

POSSIBILITIES OF THE ALTMAN ZETA MODEL APPLICATION TO CZECH FIRMS

Kateřina Pitrová

Introduction

For many years a great many economists from all over the world have been trying to find a method how to assess firm health as accurately as possible, possibly to predict its eventual failure. In 1966 Beaver [5] published his work in which he identified six financial ratios that are crucial in order to assess the financial health of companies. In the following years quite a number of other models were published. Altman [2] introduced his multivariate linear discriminant model in 1968; Ohlson [15] introduced his logit model in 1980. Mr. and Mrs. Neumaier with their indexes IN have been pioneers in assessing the financial health of Czech firms. The last one called IN05 [14] was published in 2005.

The aim of this paper is to analyse the predictive ability of one of the best-known bankruptcy predictive models, which the Altman's bankruptcy predictive model indisputably is, when applying to Czech firms.

Problems of Czech firms have already been dealt with in Lízal's work [11]. His work also comprises the analysis of Altman model input variables. However, he especially focused on identification of financial distress factors of firms operating in the transforming economy, as his work is based on the data from the 1990s. The survey carried out by Speth, Šebo and Kováč [18] has also dealt

with assessing of company health. They analysed how companies can actively redound to improve their ratings. Benčová and Kalavská [6] focused on the common financial problem areas in information technology industry and with the cooperation of the controllers find out the forms of financial analysis and the solutions for the company performance.

1. Altman's Bankruptcy Predictive Model

The best-known version of this model was constructed in 1968. E. I. Altman [2] compared 33 medium-sized American companies (their registered capital amounting to USD 1–25 mil.) which ceased to exist with the same number of adequate booming companies. He was the first one to apply multiple discriminant analysis to estimate weights of individual ratios which were included in the model as variables. At first, Altman included 22 financial ratios in his model. He then reduced them only to the five most important. By means of his analytical method he got the following formula known as the Altman's bankruptcy predictive model or the Z-Score model, which is used for **companies listed at the capital market**:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5, \quad (1)$$

Tab. 1: Accuracy of Altman's Company Bankruptcy Predictions

Number of years prior to bankruptcy	Correct prediction (number of companies)	Wrong prediction (number of companies)	Correct prediction (%)
1	31	2	95
2	23	9	72
3	14	15	48
4	8	20	29
5	9	16	36

Source: [17, p. 22]

where

- X_1 - working capital / total assets,
- X_2 - retained earnings / total assets,
- X_3 - EBIT / total assets,
- X_4 - market value of owner's equity / book value of total liabilities,
- X_5 - sales / total assets.

If the score is above 2.99, the firm is healthy. If it is below 1.81, the firm is viewed as failing. Values ranging from 1.81 to 2.99 represent the so-called grey area, when there is no clear prediction.

Practice has proved that the application of the Altman's Index to predict the business failure is the most reliable two years prior to bankruptcy. The model is less effective and reliable when predicting bankruptcies in the distant future. [17]

After publishing the model, a discussion on how the Z-score model could be used for "nonstock companies" started. Modification of the original model consisted in the total revaluation of the model and the market value of owner's equity in variable X_2 was substituted with the book value of owner's equity. In 1977 Altman [4] published the final model applicable to companies **nonlisted at the capital market** under the name ZETA and it is as follows:

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5 \quad (2)$$

Classification ranges for this model have been changed. If the score is above 2.9, the company is healthy. If it is below 1.23, the company is regarded as going bankrupt. Values ranging from 1.23 to 2.9 represent the so-called grey area, when there is no clear prediction. It is obvious that the grey area for this model is wider as opposed to the original Altman's model.

The original model has been modified in many other ways. Altman [1] adjusted the model in such a way so that it could be applied to nonmanufacturing companies too.

In the subsequent years the model was verified several times, whether by the author himself [3] or by other economists. Let us mention, for example, the work of two analysts Grice and Ingram [9] or Warren Miller [13] from 2009.

