BANKRUPCY MODELS IN THE BUSINESS ENVIRONMENT OF VISEGRAD GROUP COUNTRIES

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Abstract:

Bankruptcy models are a suitable way of comprehensively and clearly interpreting the achieved results of the company's health assessment. They are able to predict with some degree of probability the future assessment of the company's financial situation. The aim of the paper is to evaluate the usability of the bankruptcy models for SMEs in the V4 countries. The available research shows that the suitability of applying bankruptcy models varies according to the country in which the analyzed companies operate. For evaluation of the company's financial situation the Altman analysis, Taffler analysis and Index 05 are used. The observed period is set for the years of 2005 – 2016. This period contains the effect of business cycle on the financial health of companies. The practical applicability of the selected bankruptcy models is evaluated on the basis of a comparison of their results with the number of detected bankruptcies in V4 countries. In particular, the Z´´EM and IN05 models can be recommended for practical applicability.

Key words: Banckruptcy models, Financial distress, Financial situation, Visegrad Group

JEL: M21, G33

1 Introduction

Due to increasing globalization, deepening integration, but also due to economic structural changes at the beginning of the new millennium, companies were struggling with the transformation of their business activities according to current trends. The financial performance and financial health of a company is determined by the company's ability to create added value, the return on invested capital or the return on invested inputs. For the final effect of value added, maximum activity is necessary, which is one of the basic preconditions for the effective appreciation of funds.

A financially sound company does not show signs of a financial threat to its continuing business activities. Conversely, a firm's financial distress arises in situations where the firm is experiencing serious payment difficulties which cannot be resolved other than by a radical change in its activities or structure. The criterion for financial distress is defined not only by capital restructuring of the company or extensive redundancies, but also as non-payment of dividends from preference shares, non-fulfillment of bond obligations, accumulated losses of the company or repeated negative cash flow. According to Baker and Powell (2005), a company is in financial distress provided that it has difficulty meeting its contractual obligations related to debt financing. In such a case, it is an overall weakening of the financial condition of the company caused by enormous indebtedness, while the extreme case of financial distress is bankruptcy.

Bankruptcy models (Altman's bankruptcy model, Taffler's bankruptcy model or IN credibility indices) are used as early warning systems against possible financial distress, which capture events typical of a company's future bankruptcy. Predictive bankruptcy or creditworthiness models can be used

to model whether a company will meet its obligations on time and to a sufficient extent. The models are based on real data from companies that have already gone bankrupt. Using the created formulas and financial ratios, it is predicted whether the company is going bankrupt or prospering. The prediction of bankruptcy can be ascertained several years before the actual bankruptcy.

However, the financial situation of companies is significantly affected not only by the decisions of the company's management, but also by the macroeconomic environment in which the company is located. The financial performance of a company is directly linked to the business cycle. At the time of expansion, companies are expanding their production capacities and unemployment is falling, which is increasing consumer spending and business investment. Conversely, in the event of a recession, consumers and businesses are cutting back on spending and postponing investment. It is also generally accepted that at a time of economic expansion and an improving macroeconomic environment, the number of companies affected by financial distress is declining and the financial performance of companies is improving. However, individual macroeconomic factors affect companies differently. This difference can be perceived both in the different effects of macroeconomic factors on enterprises within individual economies, as well as in the different effects on individual sectors or in the different effects on enterprises differentiated according to their size.

Models for predicting the financial situation of a company enable the basic classification of the evaluated company into the categories of prosperous or failing companies. The aim of the paper is to evaluate the usability of the bankruptcy models for companies in the Visegrad Group (V4) countries. The practical usability of the models will be evaluated according to the best predictive abilities of a possible financial distress in comparison with the real numbers of bankruptcies in a given period.

The V4 countries was created as a result of the joint efforts of these countries for pan-European integration. These countries share common cultural and intellectual values and their activities aim to strengthen stability in the Central European region. Based on the availability of data, the observed period was the years 2008–2016. These years are characterized by the volatility of real GDP. Economic growth before 2008 was followed by a sharp economic downturn caused by the global financial crisis and the ensuing European debt crisis. However, 2012 was again followed by a gradual economic recovery. Similar features of the economic cycle can be observed in the coming years. For this reason, it was also necessary to evauate whether there is a short-term causal effect of GDP on the assessment of bankruptcy models.

Bancruptcy models can be included among the ex-ante analyzes, which can predict the financial health of companies and how the company will develop in the next 3 to 5 years. The construction of bankruptcy models proved to be the most suitable for monitoring the company's activities according to Lízal (2012) or Škerlíková and Rudolfová (2015). The instability and risk of the overall economic environment in recent years have highlighted the need for precise tools to anticipate financial distress and assess the overall financial situation of companies.

The basic models for predicting financial distress and bankruptcy businesses based on financial indicators are Edward Altman's models, Taffler's models or Neumaierová and Neumaier's models. Altman (1968) developed multivariate discriminant analysis, which showed that in most cases be correctly classified bankrupt company for one year to a two-year forecast horizon. For its analysis, 22 indicators divided into liquidity, profitability, indebtedness, solvency and asset management were selected. The Taffler Bankruptcy Model (1983) was developed by compiling more than 80 selected ratios of all industrial firms in 1968 to 1976 and 46 randomly selected solvent industrial firms The predictive ability of the original Taffler model over the years has been confirmed by Agarwal and Taffler (2007). The specifics of Czech financial statements and the economic situation in the Czechia are included in Neumaierová and Neumaier's model (2005). The remainder of this paper is organized as follows. The relevant literature is reviewed in Section 2. The data and the methodology used in this paper are introduced in Section 3. The results of the empirical estimation are reported in Section 4. The discussion and summary of the main findings are contained in Section 5.

