

## PREDICTIVE MODELS OF CORPORATE INSOLVENCY RISKS

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### ABSTRACT

*In a rapidly changing world, it is necessary to adapt to new conditions. From day to day approaches can be varied. For proper company management is essential the knowledge of their own financial situation. Assessment of the company financial health is carried out by financial analysis which provides a number of methods how to evaluate the company financial health. This paper describes the prediction models which are among the tools to identify in a timely manner the risk of future bankruptcy or poor development of business financial health. Correct and timely evaluation of the corporate financial situation is currently very actual topic. The number of enterprises that are discontinuing their business by forced exit from business premises is constantly growing. We recognize two situations when the company goes to the bankrupt. The first is the insolvency and the second is the over-indebtedness. The aim of this paper is to create a model capable of predicting the corporate insolvency risk, and also to explore which factors affect the corporate insolvency and how to model and predict corporate insolvency. The first step in creating a quality model is to select the right determinants to enter it. After the literature research and our finding, we select the most appropriate variables to detect corporate insolvency risk.*

**KEYWORDS:** *predictive models, bankruptcy prediction, insolvency, risk, bankruptcy models.*

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### 1. INTRODUCTION

Regardless of whether the company is operating in the domestic or in the international environment, its failure has serious impact on its environment. The failure itself can have various forms, performances or results, which all interested groups have to bear with in the market economy whether they are owners, employees, business partners, competitors, state etc. The failure affects not only company's competitiveness but also its own existence. If the company is operating in the international environment, the consequences are even beyond the borders of the state. For this reason, it is very important for the company and other interested groups to identify situations, which are able to lead the company to its failure. And this identification is the object of the risk management focused on the risk reduction by using of the various methods and techniques of the risk prevention with the aim to prevent problems or negative effects. (Weissova et al., 2015)

Analysis indicators are often included in the company assessment, in obtaining bank loans and other financial resources to ensure the company functioning. As company focus on the future and its planning, it is essential to forecast the financial situation. (Bernhardsen, 2001) According to the results of company financial health prediction, the company decide on the extension or limitation their business. Only on the capabilities of company management depends of using information from financial analysis in practice. Corporate insolvency risk can be defined as the probability that a company will become insolvent in the next 12 months. (Makeeva and Neretina 2013) The

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prediction of corporate insolvency and the assessment of credit risk have been the subject of much academic and professional research over the last half century. (Durica et al., 2019).

Bankruptcy prediction and also the bankruptcy models have begun to appear in the literature since the late 1960's. Beginning with Altman model (1968), Taffler (1982), Ohlson (1980) and continuing through Grunwald and Šmídová (2010). The importance of bankruptcy models is felt especially by creditors, because they are able to determine the financial performance of the company or to predict whether the company will become insolvent. They are synthetic in nature, because they are a set of several ratios that are weighted and their weighted sum gives a score to judge whether a business is prone to financial distress and bankruptcy or bankruptcy is unlikely. Models consisting exclusively of ratios are rather history. Currently, ratios are complemented by other variables based on market characteristics, macroeconomic data or specific values that describe the company's characteristics in more detail. Such approaches can be found, for example, in works Shumway (2001), Hillegeist et al. (2004) or Bharath and Shumway (2001).

## 2. METHODOLOGY

Nowadays we recognize hundreds of prediction models which are different by for example used mathematical-statistical methods, the time of construction, the place of construction or used variables for the predicting of the company's financial health. (Siekelová et al., 2015)

The first step in creating a quality model is to select the right determinants to enter it. At this point, it is necessary to proceed correctly, because not only the inclusion of potentially significant variables, but also overspeeding may result in the resulting model being biased. There are several different groups of variables that can be considered in modeling. We can divide them as follows: *(i) variables formed from accounting data, where we rank mainly ratio variables, (ii) variables that are derived from the market values of the company, (iii) variables based on soft facts and (iv) macroeconomic variables.*

### 2.1 Variables formed from accounting data

Investigation of financial ratios is the most common method of financial analysis, by which financial analysts try to assess the past and present state of management of the company and obtain the basis for the analysis of future decisions. Therefore, as Boratyńska (2016) states, the basic objective of financial analysis is to comprehensively assess the financial health of a company using appropriate instruments.

An appropriate, if not the most appropriate, way of evaluating the data obtained from the financial statements is the analysis of financial ratios, because by analyzing items from the financial statements in relation to another item, we are able to eliminate shortcomings resulting from different company size (Valaskova, et al., 2015). There are a large number of ratios, but according to Sedláček (2007) only a small number of them can be used effectively. The number of final explanatory variables depends on how we determine the significance levels for keeping them in the model.

