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Management of financial risks in Slovak enterprises using regression analysis

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Abstract
Research background: Financial risk management is the task of monitoring financial risks and managing their impact. Financial risk is often perceived as the risk that a company may default on its debt payments. The issue of the debt, default or prosperity of the company are presented in the article as one of the ways of the risk management. A prediction of corporate default is an inseparable element of the risk management. Mainly the consequences of risk are the engine of research and development of methods and models, which enable to predict economic and financial situation in specific conditions of global economies.
Purpose of the article: The main aim of the presented article is to assess financial risks of Slovak entities, realized by the identification of significant factors and determinants affecting the prosperity of Slovak companies.
Methods: To conduct the research we have used the data of Slovak enterprises, obtained from annual financial reports covering the year 2015 and the calculated financial ratios of

profitability, activity, liquidity and indebtedness that may affect the financial health of the company were applied in the regression analysis. Realizing the multiple regression analysis, the statistically significant determinants that affect the future financial development of the company are identified, as well as the regression model of the bankruptcy prediction.
Findings & Value added: In the research aimed at the management of financial risks in Slovak enterprises, we focused on the revelation of significant economic risk factors using multiple regression. The results suggest that the most significant predictors are net return on capital, cash ratio, quick ratio, current ratio, net working capital, RE/TA ratio, current debt ratio, financial debt ratio and current assets turnover based on which the decision about the future company default can be made. These factors are significant enough to manage financial risks and to affect the profitability and prosperity of the company.

Introduction

Financial risk may be defined as a potential financial loss of a subject, i.e. an existing realized or non-realized financial loss, but also a future loss given by the financial or commodity tools (Jílek, 2000, p. 15). Financial risk refers to a company ability to manage its debt and financial leverage, and it is often perceived as the risk that a company may default on its debt payments (Moles, 1998, p. 19).

The default of companies is the problem of every economy in the world. Defaults can have various forms, various manifestations and consequences. In particular, the consequences are the engine of research and development of methods and models that help predict the failure in advance. Prediction models are used for an early detection of impending problems in the analysed company, their task is to evaluate the financial health of the company based on selected financial indicators (Zvarikova *et al.*, 2017, pp. 145–157) or other characteristics of the company or the environment where it operates (Svabova & Kral, 2016, pp. 1759–1768). Berent *et al*. (2017, pp. 753–773) indicate that default can be understood as a shift in research from maximizing accuracy to the analysis of the information capacity of predictors. More often, authors try to apply some mathematical or statistical methods to form a model of the bankruptcy prediction. Kovacova & Kliestik (2017, pp. 775–791) proved significant differences in the process of the model formation using logit and probit analysis. There are a number of various prediction and default models being used around the world, the terminological differences between them were indicted and compared in the study of Boratyńska (2016, pp. 107–129). However, it has to be noted that each model of the prediction of the financial health of a company was formed in different time, different country and economic conditions and their application in other countries is thus questionable.

This problem was first noticed by Argenti (1976, pp. 172–179) and Taffler (1983, pp. 295–307) when forming a model of a default prediction in conditions of an English economy. They concluded that the limits of Atlman Z score are completely different in the US from the corresponding markets in England. The thing is that there are the differences not only among the countries but also within the same country considering the different industrial and economic sectors. This led to the fact that researchers have started to create the prediction models suitable for exact conditions of the country. The formation of the complex prediction model in the economic conditions of the Slovak Republic is still missing, but it is a subject of the present research.

The novelty of the study is that the paper defines the financial risk by determinants that can be used in the prediction model for Slovak companies. The purpose of the research is to help reveal the significance of the determinants in the model to be able to predict which companies will be successful and profitable in the future and which will default.

The main aim of the paper is to assess financial risks of Slovak entities, which is done by the identification of significant factors and determinants affecting the health of Slovak companies. Firstly, we analyse and define financial determinants that can be calculated for all 62,533 Slovak companies in the database and then, using the regression analysis, we decide which factors are significant to be used in the model. The significance of the model is also considered.

The paper is divided into four main parts. Literature review analyses the theoretical background of the development of the prediction models with main emphasis given to the models used in the Slovak conditions. Research methodology introduces the database of the companies, which is used in the research, the financial indicators, which are calculated and their interpretation. Results contains the detail procedure of the research and the calculation of the parameters of the determinants using the regression analysis and the errors than can arise together with the determination of the final regression model. Discussion is focused on the presentation of the results of other authors using the same statistical method and of other recent models formed in condition of the Slovak economic environment.

The paper focuses on the identification of financial risks and of the significant factors, affecting the profitability and prosperity of the company and it may help form the prediction model in the condition of the Slovak Republic. The theoretical background of the paper is based on the work of several experts and economists interested in the prediction models, but especially on the work of Altman (1968, pp. 589–609), Beaver (1966, pp.