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2   Literature Review

The above-mentioned bankruptcy models have become a frequent object of research. Opinions on the applicability of bankruptcy models vary widely. However, a common feature of the monitored studies dealing with the practical application of bankruptcy models is the opinion on the need for their combination.

Machek (2014) or Čamská (2016) dealt with the comparison of individual models and their ability to identify a company in financial distress in Czechia. Machek (2014) analyzed Kralick's Quick test, Taffler's bankruptcy model, IN99 and IN 05 indices and Altman's Z´score in the case of Czech companies from 2007 to 2010. Based on the results of individual models, which predicted the company's financial distress, he found that the most suitable models for the practical use of the prediction of financial distress are Altman's Z´score and indices IN 99 and IN05. On the contrary, the Quick test is the least suitable. Although Taffler's model was able to draw attention to companies in financial distress, its predictive ability was low compared to other bankruptcy models. Similarly, Čamská (2016) compared the predictive power of bankruptcy models in the manufacturing industry during the global financial crisis. The bankruptcy models that achieved the highest predictive values were IN01, IN05 or Altman's Z´ score, thus confirming Machek's (2014) conclusions .

Similarly, Gavurová, Janke and Pack (2017) or Gavurová et al. (2017). Based on previous research in Slovakia, they determined a portfolio of four models (Altman's model, Ohlson's model and indices IN01 and IN05), which were validated on a sample of 700 Slovak companies. They assessed the accuracy of the assessment of the financial distress prediction at three levels. In their articles, they monitored the overall accuracy, accuracy of bankruptcy prediction, and inaccuracy of bankruptcy prediction. Based on the results, they proved that Ohlson's model is not applicable to bankruptcy predictions in Slovak conditions, as it achieved the lowest predictability of bankruptcy. On the other hand, the IN05 index is the most suitable model applicable to the Slovak business environment.

The study of Bohdalová and Klempai (2017) also reaches similar conclusions, which is focused on monitoring the predictive abilities of bankruptcy and creditworthiness models in Slovakia. The best results from the bankruptcy models used are achieved by the IN05 models and the original Altman Z score. On the contrary, Taffler's bankruptcy model performed worst. While the predictive power of the IN05 index for 2 years is up to 87%, for the Altman model 67%, for the Taffler model it was only 7%. The authors recommend using a combination of the IN05 index and the Altman model to monitor the financial situation of companies in individual sectors and to predict their financial distress.

Csikosová et al. (2019) dealt with the application and comparison of the most frequently used bankruptcy models in the V4 countries. Models IN95, IN99, IN01, IN05, the original Altman's Z score model as well as modified Z´score or Z´´EM Score models were applied to the data of V4 industrial companies. The results of the studies draw attention to the fact that the financial situation of companies is influenced not only by the decisions of managers, but also by the macroeconomic environment. By applying correlation analysis or chow test, they confirmed the theory that structural changes had a strong negative impact on the financial situation of the monitored companies. According to the results, Z'Score Model, Z'EM Score or IN05 models can predict possible financial distress of companies. Karas and Režňáková (2014) discuss the possibility of use Z''EM Score model in V4 countries. The results of study shows important differencies between Z'Score a Z''EM Score models. Due to the construction model, especially the higher attention to liquidity ratios, the Z''EM Score model captures specifics of companies in V4 countries.

On the contrary, Delina and Packová (2013) came with completely different results. The validation of the IN05 bankruptcy models, Altman's Z´Score and the Creditworthiness Index, found that in the conditions of the Slovak economy, the models achieve high error values. The low predictive ability of default models was also mentioned by Misanková et al. (2017). The study tested the predictive ability of default models designed in the V4 countries. The authors point out the different explanatory power within individual branches of business activity.

According to a study by Liu and Smith (2007), macroeconomic indicators have a high predictive value of financial distress in the models. Jakubík and Teplý (2008) or Hunter and Isachenkova (2003) explained the negative impact of global crises on the corporate sector, generally measured by the development of real GDP. The relationship between the growth rate of real GDP and the financial situation of a company is usually positive, with increasing real GDP and higher household consumption increasing corporate profits and the fundamental value of shares. This assumption is confirmed in their works by Dincergok and Yalciner (2011) or Angelache et al. (2014). On the contrary, Hanousek and Shamshur (2011) or Stoklasová (2018) point out the opposite influence, who see a negative influence caused by the lack of capital of companies in times of economic boom.

The assumptions of individual authors are used to determine research questions that will be a means to fulfill the goal of the work. Statistical methods will be used to answer the selected research questions, the more detailed characteristics of which are part of the following subchapter. The following research questions are identified in this study:

• Research question No. 1: Does real GDP growth affect the results of bankruptcy models within the individual countries of the Visegrad Group?

• Research question No. 2: Which of the analyzed bankruptcy models can be recommended for practical applicability in the Visegrad Group countries?

3 Methods

Company data are used to determine the financial situation of companies in V4. The annual reports of companies are recorded in the company data databases Orbis from Bureau van Dijk (BvD) and Amadeus. Due to the availability of data and obtaining a sufficient time series, both mentioned databases were used. The selected period includes the development of the entire business cycle; from economic growth lasting until 2008, through the global financial crisis and the euro area debt crisis, to the gradual recovery of the V4 economies. However, the financial situation of companies is not only significantly influenced by the decisions of the company management, but also by the macroeconomic environment in which the company is located. The company's financial performance is directly linked to the business cycle. The macroeconomic development of the individual V4 countries in the period under review was affected by the euro area debt crisis, which emerged as a consequence of the global financial crisis in 2008, as is shown in Figure 1. Despite this, the euro area crisis had different effects on the economies under review. Poland is the only country that did not experience a recession linked to the global financial crisis. Despite a slowdown in GDP growth, it did not fall into negative territory in any of the years under review. The growing problems of the euro area in dealing with highly indebted economies, combined with unfavourable domestic conditions, plunged the Czechia and Hungary into further recession in the second half of 2011 and in 2012. The period between 2013 and 2014 became a turning point for the subsequent economic development of the V4. Economic growth was driven by rising domestic demand, reflecting optimistic consumer and business expectations.