2. Research Preparations and Data Collection

As already mentioned in the paper introduction, the Altman model ranks among the best-

known bankruptcy models, and hence, we will check up possibilities of its application to Czech firms. The analysis will comprise companies that went bankrupt in the past as well as companies which are, according to various ratings, considered to be the most prosperous in their branch. We based our research on the best-known rankings, namely on "Štítky českého byznysu" (Pikes of the Czech Business) [7], which is compiled by the company Coface Czech and then on "Českých 100 nejlepších firem" (100 Best Czech Companies) [8] compiled by the company called Comenius. Of course, there are a lot of other ranking lists. However, their disadvantage is that they often evaluate companies only by one criterion (in most cases by sales). The complex evaluation of the total output of a given firm is included in the above-mentioned chart by Coface Czech. In addition to standard accounting ratios, as are the turnover or profit, it assesses also other aspects, especially the development of company financial management over the last three years, its solvency and regional prospects.

The concrete accounting data of individual examined companies were obtained from the database called "Creditinfo-Firemní Monitor" (Creditinfo-Company Monitor). The period from 2003 to 2006 was the source of the most frequently observed values of necessary ratios of the successful companies. At the time of data collection (the second half of 2008), the accounting data for the year 2007 of the majority of examined companies were not available. As to the bankrupt companies, the examined period was 4 years prior to bankruptcy order.

37 companies (see Table 2), whose assumed value of Altman Z-Score was very high, were classified as the most successful ones.

13 companies (Table 3) were classified as those that went bankrupt (they were adjudged bankrupt) by reason of financial insolvency in recent years.

Many other companies were declared bankrupt in the past. The problem is, however, to obtain their accounting data. They are either totally missing or are incomplete; therefore, these companies cannot be used in the research.

To choose an appropriate Altman Z-Score model was very important. In view of the fact that majority of Czech companies are not publicly traded

Tab. 2: List of Successful Companies

Consec. number	Company name	Consec. number	Company name	Consec. number	Company name
1.	AAA Auto	14.	Grada Publishing	27.	První novinová společnost
2.	AGC Flatt Glass Czech	15.	H r u š k a	28.	Shell
3.	Agropol Group	16.	Iveco Czech Republic	29.	Skanska
4.	Ardeapharma	17.	Lanex	30.	Student Agency
5.	Bonus	18.	Linde Gas	31.	T-mobile
6.	Česká rafinérská	19.	Lomax & Co	32.	Třinecké železářny
7.	Čepro	20.	Lucas Varity	33.	Unilever
8.	Čeps	21.	Makro Cash & Carry ČR	34.	Visteon – Autopal
9.	Czech Coal	22.	Metalimex	35.	VSP Data
10.	Dalkia ČR	23.	Mitas	36.	Zapa Beton
11.	Deza	24.	Moravia Energo	37.	Zentiva
12.	Elektrolux	25.	Paramo		
13.	Eurest	26.	Pharmos		

Source: own

on the Stock Exchange, the Z-Score model applicable to nonlisted companies on the Stock Exchange, specifically the ZETA Model, (2) was chosen for the research.

The aim of this research is to evaluate whether the ZETA Model provides correct results; that is whether it predicted bankruptcy of the bankrupt companies, conversely, whether it ranked the successful companies among the group of healthy

companies. At the same time the significance of individual ratio coefficients in the model is assessed, namely by means of two methods. The multicollinearity between individual ratios and their significance for the Z-Score resultant value is determined by the correlation matrix. We try to check the difference in values of individual ratios for both healthy and bankrupt firms by means of testing of difference between means.

Tab. 3: List of Bankrupt Companies

Consec. number	Company name	Consec. number	Company name	Consec. number	Company name
1.	Adex Agro	6.	Chebský masokombinát	11.	Rybenor
2.	Benar	7.	J. Porkert	12.	Textilana
3.	Crystalex	8.	Mada – Pack	13.	Zbrojovka Brno
4.	Czech Aircraft Works	9.	Olšanské papírny		
5.	Hanácký masokombinát	10.	Průmyslové stavitelství Brno		

Source: own

3. Altman ZETA Model Values of Selected Czech Companies

If we examine results of the ZETA model of the successful companies (see Table 4), it is obvious that the Altman's model assessed 31 companies as financially healthy. That is 84 percent of the examined successful companies. Five companies were classified as those in the grey area and only the company Agropol Group (consecutive num-

ber 3) is regarded as failing for a long time. In the table the companies were substituted by consecutive numbers, which were given in Chapter 2, Table 2.