71–111) Argenti (1976, pp. 155–171), Taffler (1983, pp. 295–307), Cisko and Kliestik (2013, pp. 635–728) and the others.

Literature review

First researches devoted to the issue of businesses default began to appear in the 30s of the 20th century. They were focused mainly on the comparison of the financial ratios between the companies, which failed and those that did not. One of the first studies focused on the bankruptcy prediction was a study of Fitzpatrick (1931, pp. 598–605) dedicated to the identification of significant differences between successful and unsuccessful business entities. This work was inspiring for several papers in the mid-60s of the 20th century. The breakpoint in this issue was the work of Beaver (1966, pp. 71–111) who firstly used financial ratios to predict an actual failure of businesses. He proved that not all variables have the same predictive power, which was largely impugned. In order to overcome this deficiency, the models based on complex and multivariate statistical methods were theoretically examined and put into practical use. Their essence is a combination of simple characteristics (financial ratios) into a comprehensive integrated variable based on which the businesses can be clearly classified. The first of applied multivariate methods was a multivariate discriminant analysis. A typical representative of this method was Altman (1968, pp. 589–609), whose work became a symbol of prediction of businesses failures.

Considering the nature of the businesses failures, the logistic regression started to be used (logit models). The first author who introduced the use of the logit method was J.A. Ohlson (1980, pp. 109–131). The essence of this method lies in finding the logistic dependence of variable (1 — unsuccessful entity, 0 — successful entity) on several independent variables (financial ratios).

As an alternative to the previously mentioned methods, based on analysis of historical data, they are some theory-based models — Wilcox (1971, pp. 163–179) and Merton model (1973, pp. 141–183). The biggest disadvantage of these methods to a wider practical application is their difficult mathematical apparatus. The development of prediction models was largely influenced by the development of a new field of science — research of artificial intelligence. Another important element of the practical application of these methods was a very rapid development of computer technology. The result is the application of neural networks and genetic algorithms in predicting failures (Cisko & Kliestik, 2013, pp. 648).

Since the first developed model, there have been numerous research conducted. Various predictors have been identified to predict the future situation of the entities, e.g. Horrigan model (1996, pp. 44–62), Beaver model (1966, pp. 71–111), Altman model (1968, pp. 589–609), Springate model (1978, pp. 84), Ohlson model (1980, pp. 109–131), Taffler and Tisshawa model (1984, pp. 263–269), Fulmer model (1984, pp. 25–37), Zmijewski model (1984, pp. 59–82), etc. Currently, the known bankruptcy models are applied and modified in specific conditions of national economies, e.g. Pereira *et al*. (2017, pp. 276–280), Barreda *et al*. (2017, pp. 86–106), Singh and Mishra (2016, pp. 13–25), Pawelek *et al*. (2016, pp. 369–382), Ékes and Koloszár (2014, pp. 56–73), Kiaupaite–Grushniene (2016, pp. 222–234), etc. Moreover, also new ways of the default prediction have arisen introduced by Antunes *et al*. (2017, pp. 831–843), Barboza *et al*. (2017, pp. 405–417), Lalbakhsh and Chen (2017, pp. 758–785), Zhao *et al*. (2017, pp. 325–341).

Each model is formed under specific conditions of the country, considering the development of its capital market, economic and financial situations and potential financial risks. That is the reason why the models are not applicable in every economy. In our conditions, many of the mentioned models are not usable mainly due to the development of the capital market. Our country lacks the general prediction model. However, the economic situation of Slovakia is very similar to the Czech Republic, which uses its own prediction models. The most frequently used is the IN model of Inka and Ivan Neumaiers (2002, pp. 158), which has several modifications. IN 95 which estimates the financial risk of Czech companies on the basis of the world rating agencies, IN 99 considering the corporate value for the owner, IN 01 which is defined as the combined owner — credit model and IN05, which is a brief modification of the previous one.

The situation in our country has been changing, as many researchers try to develop a prediction model in our conditions. Kamenikova (2005, pp. 337–343) determines the limitations of existing models used for financial development predictions. Gundova (2015, pp. 26–39) and Sofrankova (2014, pp. 101–109) compare the results of selected prediction methods in a group of Slovak companies, an accuracy verification of prediction methods is evaluated by Camska (2016, pp. 353–366). Stachova *et al.* (2015, pp. 1–7) apply two different approaches (RE-EM and CART) to predict a risk of financial distress of companies in the next period, Svabova and Kral (2016, pp. 1759–1768) use statistical analyses of predictors and cluster analyses, Durica and Adamko (2016, pp. 400–407) verify MDA bankruptcy prediction models for enterprises in Slovakia.