Figure 1: Development of GDP growth in Visegrad Group Countries
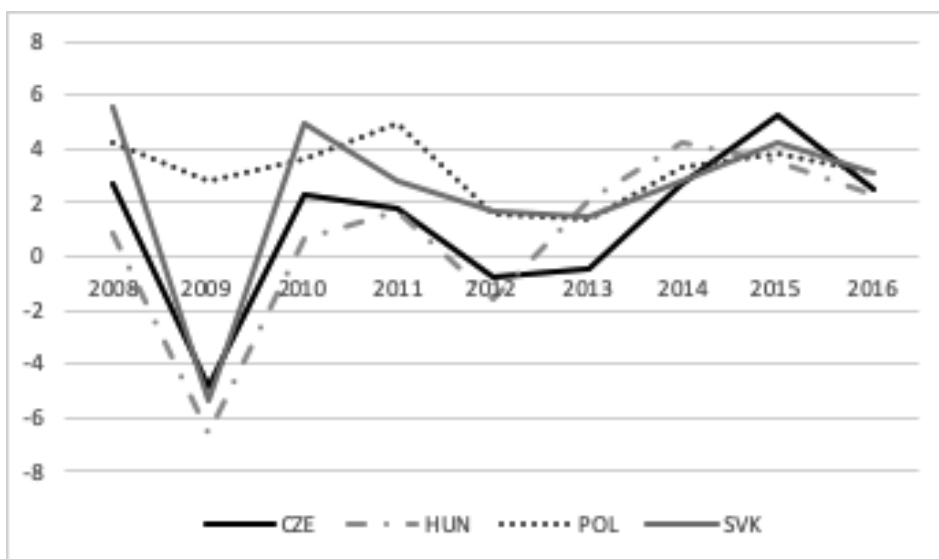
Source figure: Eurostat database (2021)

The initial phase of the research involved the creation of a database of corporate data and selected macroeconomic factors of the V4 countries. Based on the BvD identification number of companies and the use of advanced functions in MS Excel, it was possible to connect the two available databases. Based on the availability of data and to fulfill the aim of the paper, the period between 2005 and 2016 became the observed period. In the second phase of the research, bankruptcy models were processed using the MS Excel tool. The representativeness of the sample was ensured by a systematic improbability selection. The sample size was given by the total number of available companies in the enterprise databases Orbis and Amadeus. All companies that had available data in the observed period became the examined sample. A total of 3,736 companies are monitored in the Czechia. In Hungary, attention is paid to a total of 1,502 companies. A total of 4,006 companies are monitored in Poland and a total of 985 companies in Slovakia.

The following bankruptcy models will be used in the paper:
• Altman's model for companies not traded on capital markets (Z'Score),
• Altman's model for companies operating in emerging markets (Z''EM),
• Modified variant of the Taffler Index (Tf),
• Modified variant of index IN05 (IN05).

Altman's original bankruptcy model was subsequently modified for companies that are not traded on the capital markets (Z´Score). The highest weight is still given to indicator X 3 (EBIT / assets), but the second highest weight this time belongs to indicator X 5 (sales / assets). The final form of the equation according to Altman (2006, p. 246) is as follows:

$$Z' = 0{,}717X_1 + 0{,}847X_2 + 3{,}107X_3 + 0{,}420X_4 + 0{,}998X_5, \qquad (1)$$

where: X 1 = net working capital / assets,
      X 2 = retained earnings / assets,
      X 3 = EBIT / assets,
      X 4 = market value of equity / debt,
      X 5 = sales / assets.

In the Z´Score model, these boundary points are 1.23 and 2.90 (Table 1). Altman states that this variant of the bankruptcy model can predict a possible financial distress of a company with a probability of 91% and an error rate of 3% will include a prosperous company in the set of companies at risk of possible bankruptcy.

Table 2: Categories of Altman's Z´ Score

Intervals	Evaluation
Z'Score ε < 2 , 90 ; ∞)	Safe zone
Z'Score ∈ (1 , 23 ; 2.90)	Gray zone
Z'Score ∈ (- ∞ ; 1,23 >	Distress zone

Source table: Altman (2006)

Another selected model is a variant of Altman model designed for the evaluation of companies in emerging markets (Z"EM Score). For the purposes of constructing the model, it is abstracted from the indicator X 5 (sales/assets) and the individual weights of the coefficients are also adjusted. Due to the reduced number of indicators, the weights are increased compared to the previous models. For the comparison of the resulting value of the bankruptcy model for companies operating in emerging markets with the US Bond Rating, a constant of 3.25 was added. The resulting values of the Z´´EM model for assessing the financial health of non-US companies and for emerging markets allow the monitored companies to assign an adequate rating, which indicates the ability of the entity to meet its obligations on time. According to Altman (2006, p. 248), individual models can be quantified as follows:

$$Z''EM = 3{,}25 + 6{,}56X_1 + 3{,}26X_2 + 6{,}72X_3 + 1{,}05X_4 \qquad (2)$$

where: X 1 = net working capital / assets,
X 2 = retained earnings / assets,
X 3 = EBIT / assets,
X 4 = market value of equity / debt.

Based on the changes in the construction of the model, it was also necessary to change the individual boundaries of the intervals. As shown in Table 2, the boundary points of the intervals in this case are 4.35 and 5.85.