If we examine the values of ratio indicators of "successful companies" included in the grey area or classified as the bankrupt ones (see Table 5) in detail, it is evident that the greatest difference as compared with financially healthy companies is in variable X_1 (working capital / total assets). Also

Tab. 4: ZETA Model Values of Successful Companies

	2006	2005	2004	2003		2006	2005	2004	2003
1	4.66	5.32	6.04	N	20	3.44	3.84	3.69	3.97
2	1.75	1.50	1.82	N	21	4.76	4.40	4.54	N
3	1.17	0.90	0.69	0.81	22	10.97	7.72	7.72	4.35
4	5.10	3.95	4.11	3.57	23	2.18	2.20	1.78	1.97
5	5.71	4.35	6.35	4.49	24	6.19	5.48	5.42	6.09
6	1.59	1.79	1.26	2.39	25	3.77	N	N	N
7	2.92	2.23	3.66	3.43	26	2.94	2.95	2.79	3.03
8	3.40	2.87	2.75	2.49	27	4.01	3.48	3.30	1.95
9	5.93	4.77	7.07	2.34	28	5.29	6.04	4.21	3.23
10	2.08	1.96	2.09	1.96	29	1.69	1.91	1.89	2.41
11	3.00	3.67	3.30	2.34	30	9.77	10.95	10.46	9.33
12	4.12	4.18	4.84	5.29	31	3.50	3.29	3.16	2.76
13	4.52	5.07	4.66	5.08	32	3.59	3.34	3.44	2.27
14	3.75	4.88	4.93	4.63	33	2.95	2.59	2.35	3.47
15	6.45	6.13	6.99	6.72	34	3.24	3.21	3.01	2.17
16	3.38	3.12	3.31	3.66	35	6.18	6.21	4.98	5.28
17	2.91	2.58	2.48	N	36	3.33	3.00	2.68	N
18	3.06	2.55	2.30	1.73	37	3.39	2.93	3.47	1.94
19	6.78	6.21	6.62	N					
N Data are not available								
X,XX value of Z-Score $Z' \leq 1.23$ (the company may go bankrupt)								
X,XX value of Z-Score $1.23 < Z' \leq 2.9$ (the so-called grey area)								
X,XX value of Z-Score $Z' > 2.9$ (financially healthy company)								

Source: own calculations

Tab. 5: "Successful Companies" Ratio Mean Values in 2006

	X_1 WC/TA	X_2 RE/TA	X_3 EBIT/TA	X_4 MVE/BVTL	X_5 S/TA
Successful companies with the ZETA value > 2.9	0.218	0.340	0.166	1.461	3.045
Successful companies with the ZETA value ≤ 2.9	0.004	0.256	0.088	0.982	0.836

Source: own calculations

the difference in variable X_5 (assets turnover) has a significant impact on the resultant value of Z-score. In such cases the values are very low. Only in two companies out of the six the difference exceeded value one. On the contrary, companies ranked among financially healthy showed assets turnover

above 2.5 or higher. Debts of these companies are regarded as another problem. Most of them are very dependent on the loan capital. That can liquidate majority of companies especially at the time of economic crisis, because banks are not willing to grant loans and credit as before.

Tab. 6: ZETA Model Values of Bankrupt Companies

Company	Number of years prior to bankruptcy			
	1 year	2 years	3 years	4 years
Adex Agro	1.20	1.58	1.32	0.45
Benar	-1.58	1.80	2.06	N
Crystalex	N	1.22	1.38	1.46
Czech Aircraft Works	N	0.53	2.82	3.49
Hanácký masokombinát	0.90	1.34	1.58	1.36
Chebský masokombinát	N	2.72	3.03	3.58
J. Porkert	N	1.77	2.22	2.26
Mada – Pack	N	-0.13	0.82	0.81
Olšanské papírny	N	2.24	2.13	2.50
Průmyslové stavitelství Brno	N	1.72	1.58	1.79
Rybenor	1.02	2.52	2.71	N
Textilana	0.45	0.65	1.25	N
Zbrojovka Brno	-2.69	-0.04	N	N
N data are not available			
X,XX Z-Score value $Z' \leq 1.23$			
X,XX Z-Score value $1.23 < Z' \leq 2.9$			
X,XX Z-Score value $Z' > 2.9$			

Source: own calculations

Altman's model are ranked among the group of bankruptcy models and hence it is important that they manage to predict a company bankruptcy in time. Table 6 shows the **ZETA model results of the bankrupt companies** in individual years prior to bankruptcy.