### 2.2 Market value variables

To this group we can include e.g. share value, net profit per share, percentage change in share value, or other. More authors, e.g. Ohlson (1980) or Hillegeist et al. (2004) agree that market data is a better source of information to predict a company's financial distress. Especially because the market is able to better and faster reflect the company's situation. These authors suggest that accounting models should be supplemented at least with these market data, in order to improve predictability. To include these variables in the model, it is necessary that the financial market is well developed in the market. The Slovak Republic do not have well developed financial market, so it's hard to get market value variables.

### 2.3 Soft facts

Another group that could theoretically improve the results of the model are called soft facts. Soft facts can be characterized as variables expressing mainly internal but also external factors affecting the company. For example, the quality of management or the auditor's opinion can be added to internal influences. To the external influence can be included the company position on the market. The traditional model that deals with soft facts is the Argentine model (Macovei, 2017).

### 2.4 Macroeconomic variables

The last-mentioned group of data that could bring more accuracy to the model are macroeconomic variables. As researched by Jackson and Wood (2013), the success rate of models decreases as the economic situation deteriorates. Therefore, it might seem appropriate to use a variable in the models that would also reflect the decrease. This could be done by a percentage change in GDP. The impact of macroeconomic variables on the model's success was examined by Klieštikova et al. (2017). According to his conclusions, the model using macroeconomic variables was not better.

The frequency of use of the different groups of variables was investigated in paper published by Aziz and Dar (2006) who reviewed 89 published studies. The mentioned authors concluded that in up to 60% of the surveys, only ratios calculated on the basis of accounting data were used. Approximately 7% of the researches were modeled using cash flow information and a mix of these groups was used in the remaining work.

Another statistical view of the explanatory variables used is provided by Bellovary et al. (2007), who examined bankruptcy models from 1995 to 2007. They examined 165 bankruptcy models during the reporting period and found, that the number of input variables in each model ranged from 1 to 57, and the average number was 10 variables. A total of 757 unique ratio variables were used. The most used indicator was ROA (54 research) and the second most used was liquidity (51 research).

## 3. RESULTS

The result of the literature research and our findings are in the following table (Table 1), which, in addition to the name of the indicator and its precise definition, includes a reference to domestic or foreign publications from which the indicators were obtained. The table also includes a column that shows the expected impact on the bankruptcy situation. A negative value indicates that as the value of the ratio increases, the probability that bankruptcy will occur will decrease. A positive value analogously symbolizes an increase in the probability of bankruptcy.

Table 1 contains a list of all ratio variables that would be appropriate to use in the bankruptcy model. The primary objective in their selection was to omit exotic indicators, which are mostly made up of more analytical items in the income statement, as was practiced by Ohlson (1980). In our model we include these variables. Seven liquidity variables, in addition to the traditional indicators of cash, prompt and current liquidity (R1, R2, R3), we used variables that relate working capital, sales and assets (R4, R5, R6). The last indicator in this group (R7) is a reward for current liquidity, which compares current assets to external resources. All variables are expected to have a negative impact on bankruptcy, which means that the probability of bankruptcy will decrease as value increases.

The second group, Indebtedness group, contains 13 ratio variables. The first subgroup of this group are indicators R8 and R9, which express the degree of self-financing, but both in other ways. The traditional indicator is interest coverage (R10). By this indicator, we are able to evaluate the ratio of covered interest expenses generated by profit. Indicator R11 characterizes the company's insolvency and we expect a positive impact. With the help of indicator R12 we are able to evaluate the coverage of fixed assets with equity.