Table 2: Categories of Altman's Z´´EM Score

Intervals	Evaluation
Z"EM Score ε < 5 , 85 ; ∞)	Safe zone
Z"EM Score ε (4 , 35 ; 5.85)	Gray zone
Z"EM Score ∈ (- ∞ ; 4.35 >	Distress zone

Source table: Basovníková et al. (2018)

The reaction to Altman's original bankruptcy model was the creation of the Taffler Index (1977). British economists Taffler and Tisshaw analyzed the financial situation of British companies on more than 80 ratios, from which they selected four key figures and assigned them specific weights. The modified version of the original version of model was captured by Taffler (1984):

$$T_f = 0{,}53X_1 + 0{,}13X_2 + 0{,}18X_3 + 0{,}16X_4 \tag{3}$$

where: X_1 = EBIT / current liabilities
X_2 = increase in fixed assets / depreciation,
X_3 = EBIT / sales,
X_4 = liabilities to banks / debt.

The modified variant already considers the existence of a gray area category, which includes companies that could not be classified as having a low or high probability of bankruptcy. As shown in Table 3, the boundary points in this variant are 0.2 and 0.3.

Table 3: Categories of modified Taffler Index

Intervals	Evaluation
$T \in (0{,}3 ; \infty)$	A company with a low probability of bankruptcy
$T_f \in <0{,}2 ; 0.3>$	Gray zone
$T_f \in (-\infty ; 0{,}2)$	A company with a high probability of bankruptcy

Source table: Taffler (1984)

The specifics of the Czech financial statements are described by the Neumaierová and Neumaier's model (2005). Over the years, four modifications of bankruptcy indices have emerged. The IN05 index was created in 2005 as an updated version of IN01. The modified version of IN05 is focused on predicting financial difficulties, but also on the ability to create value for owners. According to Csikosová et al. (2019), the IN05 model is considered to be the most accurate and most suitable for use in monitoring companies from V4 countries. The boundary points for the classification of companies into individual categories are 0.9 and 1.6 (Table 4). The construction of model is as follows:

$$IN05 = 0{,}13X_1 + 0{,}04X_2 + 3{,}97X_3 + 0{,}21X_4 + 0{,}09X_5 \tag{4}$$

where: X_1 = assets / debt,
X_2 = EBIT / interest expenses,
X_3 = EBIT / assets,
X_4 = income / assets,
X_5 = current assets / current liabilities,

Table 4: Categories of Index IN05

Intervals	Evaluation
$IN05 \in <1{,}6 ; \infty)$	Creditworthy company
$IN05 \in (0{,}9 ; 1.6)$	Gray zone
$IN05 \in (-\infty ; 0.9>$	Bankruptcy company

Source table: Neumaierová and Neumaier (2005)

The practical applicability of the monitored bankruptcy models is evaluated on the basis of a comparison of their results with the number of detected bankruptcies. In the case, where the identified number of companies with potential financial distress was higher than the number of companies with terminated business activity, it was possible to evaluate the model as practically applicable. In the opposite case, when the number of companies in financial distress was lower or the same as the number of companies with terminated business activity, the model was not recommended for practical use in the V4 countries. When evaluating the usability of individual models, the comparison of the identified bankrupt companies in year *t* with the number of identified companies in financial distress in years *t-1* and *t-2* was used.

Subsequently, a causality test will be applied to decide on the possible interaction of GDP on tame models. Granger's causality test is used in econometrics to determine the existence of short-term relationships between two time series. In the case of Granger causality, the aim is to reject the null hypothesis that there is no causal relationship between the observed variables. In their study, Engle and Granger (1987) quantify Granger causality by equations (5) and (6) below, where Yt represents the result of the company's financial performance measured by the Altman model and Xt represents GDP variables, *εt* the error or residual component, *β0* and *φ0* the causal constants. equations, β1t, β2t, φ1t and φ2t intersections with the X and Y axes.

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{\sigma} \beta_{1i}\, \Delta Y_{t-i} + \sum_{i=1}^{Y} \beta_{2i} \Delta X_{t-1} + \varepsilon_{1t} \tag{5}$$

$$\Delta X_t = \varphi_0 + \sum_{i=1}^{Y} \varphi_{1i}\, \Delta X_{t-i} + \sum_{i=1}^{Y} \varphi_{2i} \Delta Y_{t-1} + \varepsilon_{2t} \tag{6}$$
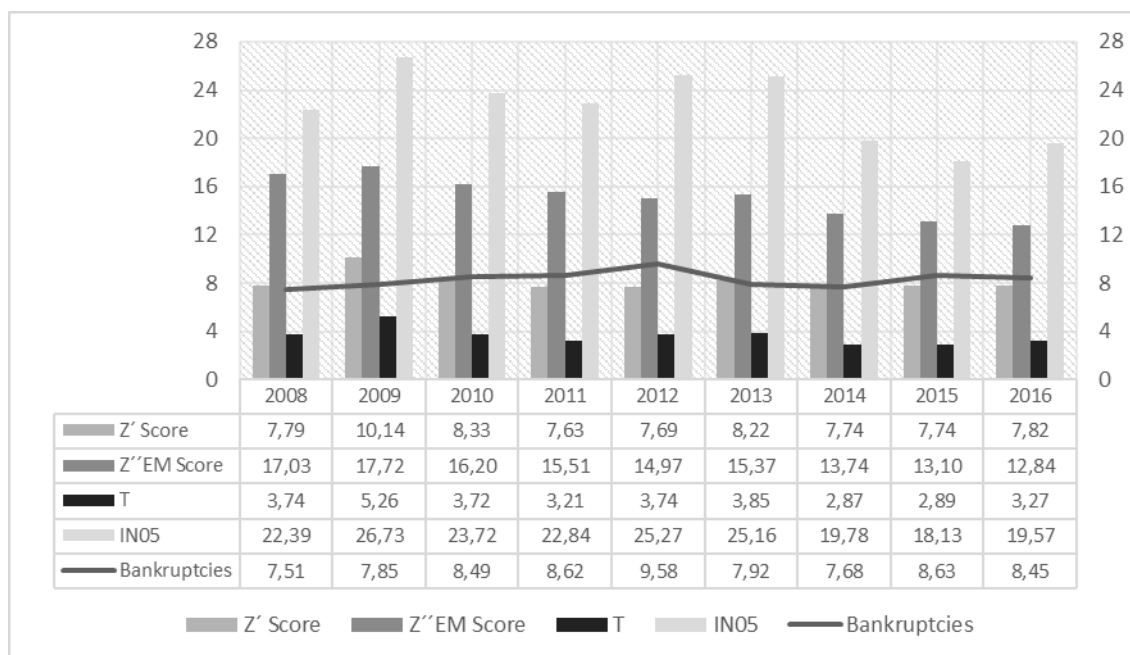
4 Paper results