Research methodology

The data for the study were obtained from the Register of financial statements of the Ministry of Finance of the Slovak Republic, covering the year 2015. The created database consists of 62,533 companies, more than 15% of them experience some financial risks, are unsuccessful and unhealthy. In the first step of the analysis, we calculate 14 financial indicators (explanatory variables) for every company in the database, using their financial statements (see Table 1).

Based on the calculated financial ratios, we are able to classify the companies into two groups: default (unhealthy, unsuccessful) and non-default (healthy, successful). We consider three criteria which have to be met simultaneously and which correspond to the default criteria determined by the Slovak legislation. If the company has the equity to debts ratio less than 0.4, current ratio L3 is less than 1 and net income is negative, the company is unhealthy, unsuccessful (marked by the value 1), if conditions are not met, the company is healthy (marked by the value 0).

We process all the data in a linear regression analysis and form a regression model. The objective of the regression analysis is to model the existing independence and to find the relation, which changes one variable dependence on others. In regression, there are two types of variables: dependent (the financial health of the company) and independent (14 financial ratios). As the number of independent variables is more than one, we realize the multiple regression. It models the dependent variable as a linear combination of independent variables and an intercept (Rimarčík, 2007, pp. 45):

$$y_i = \beta_0 + \sum_{i=1}^{k} \beta_j . x_{ij} + u_i \tag{1}$$

where:
y_i – dependent variable
x_{ij} – independent variable(s)
β_0, β_j – unknown parameters of the model
u_i – random variable

Parameters β_j are considered as unknown numerical constants, β_0 is an absolute number and, in general, β represents a slope (direction) of parameters. The parameter β_j explains the changes in the value of the dependent variable y_i, if the j-th independent variable x_{ij} changes of one unit, provided that the values of other independent variables stay unchanged.

To provide the multiple regression analysis, we use Data Analysis. The calculated P-values of financial ratios are compared with the given level of

significance. The P-values cannot be over 0.05, since we want 95% confidence, and those ratios, which P-value is over the level of significance, have to be removed from the model. After the removal of the financial ratio, another regression is calculated. Thus, the stepwise regression is used to identify the least significant variables in the model. The aim is to find out which factors are significant enough to manage financial risks and to affect the profitability and prosperity of the company and which of them can be later used in the model to predict the default of Slovak companies.

Results

The financial ratios of profitability, activity, liquidity and indebtedness and financial structure were calculated for all companies in the database. According to the calculation, we are able to decide, which company bankrupts and which not. Decisive criteria are the values of the equity to debt ratio, current ratio and net income.

We form the regression model, as described in the chapter Research methodology. The calculations are realized using the regression function. All 14 financial ratios of profitability, activity, liquidity and indebtedness are used as input variables in the model. The dependent variable Y is defined by the bankruptcy/ non-bankruptcy of the company, and the financial ratios were used as independent variables X. Using the regression function, the coefficients of all parameters were calculated together with other statistical characteristics, as depicted in Table 2.

The column coefficients determines the values of model parameters and defines the shape of the model. To determine the statistical significance of the parameters, we need to compare P-value and the significance level. For each tested coefficient we set a null (the coefficient is not statistically significant, $P > \alpha$) and an alternative hypothesis (the coefficient is statistically significant, $P < \alpha$). If the alternative hypothesis is accepted, it means that the coefficient should be included in the model.

The values which are in bold have their P-values higher than the value 0.05 and they have to be removed from the model. The removal has to be done stepwise, and after each removed financial ratio, the regression is done again. We do the stepwise regression until all P-values are lower than 0.05. In the first step, we remove the parameter A1, as it has the highest P-value and do the regression again, without this parameter. This procedure was repeated five times; the parameters were removed in the following order asset turnover (A1), net return on corporate revenues (R3), gross re-

turn on capital (R2), debt ratio (Z2) and debt-equity ratio (Z5). The final regression model is shown in Table 3.

Using the decisive criterion, we can determine the significant factors of the model: net return on capital, cash ratio, quick ratio, current ratio, net working capital, RE/TA ratio, current debt ratio, financial debt ratio and current assets turnover. The final regression model has the following algorithm:

$$Y = 0.1952 - 0.000191R1 - 0.000142L1 + 0.000150L2 - 0.000151L3 - 0.061L4 - 0.000115Z1 - 0.0612Z3 + 0.002Z4 + 9.34E - 08A2 \quad (2)$$

Next step of the analysis is the determination of the model variability, which is done by the estimation of the variance and standard deviation of random deficiencies. The calculation of the standard deviation is the subcomponent of the regression function and it is calculated with the model (standard error).

