classified in the stable business zone.

Table 6: Results of the revised Z'-score model

Actual situation	Situation predicted by Z' model		%
Group I - 30 companies (Companies with stable business)	safe zone	11	37%
	grey zone	19	63%
	distress zone	-	0%
Total		**30**	**100%**
Group II - 20 companies (Companies with business difficulties)	safe zone	-	0%
	grey zone	10	50%
	distress zone	10	50%
Total		**20**	**100%**

Source: *Authors' calculation*

With the empirical study of predictive model applicability, one needs to calculate the percentage of error in the classification of the sample and the percentage of the accuracy of the model prediction.

Hence, we show whether the revised Z'-score model made errors while classifying the companies and what was the percentage of error. The following table brings the error types:

▪ Type I error, which shows how many companies with business difficulties the model incorrectly classified as those with stable business;

▪ Type II error, which shows the companies with stable business incorrectly classified by the model as the bankruptcy zone companies.

In addition, Table 7 shows the average of type I and II errors, as well as the average accuracy of the model, calculated as the difference between 1 and the average Type I and II errors.

Table 7: Error types in the model and the percentage of average error and model accuracy

Model	Type I error	Type II error	Percentage of average error	Average accuracy of model estimation
Revised Z'-score model	50%	0%	25%	75%

Source: *Authors' calculation*

Based on the presented results, the following remarks can be made:

▪ The revised Z'-score model has a relatively good result in assessing the companies with business difficulties as it correctly classified 10 out of 20 companies. The remaining 10 companies were not incorrectly classified as the companies with stable business but rather placed in the grey zone based on the calculated values of Z'.

▪ The revised Z'-score model proved completely reliable while classifying the companies with stable business as it correctly classified all the companies in this group. The model did not classify any company in the bankruptcy zone.

▪ The percentage of average error of 25% and 30% and the average accuracy of model estimation of 75% and 70% speak in favor of the thesis that the revised Z'-score model can be considered efficient while predicting the course of the company's business.

The testing of the sampled group of the companies with stable business showed high accuracy (100%) when it comes to the indicator Z'>2.90, which showed the zone of stable business, to the effect that none of the companies assessed in such a way had difficulties in their business upon the expiry of two or more years.

The analysis of the sample showed that the manufacturing companies with the Z'-score <1.23 had business difficulties. This means that their accounts were blocked due to liquidity problems, they were irregular in paying their over-90-day credit obligations and given LRC's negative assessment of their financial status.

The empirical research confirmed the hypothesis that the revised Z'-score model may be the predictor of the financial failure of manufacturing companies operating in (F)BiH. The model achieved a relatively good result in assessing the companies with business difficulties as it correctly classified 10 out of 20 companies. The other 10 companies were not incorrectly classified as the companies with stable business but they were placed in the grey zone. The model proved completely reliable in the classification of the companies with stable business as it correctly classified all 30 companies from the group with stable business. However, the revised Z'-score model is recommended as an additional rather than the basic indicator for predicting financial failure. The reason for such recommendation is the fact that the revised Z'-score model proved reliable in predicting the continuation of company's business activities under the present economic conditions in BiH which have allowed the companies to continue their activities despite their poor business results (liquidity problems, a high percentage of borrowed assets, negative gross working capital, negative EBIT, low or negative return on capital and assets, etc.).

Apart from the fact that the model proved reliable for the assessment of the financial status of 50 companies in the manufacturing industry, categorized as large by their income, assets and employee number, we need to point to the limitations of the testing. One limitation is the sample size as it included those companies whose data were obtainable at the time. According to the data of the Agency for Statistics of BiH, 80 large manufacturing companies were active in FBiH at the time and the data for 50 companies were collected for the research.

Furthermore, the sampled industry was the C-manufacturing industry, as the goal was to analyze the application of the revised Z'-score model to the manufacturing companies. The C industry also includes the companies whose primary activity was not manufacturing but services such as installation of equipment and machines, various repairs, etc. "Other industries" that mark other activities also include manufacturing companies. Naturally, as the authors were familiar with all the companies in the sample, the paper is restricted to the application of the model on the manufacturing companies.

Another research limitation was the classification of the companies into bankrupt and non-bankrupt companies or in this specific case into the companies with stable business and the companies with business difficulties as the sample did not include the companies that went bankrupt in the period the research was conducted.

The classification process requires setting the criteria, which was by no means easy since the BiH environment lacks absolutely any criteria regarding (non)-bankruptcy, (un)successful and (un)stable business, assessment of business quality, company's creditworthiness, etc. The criteria used for this classification were: whether the companies regularly (up to 90 days, A and B credit category) paid their obligations to banks, whether during their activities in the period from 2015 to the time of the research their accounts were blocked, and what was the assessment they were given by the credit rating company LRC d.o.o. Sarajevo.