4.1 Evaluation of predictive ability of selected bankruptcy models

Comparing the real number of bankruptcies with the results of the predictive bankruptcy models in Czechia, it is clear that only Taffler 's model ranked fewer companies in financial distress than actually ceased their activities. A similar number of companies in financial distress as already bankrupt can be seen in the results of the Altman's Z´Score. The other two models; Altman's Z´´EM Score and IN05, ranked more companies among the potentially financially vulnerable than they actually bankrupt. Based on these facts, it can be stated that only the Z´´EM Score and IN05 models fulfill their predictive ability of the company's financial distress. On the contrary, the Taffler and Z´Score models could not adequately predict financial situation of companies.

Figure 2 shows that the largest number of companies at risk of financial distress was, in 2009. Conversely, the number of bankruptcies can conclude that 2009 was a year of accelerating bankruptcies, where until 2012 it is possible to see the peak of the maximum number enterprises that have ceased their activities. The real number of bankruptcies is affected by the insolvency proceedings in which companies enter. Whether a company really goes bankrupt or is saved will only become apparent after the time when the company is officially included in the database of companies with closed activities. Most companies at risk of financial distress are recognized by the IN05 bankruptcy model, which in 2009 draws attention to possible financial difficulties for up to 26.73% of companies. In the same year, the Z´´EM Score model ranked 17.72% of the monitored companies among the financially endangered companies, the Z´Score model 10.14% of companies and the Taffler model 5.26%. The renewed economic growth in Czechia was also reflected in the improved financial situation of the monitored companies, where in 2014 and 2015 the monitored models show the lowest number of companies at risk of financial distress. Only the Z´Score model achieves the best results (lowest values of the indicator) in 2011 and 2012.

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Figure 2: Resulting values of the number of companies in financial distress in Czechia in %

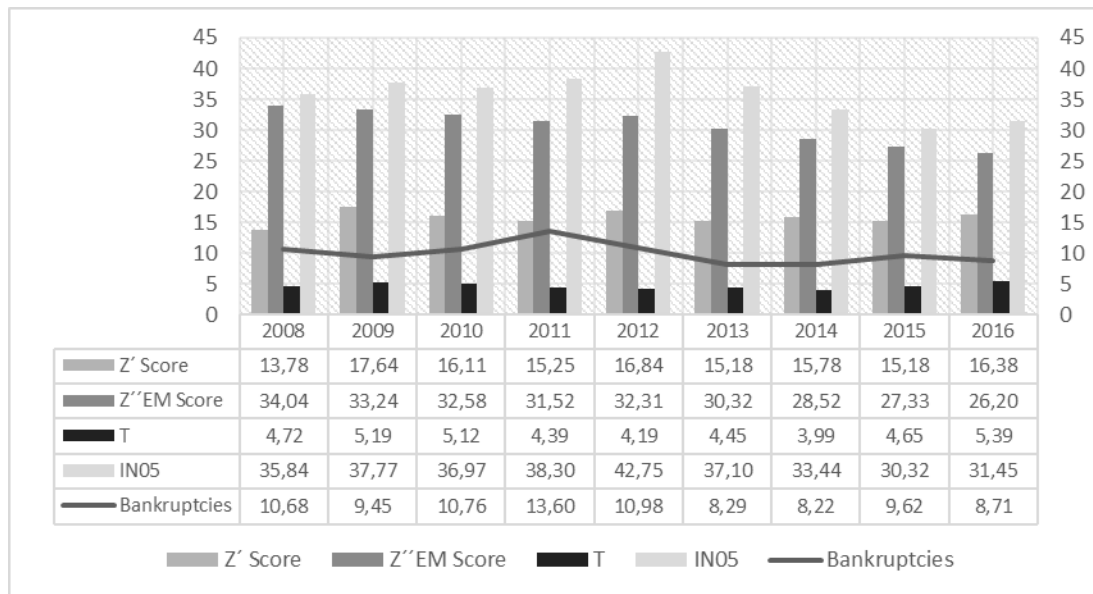|	2008	2009	2010	2011	2012	2013	2014	2015	2016
Z´ Score	7,79	10,14	8,33	7,63	7,69	8,22	7,74	7,74	7,82
Z´´EM Score	17,03	17,72	16,20	15,51	14,97	15,37	13,74	13,10	12,84
T	3,74	5,26	3,72	3,21	3,74	3,85	2,87	2,89	3,27
IN05	22,39	26,73	23,72	22,84	25,27	25,16	19,78	18,13	19,57
Bankruptcies	7,51	7,85	8,49	8,62	9,58	7,92	7,68	8,63	8,45

Source figure: author's calculations

Figure 3 shows that only the Taffler model has classified fewer companies with potential financial distress than actually bankrupt in Hungary. The remaining three models assigned more companies to the category of potential financial distress than the number of bankruptcies. The predictive ability of the company's financial distress is therefore fulfilled by the Z´Score, Z´´EM and IN05 models. On the contrary, the Taffler model could not adequately predict financial situation of companies.