The table clearly shows that only Mada - Pack was regarded as bankrupt for a long time. Other companies were in the grey area for several years and were evaluated as bankrupt only just before the declaration of insolvency. "Chebský masokombinát" (Cheb's Meat-Packing Plant), whose owners themselves filed a petition in bankruptcy since they could not have met their obligations, was regarded as a completely healthy business even as late as three years prior to the bankruptcy order.

However, sometimes it is more important to follow development trends than absolute values. All the while the seven companies showed a deteriorating score of the Altman model. Values of the others were stagnating.

If we wanted to find some identical factors of these bankrupt companies, it would be quite difficult. We would need much more data for such an analysis. Let us outline, at least, basic common features though. The first common feature of these companies is the book loss showed in recent years. That book loss progressively increases and due to it variable X_2 (retained earnings / total assets) is continually deteriorating. Variable X_3 (EBIT / total assets) has a negative value owing to the loss from operations. Another common feature is a high volume of current liabilities. Due to that the value of working capital is greatly diminished. In many cases the fixed assets are even financed by short-term resources and the value of working capital is then negative. Thus, the value of variable X_1 (working capital / total assets) is lower.

The survey showed that the Altman ZETA model did not give us conclusive results regarding the bankrupt companies. Even though the Zeta model classified these companies as problematic for a long time and ranked them in the grey area, the model detected the very financial failure no sooner than just before the bankruptcy order. That could be explained by the present turbulent time, when a company can get into difficulties very fast and go bankrupt sooner than expected.

4. Significance Analysis of Individual Ratios in the Model - Correlation Matrix

When constructing any model, it is necessary to analyze variables that we want to include in the model. The most common requirement as to independent variables is their significant relation to the dependent variable. We always try to find a compromise between the number of variables comprised in the model and the model informative value. At the same time it is not desirable that there be any dependence between individual independent variables (then we talk about multicollinearity).

In our case the model version is known. Therefore, we only check the impact of individual variables (ratio indicators) on the resultant score (value) of the ZETA index and whether there is no multicollinearity between indicators. Since we consider only linear dependence, a suitable statistical instrument for the given analysis is the **correlation matrix**.

Values of paired coefficients of correlation for each couple of examined variables are recorded in the correlation matrix. The coefficient of correlation is a measure of the degree of linear association between the two variables. It is always a number between -1 and +1 inclusive. a value of +1 represents perfect positive correlation; -1 represents perfect negative correlation; and 0 indicates no correlation whatsoever. [10]

Of course, there is a directly proportional relation between each of the ratios and the overall score of the ZETA index. If the ratio value is increasing, so is ZETA. As the model comprises more than one variable, the relation is not so unambiguous. Certain values of a ratio can be quite characteristic of thriving or collapsing companies. However, as to other ratios we may not find a strong relation between their values and financial health of a company.

Each examined company, whether prosperous or failing, was represented in the correlation analysis by ratio values for one accounting period. In the research we used the ratio values of successful companies from 2006; as for the bankrupt companies, we used ratio values from the period of one year (in some case two years) prior to the bankruptcy order.

From the correlation matrix it is obvious that variable X_5 (sales / total assets) has the stron-

Tab. 7: Correlation Matrix of the Altman ZETA Model Variables

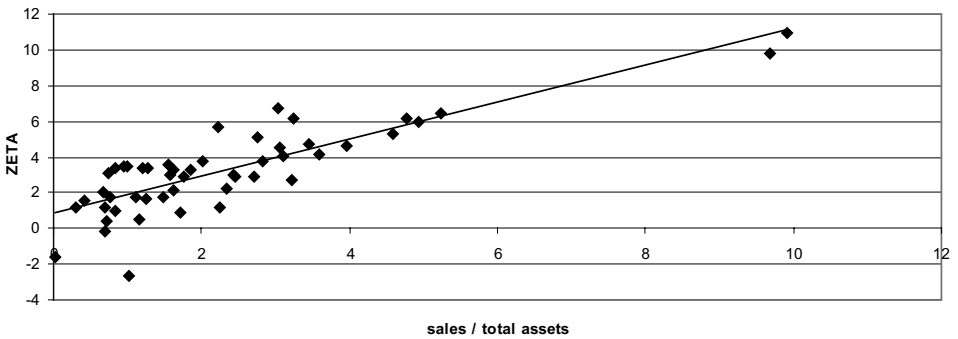
	ZETA	X ₁ WC/TA	X ₂ RE/TA	X ₃ EBIT/TA	X ₄ MVE/BVTL	X ₅ S/TA
ZETA	1	0.538	0.589	0.644	0.193	0.844
X1	0.538	1	0.630	0.667	0.509	0.143
X2	0.589	0.630	1	0.756	0.502	0.145
X3	0.644	0.668	0.756	1	0.467	0.207
X4	0.193	0.509	0.502	0.467	1	-0.264
X5	0.844	0.143	0.145	0.207	-0.264	1