**Table 1.**

<b>Ratio variables</b>				
Ratio	Formula	Expected impact	Reference Foreign	Reference Domestic
<b>Liquidity</b>				
R1	<i>Financial Assets/Short-term Liabilities</i>	-	n/a	G, H, Kl, Kis, Kn, S, V, Z
R2	<i>(Financial Assets + Short-term Receivables)/short-term liabilities</i>	-	n/a	G, H, Kl, Kis, Kn, S, V, Z
R3	<i>Current Assets/Short-term Liabilities</i>	-	B, IN, Zm	G, H, Kl, Kis, Kn, S, V, Z
R4	<i>Working Capital/Inventory</i>	-	n/a	H
R5	<i>Working Capital/Sales</i>	-	n/a	H, Kis, S
R6	<i>Working Capital/Assets</i>	-	A, B, JT, O	n/a
R7	<i>Current Assets/External Resources</i>	-	T	n/a
<b>Indebtedness</b>				
R8	<i>Equity/Fixed Assets</i>	-	n/a	G, H, Kl, Kis, Kn, S, V, Z
R9	<i>Assets/Equity</i>	+/-		Z
R10	<i>EBIT/Interest Expense</i>	-	IN, JT	G, H, Kl, Kis, Kn, S, V, Z
R11	<i>Liabilities/Receivable</i>	+		Z
R12	<i>Equity/Fixed Assets</i>	-		Kn, S, Z
R13	<i>Retained Earnings/Assets</i>	-	A	n/a
R14	<i>External Resources/Assets</i>	+	B, O, Zm	G, H, Kl, Kis, Kn, S, V, Z
R15	<i>Assets/External Resources</i>	-	IN	n/a
R16	<i>Current Liabilities/Assets</i>	+	T	n/a
R17	<i>CF(EBITDA)/External Resources</i>	-	B, O	n/a
R18	<i>External Resources/Equity</i>	-	JT	G, Kn, S, V
R19	<i>Equity/External Resources</i>	-	A	n/a
R20	<i>Liabilities/Equity</i>	-	JT	n/a
<b>Profitability</b>				
R21	<i>EBIT/Assets</i>	-	A, B, IN, O, Zm	H, Kl, Kis, Kn, S, V, Z
R22	<i>EAT/Sales</i>	-	JT	H, Kis, Kn, S, V, Z
R23	<i>EBT/Liabilities</i>	-	T	Kl, S, V, Z
R24	<i>EAT/Revenues</i>	-	n/a	Z
<b>Activity</b>				
R25	<i>Sales/Assets</i>	-	A, T, IN	H, Kis, Kn, S, Z
R26	<i>Sales/Inventory</i>	-	JT	G, H, Kl, Kis, Kn, S, V, Z
R27	<i>Recivable*365/Sales</i>	+	n/a	G, H, Kl, Kis, Kn, S, V, Z
R28	<i>Liabilities*365/Sales</i>	+	n/a	G, H, Kl, Kis, Kn, S, V, Z
R29	<i>Financial Assets*365/Sales</i>	+	n/a	H
R30	<i>Sales/Fixed Assets</i>	-	n/a	Kl, Kis, Kn, S

*Source:* A=Altman (1968), B=Beaver (1966), G=Grunwald and Šmídová (2010), H=Holečková (2008), IN=Index, JT=Jakubík and Teplý (2008), Kl=Kalouda (2011), Kis=Kislingerová and Hnilica (2005), Kn=Knapková (2013), O=Olhson (1980), S=Sedláček (2007), T=Taffler (1982), V=Valach (2010), Z=Zalai (1997), Zm=Zmijewskij (1984)

Interestingly is the indicator R13, which compares the retained earnings of previous years and total assets. This indicator was significant only in the Altman model (Altman, 1968). It is interesting because it indirectly includes the age of the company, since the value of the retained earnings of a young company is likely to be lower than that of a company that has been active on the market for several years. Another subgroup of indebtedness variables puts external resources to assets in two different forms (R14, R15). And the last subgroup consists of debt ratios that compare external resources with equity (R18, R19, R 20).

Profitability group consist from 4 indicators. These indicators are created so that the numerator enters the profit in various forms and in the denominator is a group of accounting items, according to which we want to examine profitability. We chose assets, sales, long-term resources and revenues for our analysis. In particular, the return on assets appears to be a significant indicator, as up to 5 models came out as significant. Higher values of all profitability ratios can be expected to make companies less likely to fail.

The last group of variables are activity indicators. These indicators measure the effectiveness of using different inputs in the production process. In general, the higher the company's resource efficiency, the less likely it is to fail. These indicators included 6 indicators, asset turnover (R25), inventory turnover (R26), receivables collection time (R27), repayment period (R28), turnover time of financial assets (R29), and fixed assets (R30).

Last variable which is necessary to include (and is not mentioned in Table 1) is the size of the company. More authors, e.g. Shumway (2001) and Ohlson (1980) agree that the size of a company is a very important input variable. It is assumed that large companies are more stable and therefore bankruptcy, even if these companies encounter financial problems, is less likely than for small companies.

#### **4. CONCLUSION**

Decline of the company can be a long process of crisis in the company or it may be a sudden decline. In the event of bankruptcy, which is the last stage of a long-term crisis in the company, the decline is due to several causes, while on the other hand, sudden decline in company is due to the unexpected cause to which management failed to respond adequately. If the decline caused by several reasons, it is possible to use bankruptcy prediction models with an appropriate combination of financial indicators can predict potential problems in the future.

Corporate bankruptcy prediction is an important and widely studied topic. Lenders and investors in companies that need in order to estimate the probability of default for profitable business decisions. In the present paper we examined whether we can determine the future financial situation of companies and the closely related disclosure of the insolvency risk by using accounting data in good time. Using bankruptcy models that have been developed in the past, we have created a list of ratios variables. This list of variables consists of variables that have proved to be significant in the prediction models of the past, but also from indicators that appear in publications by Slovak and Czech authors dealing with financial analysis.

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