The IN05 model ranked the most companies among companies with potential financial distress, which in the whole period included more than 30% of the monitored companies in this category. In 2012, it was as high as 42.75% of companies. The different development of the number of companies in financial distress can be observed in the case of the Z´´EM Score model. This model ranked most companies among them already in 2008 (34.04%). In the following years, the values of the indicator gradually decreased to 26.20%. The development of the values of the last monitored Z´Score model almost copies the development of the domestic Hungarian economy. The peak number of businesses at risk model achieves the crisis in 2009. Then owned by Z'Score between businesses at risk of financial distress to 17.64% of monitored enterprises. In the following years, the number of companies in financial distress increased in 2012 and 2016.
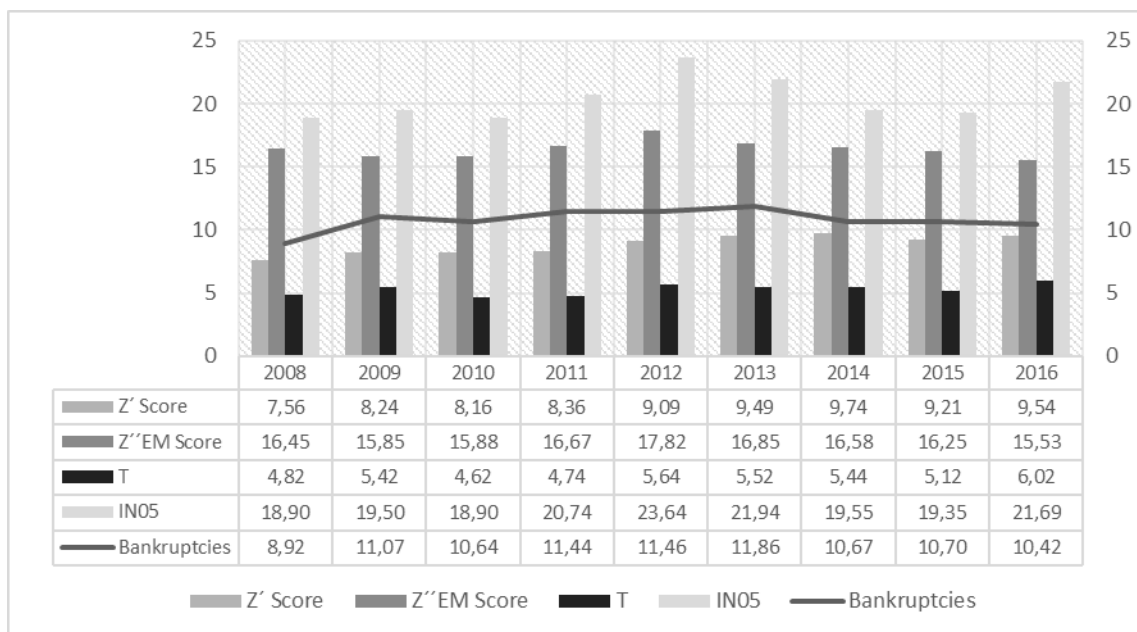
Figure 3: Resulting values of the number of companies in financial distress in Hungary in %

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Z´ Score	13,78	17,64	16,11	15,25	16,84	15,18	15,78	15,18	16,38
Z´´EM Score	34,04	33,24	32,58	31,52	32,31	30,32	28,52	27,33	26,20
T	4,72	5,19	5,12	4,39	4,19	4,45	3,99	4,65	5,39
IN05	35,84	37,77	36,97	38,30	42,75	37,10	33,44	30,32	31,45
Bankruptcies	10,68	9,45	10,76	13,60	10,98	8,29	8,22	9,62	8,71

Source figure: author's calculations

As can be seen from Figure 4, the practical applicability of the analyzed models was demonstrated only for the Z´´EM and IN05 models, which regularly predict the possible financial distress in more companies during the monitored period than they actually bankrupt in Poland. From this point of view, the Z´Score and Taffler models did not fulfill their ability to provide early warning of possible financial difficulties. It can be seen that the Taffler and Z'Score models ranked less than 10% of companies among the financial distressed companies at risk. The remaining two models Z´´EM Score and IN05 ranked more than 15% of companies among the endangered companies. The bankruptcy models Z´Score and T ranked the most companies among companies with possible financial distress in 2016.