In addition to the limitations mentioned, we have to say that the criteria used in this research were those believed to be the best at the given moment for representing the entire population and for realistic classification of the companies into stable ones and those with business difficulties. Based on these criteria, we made the sample groups for the assessment of the applicability of the revised Z'-score model to large manufacturing companies in FBiH.

5. CONCLUDING REMARKS AND RECOMMENDATIONS

The Altman Z-score model is one of the most renowned models for the assessment of a company's financial status. In its central formula, this model defines the five most important financial ratios and five weights for the assessment of a company's stability. The starting point of Altman's model is that financial indicators of healthy and stable companies are different from those of unsuccessful companies with business difficulties. Since 1968, when the model was developed, the Z-score has been accepted and applied to all world markets even though it was created on a sample of US companies.

In this paper, the revised Z'-score model achieved a relatively good result in assessing the companies with business difficulties as it correctly classified 10 out of 20 companies. The other 10 companies were not incorrectly classified into the companies with stable business; based on the calculated Z' values these companies were placed in the grey zone.

The revised Z'-score model proved completely (100%) reliable in the classification of the companies with stable business as it correctly classified all 30 companies from the group with stable business. The model did not place any company in the bankruptcy zone.

The percentage of average error of 25% indicates the percentage of model accuracy of 75%. This points to the fact that the financial situation of 75% of the companies was the same as calculated by the value of Z' and in reality, even upon the expiry of two or more years for which the Z'-score was calculated.

This average error of 25% does not mean that the model incorrectly classified the companies in the sample but rather that it placed some companies with business difficulties into the grey zone.

All this points to the fact that the revised Z'-score model has the appropriate level of accuracy when it comes to the assessment of the financial status of the manufacturing companies in (F)BiH. It is concluded that the empirical research confirmed the hypothesis that the revised Z'-score model can be the predictor of the financial failure of manufacturing companies. However, it is recommended as an additional rather than the basic indicator for predicting financial failure.

The revised Z'-score model enables timely recognition of business problems and provides the opportunity for timely commencement of corrective measures. The revised Z'-score model is definitely the tool that might assist in making business decisions. However, due to the underdevelopment and disorder (or a specific organization) of the emerging market in BiH, one needs to bear in mind all the specificities of a particular company, its business conditions, social and political situation and concrete knowledge of the industry, legal regulations, etc. while making relevant business decisions. Precisely these differences in terms of the type of activity, company size and economic conditions in a specific country cause different empirical results, which is why it is not possible to develop a unique model with 100% accuracy for all companies. This indicates the possibilities and need for further adaptation of the model to the reality of every country, including BiH, and the company's specificities and business conditions, which may lead to a more objective and higher level of assessment accuracy.

Finally, it should be pointed out that timely prediction of financial failure is of extreme importance for the entire business community and all interested groups in the value chain of a company's business. The key factor of the success in recognizing potential business problems lies in the selection of the model that would precisely and objectively generate the correct assessment of the future course of the company's business and enable the timely bringing of business decisions. For that reason, when it comes to future research, a comparison between the revised Z'-score model and the Business Excellence Model (BEX) for predicting business success and failure is strongly recommended.

BIBLIOGRAPHY

1. Altman, E. I. (1968). Financial ratio analysis, discriminant analysis and the prediction of corporate bankruptcy. *Journal of Finance*, *23*(4), 589-609. https://doi.org/10.2307/2978933.

2. Altman, E. I. & Hotchkiss, E. (2006). *Corporate Financial Distress and Bankruptcy - Predict and Avoid Bankruptcy, Analyze and Invest in Distressed Debt*. 3rd edition, Hoboken, New Jersey: John Wiley & Sons, Inc.

3. Altman, E. I., Danovi, A. & Falini, A. (2013a). Z-Score Models' Application to Italian Companies Subject to Extraordinary Administration. *Journal of Applied Finance*, *23*(1), 128-137.

4. Altman, E. I. (2013b). Predicting financial distresses of companies: Revisiting the Z-score and ZETA® models. In Bell, A. R., Brooks, C. & Prokopczuk, M. (*Eds.*). *Handbook of Research Methods and Applications in Empirical Finance (428-456)*. Cheltenham: Edward Elgar Publishing.

5. Begović, S., Momčilović, M. & Tomašević, S. (2014). Ocena kreditnog boniteta preduzeća Z-score modelom. *Ekonomske teme*, *52*(2), 193-204.

6. Boda, M. & Uradniček, V. (2016). The portability of Altman's Z-score model to predicting corporate financial distress of Slovak companies. *Technological and Economic Development of Economy*, *22*(4), 532-553. https://doi.org/10.3846/20294913.2016.1197165.