Source: own calculations

gest relation to the value of the Altman ZETA index. That means that the Altman index value increases with the increasing value of this variable.

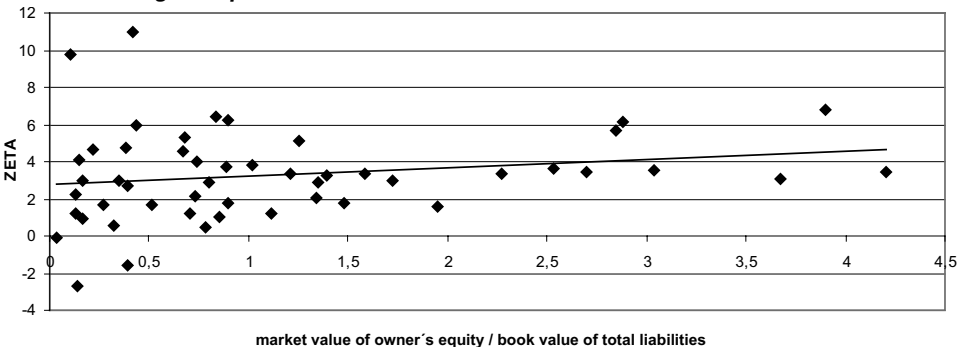
In comparison with that the lowest linear relationship is between the ZETA index and variable X₄ (market value of owner's equity / book value of total liabilities). Or, in other words, there is no

Fig. 1: Dependence between Variable X5 and the Value of ZETA Index



Source: own calculations

Fig. 2: Dependence between Variable X4 and the Value of ZETA index



Source: own calculations

unambiguous relation between these two variables; the increasing value of variable X_4 does not necessarily mean the increasing value of the overall score. This conclusion would not change even in the case when the weights assigned to individual variables were included in the analysis. In the case we changed the weight of a given variable; then, overall results of the model would change.

The given situation can also be represented graphically by point charts, in which the intensity of the both relations mentioned above is clearly evident.

Figure 2 shows that individual observations are much more scattered compared to Figure 1.

If we examined correlation between pairs of ratios (already mentioned multicollinearity), we would find out that there is highest correlation between X_2 (retained earnings / total assets) and X_3 (EBIT / total assets). In this case the coefficient of correlation value equals to the value of 0.756, which is considered as a high positive correlation. However, this conclusion is not so surprising with respect to the cohesion of these ratios. The correlation matrix also clearly shows that variable X_5 (sales / total assets) is least sensitive to changes of other ratios. Values of correlation coefficients between variable X_5 and any other ratio represented in the model are very near to zero and the intensity of linear dependency is then very low.

5. Significance Analysis of Individual Ratios in the Model - Testing

Certain values of the ratios are characteristic of prosperous as well as of bankrupt companies. Models which predict a company bankruptcy shall comprise the ratios that show significant difference in their value for financially healthy companies in comparison with bankrupt companies.

Therefore, this chapter aims to check whether there are statistically significant differences in mean values of the ratios, which are included in the Altman ZETA Model, for the prosperous companies in comparison with those that went bankrupt. For this purpose we will use statistical

testing of hypotheses, **two sample tests** [10], specifically the comparison of two mean values from two sets (the first set comprises ratio values of prosperous companies, the second one comprises ratio values of bankrupt companies).

Each examined company, whether successful or failing, is represented in this analysis by ratio values for one accounting period. The prosperous companies are represented by ratio values from 2006, the bankrupt ones are represented by ratio values dating back to one year (in some case two years) prior to the bankruptcy order. Mean ratio values of the model for individual groups of companies are given in the following Table 8. It is obvious that the mean values of prosperous companies exceed the means of bankrupt companies.