Figure 4: Resulting values of companies in financial distress in Poland in %
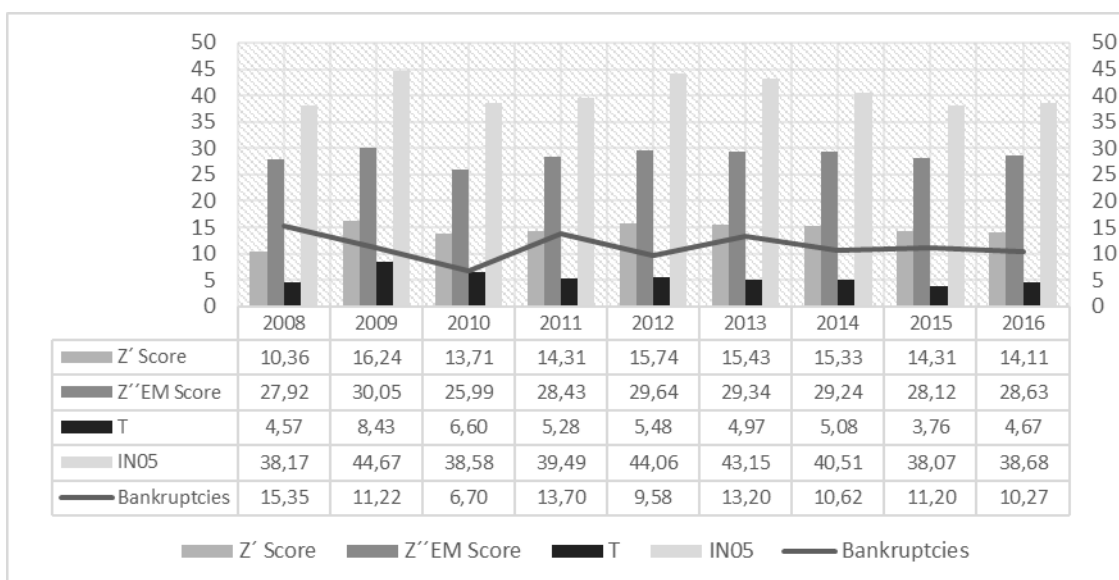

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Z´ Score	7,56	8,24	8,16	8,36	9,09	9,49	9,74	9,21	9,54
Z´´EM Score	16,45	15,85	15,88	16,67	17,82	16,85	16,58	16,25	15,53
T	4,82	5,42	4,62	4,74	5,64	5,52	5,44	5,12	6,02
IN05	18,90	19,50	18,90	20,74	23,64	21,94	19,55	19,35	21,69
Bankruptcies	8,92	11,07	10,64	11,44	11,46	11,86	10,67	10,70	10,42

Source figure: author's calculations

The results from Slovakia shows that the Taffler and Z´Score models did not fulfill their predictive ability (see Figure 5). The number of companies identifying financial difficulties either did not even reach the number of real bankruptcies in Slovakia (Tfm model) or reached a number similar to actually terminated companies (Z´Score model). For practical use, it is recommended to use the Z´´EM or IN05 models. From Figure 4 is further evident big difference between the development model of the measured values monitoring the financial health of companies. The lowest number of companies in potential financial distress is recorded by the T model. In the period under review, the bankruptcy model of Z´Score included on average about 15% of companies in the category with potential financial distress. The Z´´EM Score model ranked 26–30% among companies with financial problems. The last analyzed model IN05 classified them between 38% and 45%.

A common feature of all models is the highest number of companies listed among the financially vulnerable in 2009, the fewest in the case of the model IN05 and T was in 2015, the model Z"EM Score in 2010 and Z'Score in 2008. At the same time, only the results analysis of the financial situation of companies using the model Z'Score the year 2016 will not come to the level of the pre-crisis period. The evaluation of other models in 2016 almost corresponds to the evaluation from 2008.

Figure 5: Resulting values of companies in financial distress in Slovakia in %

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Z´ Score	10,36	16,24	13,71	14,31	15,74	15,43	15,33	14,31	14,11
Z´´EM Score	27,92	30,05	25,99	28,43	29,64	29,34	29,24	28,12	28,63
T	4,57	8,43	6,60	5,28	5,48	4,97	5,08	3,76	4,67
IN05	38,17	44,67	38,58	39,49	44,06	43,15	40,51	38,07	38,68
Bankruptcies	15,35	11,22	6,70	13,70	9,58	13,20	10,62	11,20	10,27

Source figure: author's calculations

4.2 Evaluation of predictive ability of selected bankruptcy models

The resulting values of bankruptcy models may have been affected by the real GDP indicator in the period under review. To evaluate the second research question, it was necessary to monitor the results of the Granger causality test. The null hypothesis of the Granger test indicates the absence of a causal link. Table 8 sets out the individual null hypotheses for each bankruptcy model in a given country. Based on F-statistics and probability, it was possible to reject or not reject the null hypothesis.

Table 5: Granger Causality Test

Country	Granger Causality	F-stat.	Prob.
Czechia	**GDP =/=> Z'Score**	**37.7400**	**0.0000**
	GDP =/=> Z'EM Score	**10.1475**	**0.0014**
	GDP =/=> Taffler	**37.0601**	**0.0000**
	GDP =/=> IN05	**28.6320**	**0.0000**
Hungary	**GDP =/=> Z'Score**	**23.5242**	**0.0000**
	GDP =/=> Z'EM Score	**5.4028**	**0.0201**
	GDP =/=> Taffler	**14.8391**	**0.0002**
	GDP =/=> IN05	**37.0601**	**0.0000**
Poland	GDP =/=> Z'Score	0.9963	0.3352
	GDP =/=> Z'EM Score	3.2389	0.0719
	GDP =/=> Taffler	2.2639	0.1223
	GDP =/=> IN05	**8.0635**	**0.0102**
Slovakia	GDP =/=> Z'Score	3.0256	0.0622
	GDP =/=> Z'EM Score	1.9658	0.1873
	GDP =/=> Taffler	0.8965	0.4210
	GDP =/=> IN05	**16.3265**	**0.0001**

Source figure: author's calculations

According to the results, it is possible to determine that the real GDP indicator had a significant effect on the values of bankruptcy models. In all cases in the Czech Republic and Hungary, it was possible to reject the null hypothesis and thus the causal effect of GDP on the values of bankruptcy models was demonstrated. In these countries, it is therefore necessary to further quantify this impact on the financial evaluation of companies for further research. On the other hand, in Poland and Slovakia, there was a statistically significant effect at the 5% level of significance only in the IN05 bankruptcy model. In other cases, there was no significant causal effect of GDP on the financial health of companiesSubheading 2: Subheading for the 3rd chapter

5   Summary and Discussion

Bankruptcy models are used to express the financial situation of companies. The construction of models is based on the assumption that companies in financial distress experience certain anomalies several years before their bankruptcy. Their use is suitable not only for current and future management decisions, but also in the evaluation of companies by the banking sector. The aim of the paper was to evaluate the usability of the bankruptcy models for SMEs in the V4 countries. As it was already possible to see from the literature review, the combination of bankruptcy models seems to be adequate for the practical use.