7. Bogdan, S., Bareša, S. & Hađina, V. (2019). Testiranje primjenjivosti Altmanovog Z-score modela za predviđanje stečaja u Republici Hrvatskoj. *Notitia*, *5*(1), 31-46. https://doi.org/10.32676/n.5.1.4.

8. El Khoury, R. & Al Beaino, R. (2014). Classifying Manufacturing Firms in Lebanon: An Application of Altman´s Model. *Procedia - Social and Behavioral Sciences*, *109*, 11-18. https://doi.org/10.1016/j.sbspro.2013.12.413.

9. Hayes, S., Hodge, K. & Hughes, L. (2010). A Study of the Efficacy of Altman's Z To Predict Bankruptcy of Specialty Retail Firms Doing Business in Contemporary Times. *Economics & Business Journal: Inquiries & Perspectives*, *3*(1), 130-134.

10. Kaplinski, O. (2008). Usefulness and credibility of scoring methods in construction industry. *Journal of Civil Engineering and Management*, *14*(1), 21-28. https://doi.org/10.3846/1392-3730.2008.14.21-28.

11. Piljić, J. (2007). Financijski pokazatelji u funkciji procjene rizika. *Međunarodni naučni simpozij „Finansije u društvu znanja i savremenoj poslovnoj praksi"*, zbornik radova, Ekonomski fakultet, Tuzla, 286-295.

12. Rodić, J. (2016). Američki model Zeta skor ocene boniteta preduzeća. *Financing*, *7*(4), 7-11. https://doi.org/10.7251/FIN1604007R.

13. Samkin, G., Low, M. & Adams, T. (2012). The Use of Z-Scores to Predict Finance Company Collapses: A Research Note. *New Zealand Journal of Applied Business Research*, *10*(2), 69-82.

14. Sherbo, A. J. & Smith, A. J. (2013). The Altman Z-Score Bankruptcy Model at Age 45: Standing the Test of Time?. *American Bankruptcy Institute Journal*, *32*(11), 40-41.

15. Stepanyan, A. (2014). Altman's Z-Score in the Airline Business. *International Journal of Advances in Management and Economics*, *3*(1), 16-24.

16. Wang, Y. (2012). Z-score Model on Financial Crisis Early-Warning of Listed Real Estate Companies in China: a Financial Engineering Perspective. *Systems Engineering Procedia*, *3*, 153-157. https://doi.org/10.1016/j.sepro.2011.11.021.

Emira Kozarević

Dženita Pirić

EVALUACIJA REVIDIRANOG Z'-SKOR MODELA KAO PREDIKTORA FINANSIJSKOG NEUSPJEHA PREDUZEĆA

SAŽETAK

U savremenim uslovima poslovanja prisutni su brojni modeli koji se koriste za ocjenu finansijskog stanja preduzeća i za predviđanje vjerovatnoće njegovog bankrotstva. Ovi modeli su uglavnom izvedeni korištenjem finansijskih informacija preduzeća. Jedan od njih je Altman Z-skor model. Model razdvaja finansijski uspješna i stabilna preduzeća od onih koja imaju poteškoće u poslovanju i kojima prijeti pokretanje stečajnog postupka. Kroz ovaj rad objašnjena je važnost bonitetne informacije, temeljnih finansijskih izvještaja i finansijskih pokazatelja te je provedeno istraživanje s ciljem ocjene aplikabilnosti revidiranog Altman Z'-skor modela u Federaciji Bosne i Hercegovine (F BiH). U radu je na bazi finansijskih informacija izvršena analiza poslovanja 50 velikih preduzeća iz proizvodnog sektora u F BiH. Revidirani Z'-skor model postigao je relativno dobar rezultat u procjeni preduzeća s poteškoćama u poslovanju jer je ispravno razvrstao 10 od 20 preduzeća; ostalih 10 preduzeća nije pogrešno svrstano u preduzeća sa stabilnim poslovanjem, već su svrstana u sivu zonu. Model se pokazao potpuno pouzdanim u klasifikaciji svih 30 preduzeća sa stabilnim poslovanjem. Rezultati istraživanja pokazali su da se revidirani Z'-skor može koristiti kao prediktor finansijskog neuspjeha proizvodnih preduzeća u F BiH. Ovaj model zasigurno je alat koji može pomoći kod donošenja poslovnih odluka, ali zbog specifičnih uslova poslovanja u F BiH, preporučuje se koristiti ga kao dodatni, a nikako kao osnovni pokazatelj za predviđanje finansijskog neuspjeha.

Ključne riječi: *finansijska stabilnost, fnansijski neuspjeh, predikcija, Altman Z-skor model, revidirani Z'-skor model*

JEL: *G33*