At the significance level $\alpha = 5\%$ we have tested the null hypothesis:

$$H_0: X_{i1} = X_{i2}$$

as compared with the alternate hypothesis:

$$H_1: X_{i1} > X_{i2}$$

where X_{i1} expresses the mean value of i-ratio of prosperous companies and X_{i2} expresses the mean value of i-ratio of bankrupt companies.

We have successively tested all ratios comprised in the ZETA model. The testing has implied that all ratio indicators comprised in the ZETA model have statistically higher values with prosperous companies than with bankrupt ones. Thus, we have verified that the indicators in view are significant in the Altman ZETA Model.

Conclusion

The following sub-conclusions can be drawn from the performed analysis:

- The ZETA Model ranked the prosperous companies correctly in the group of healthy companies.
- It did not detect the unsatisfactory financial health of bankrupt companies until the very bankruptcy order.
- The evident increasing linear relationship between the ZETA index value and ratio values

Tab. 8: Mean Values of Ratios Included in the ZETA Model

	X_1 WC/TA	X_2 RE/TA	X_3 EBIT/TA	X_4 MVE/BVTL	X_5 S/TA
Successful companies	0.183	0.327	0.153	1.384	2.687
Bankrupt companies	-0.188	-0.427	-0.108	0.504	1.309

Source: own calculations

- has been proved only with variable X_5 (sales / total assets). On the contrary, the lowest correlation has been identified between the ZETA index and variable X_4 (market value of owner's equity / book value of total liabilities).
- Multicollinearity has unequivocally been proved with variable X_2 (retained earnings / total assets), and variable X_3 (EBIT / total assets). As compared with that variable X_5 (sales / total assets) is least sensitive to changes of other ratio indicators.
 - It has been proved that all ratio indicators comprised in the model show different values for prosperous companies and for those going bankrupt.

The bankruptcy prediction model is expected to be highly reliable when predicting financial difficulties, or more precisely the bankruptcy of a given company. The ZETA Model has detected the financial difficulties of the analysed companies one year, in some cases two years prior to the very bankruptcy of the companies. Thus, this research corroborated the opinion stated in the first chapter, namely that the Altman Model can predict bankruptcies in the distant future only with low reliability. For example, Mensah [12] offers an explanation why the Altman's model cannot detect the approaching bankruptcy sooner than two years ahead. He alleges that the distribution of accounting ratios changes in the course of time, therefore, it is necessary to re-develop models on a regular basis or update weights assigned to individual ratio indicators represented in the model.

From the analysis we can also draw a conclusion that although the "relevance" of individual indicators included in the model has been proved (by means of statistical testing), the significance of some of them disappears with their interconnection in the model.

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Ing. Kateřina Pitrová

University of West Bohemia in Pilsen

Faculty of Economics

Department of Economics and Quantitative

Methods

pitrovak@kem.zcu.cz

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ABSTRACT**POSSIBILITIES OF THE ALTMAN ZETA MODEL APPLICATION TO CZECH FIRMS****Kateřina Pitrová**

Many economists and analysts from all over the world have been trying to find a method to assess company health and predict its eventual financial distress for many years. No economy is a small isolated island and the bankruptcy of a company can also influence a situation on the other side of the world. But companies are very complicated organisms and that is why it is not a simple task to estimate company future development.

The best-known model of prediction called Z-Score was introduced by E.I. Altman in the USA more than forty years ago, in 1968. This model was modified several times. The best-known modification is the ZETA model which is applicable to unlisted companies and was established by Altman in 1977. The Z-Score model was verified not only by the author but also by other analysts many times. Some analysts criticize that the model doesn't give correct results. Above all, it is not able to detect the coming crisis within a sufficient time period.

The aim of this paper is to introduce the ZETA model to readers and try to show the application possibilities of this model to companies in the Czech Republic. The model is described in the first chapter. The next chapter focuses on the ZETA index value calculation for Czech companies. Variables of the model are tested in others chapters. I also try to set correlation coefficient for each pair of the variables. In my analysis I worked with accounting data of thirty-seven going companies and thirteen firms which went bankrupt.

Key Words: bankruptcy, financial distress, predictive model, Zeta model.

JEL Classification: C 25, C 52, G 33.