Of the analyzed models, the Z´´EM and IN05 models in particular can be recommended for practical applicability. The resulting assessment of the financial situation of companies on the basis of the values of these models drew attention to the deteriorating financial situation of more companies than they actually closed down. As a result, they fulfilled their function of early warning of companies in a deteriorating financial situation in all V4 countries. The Z´Score model performed its function only in the case of companies operating in Hungary. In other cases, it was possible to accept the opinions of Delina and Packová (2013), Gavurová, Janke and Pack (2017) or Misanková, Zvariková and Kliestiková (2017), who pointed out the inappropriate use of this model. This bankruptcy model mainly reflects the specifics of American companies. The difference compared to Altman's Z´´EM model, adapted especially to emerging economies, is mainly in monitoring the liquidity of companies through working

capital. While the working capital indicator is assigned the fourth highest weight in the Z´Score model, in the Z´´EM model it is assigned the second highest weight right after the EBIT / total assets indicator.

Differences causing different results for the two Altman models can also be found in the ratio retained earnings / total assets. Despite the higher coefficient in the Z´´EM model, it is assigned up to the third highest weight compared to the others. In the Z´Score model, it is assigned the second highest weight and favors companies operating in the market for longer and have created sufficient reserves. Thanks to these observations, one can agree with the studies by Karas and Režňáková (2014), Basovníková et al. (2018), Csikosová, Janosková and Culková (2019) and other authors drawing attention to the suitability of using Altman's Z´´EM.

The worst results in all V4 countries were achieved by the Taffler model. As Machek (2014), Bohdalová and Klempaiová (2017) or Pražák (2019) have already pointed out, this model does not fulfill the function of early warning for companies at risk of financial distress. Due to its construction, which includes only basic information about the company and the inappropriate setting of boundaries for the assessment of the financial situation, it is not possible to recommend this model for practical use in the V4 countries.

The opposite results were found for the usability of the IN05 model. The study draws the same conclusions as Machek (2014), Čamská (2016), Bohdalová and Klempaiová (2017), Csikosová, Janosková and Culková (2019), who recommend the model within V4 for practical use. An indisputable advantage of the model is its construction for the conditions of the business environment in the Czech Republic, where attention is paid especially to the ability to cover the company's own assets with its own profit or revenues. However, the results of the dissertation recommend its use in other V4 countries.

To evaluate the financial situation of companies in the V4 countries, its use in combination with the Z´´EM model seems appropriate. Unlike Altman's models, IN05 also focuses on corporate liquidity and the ability to create value for business owners. In determining the influence of macroeconomic factors on the financial situation of companies assessed by bankruptcy models, it was possible to notice the limited use of the IN05 model in Polish companies and the Z´´EM model in Slovak companies. While the financial health of companies in Hungary and Poland is best explained by using a combination of Altman's bankruptcy models Z´Score and Z´´EM, the analyzed relationship in the Czech Republic and Slovakia best describes through the IN05 model. In particular, the Z´´EM and IN05 models can be recommended for practical applicability. The resulting assessment of the financial situation of companies on the basis of the values of these models help predict possible financial distress of more companies than they actually bankrupt. As a result, they fulfilled their function of early warning of companies in a deteriorating financial situation in all V4 countries.

According to the results of the study, the causal effect of GDP on the evaluation of bankruptcy companies was confirmed in most cases. The relationship is usually statistically positive, where the decline in financial performance is caused by a decline in GDP. This assumptions is confirmed by studies of Hunter and Isachenková), Jakubík and Teplý (2008), Dincergok and Yalciner (2011) or Angelache et al. (2014).

The study contains limitations showing the subsequent direction of the research. For the processing of the following research, other factors resulting from the conclusions of the monitored studies will be taken into account. The first is the need to combine available predictive bankruptcy models when assessing the financial situation of companies. Furthermore, the application of bankruptcy models to different economic sector of business and to different sizes of companies. Subsequently, monitor not only the impact of the environment within the company, but especially the macroeconomic environment, which directly affects the activities of business entities in the country.

For the further research, the main objective will be focused only on models with predictive ability and also on the wide macroeconomic situation. Altman (2006) or Senbet and Wang (2012) have addressed the root causes of corporate financial distress. According to them, the most common reasons for financial distress are insufficient legislation, macroeconomic factors, technological progress, deregulation in key industries (financial services, aviation, healthcare, energy industry) or growing

international competition and globalization. New areas of business are most often faced with financial distress, thanks to a high degree of optimism at the beginning of business, as well as industrial sectors that are often affected by crises (textile industry, agriculture or the financial sector). Another object of subsequent research may be the evaluation of the significance of indicators capturing the creation of added value in companies in assessing their financial situation. For groups of users of business information, from owners, through potential investors, management or employees, it is important to evaluate the financial situation of the company and its future development. From this point of view, it will be necessary in the future to take into account new methodological procedures combining ongoing assessment of the financial situation of companies with possible scenarios of the impact of the economic environment and the introduction of Industry 4.0. In this case, it will be necessary to use agent models based on predictive behavior models.

6   Bibliography

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