On the basis of the regression model, we can deduct that quick ratio, financial debt ratio and current assets turnover influence the financial health of the company directly proportional and, vice versa, net return on capital, cash ratio, current ratio, net working capital ratio, RE/ TA ratio and current debt ratio have the inversely proportional impact on the dependent variable.

The model was used to quantify future prosperity and profitability of the companies in the database and the results were compared with the individually determined prosperity legislative criteria described in the methodological part. We can conclude that the model quantifies correctly 61.29% of non-prosperous companies and 68.49% of prosperous companies. A similar research was conducted by Faltus (2014, pp. 173–177), and was aimed at finding the optimal default prediction model for Slovak companies using the regression analysis.

To manage the financial risks of the Slovak companies, we form a regression model with significant factors that may help predict the financial health of the company, to decide if the company will be successful on the market or not, and thus adopt necessary measures to eliminate the risks.

Using an F-test, we prove the significance of the model itself (see Table 4). The mutual comparison of the significance F-test and P-values shows that the value of significance F is lower than the significance level (1.54038E-89 < 0.05), so we can claim that the formed regression model of the bankruptcy prediction is statistically significant

Discussion

Regression analysis, which we apply in the study, is successfully used by other authors. Ben Jabeur (2017, pp. 197–202) is his study claims that regression model gives the opportunity to consider all the indicators in predicting financial distress, the reduction of the environment uncertainty, the control improvement and the coordination between the different company stakeholders. Regression analysis was used to assess the prediction ability of the models (Kral & Janoskova, 2016, pp. 21–26). Kostrzewska *et al*. (2016, pp. 72–81) applied regression in the research on the financial standing of entities after bankruptcy in Poland, Kubickova and Nulicek (2017, pp. 494–505) in the Czech Republic, and they both try to classify the companies into groups of healthy and after bankruptcy setting the specific national criteria. Spanish manufacturing companies were used as a sample to propose a classification device for bankruptcy prediction using regression (Lorca *et al*., 2014, pp. 124–133; de Andres *et al.*, 2011, pp. 1866–1875). Bankruptcy prediction for Russian companies was searched in study of Fedorova *et al*. (2013, pp. 7285–7293), the regression modelling of the bankruptcy risk forecasting in Romania was the aim of the research of Onofrei and Lupu (2014, pp. 197–215). Regression approach was also used in the study of Kim (2011, pp. 441–468) who searched for the characteristics of the process to predict bankruptcy and minimize empirical risks of misclassification; study of Lawrence *et al.* (2009, pp. 61–69) focused on bankruptcy prediction in retail sector. The research of Li and Miu (2010, pp. 818–833), based on the regression analysis, brings a hybrid bankruptcy prediction model with dynamic loadings on accounting-ratio-based and market-based information.

Considering the economic conditions of Slovakia, some prediction models have been developed to portray the specificities of the national environment. Gavurova *et al*. (2017a, pp. 1156–1173) focus in their study on the assessment of four known bankruptcy models applied in Slovak conditions to confirm the best prediction ability of the Czech IN05 model. The same model was proved reliable in private Slovak civil engineering companies (Bohdalova & Klempaiova, 2017, pp. 41-49). Gavurova *et al.* (2017b, pp. 370–383) suggest to use the decision tree technique to develop the most suitable Slovak prediction model, data envelopment analysis is preferred by Mendelova and Bielikova (2017, pp. 26–44). Adamko (2016, pp. 1–6), Kral *et al*. (2016, pp. 224–231) and Kubickova (2011, pp. 38–48) successfully modified Altman´s models in Slovak economic conditions. Wilson *et al*. (2016, pp. 579–600) and Belas and Cipovova (2011, pp. 104–120) aim their research at the bankruptcy prediction of SME sector in Slovakia, European

aspect is explained in the study of Patakyova & Gramblickova (2016, pp. 322–350). The development of the bankruptcy prediction model in Slovak conditions is enriched by studies and research of Mihalovic (2016, pp. 101–118), Sofrankova and Matkova (2016, pp. 51–58), Weissova (2017, pp. 699–708), Spuchlakova and Michalikova (2016, pp. 2093–2098), Svabova and Durica (2016, pp. 2174–2181).

Each prediction model is formed under specific conditions of the country, considering the development of its capital market, economic and financial situations and potential financial risks. That is the reason why the models are not applicable in every economy.

Conclusions

Risk management is the process of monitoring risks and taking steps to minimise their impact. Financial risk management is the task of monitoring financial risks and managing their impact. It is a sub-discipline of the wider risk management function and an application of the modern financial theory and practice. Financial risk management falls within the financial function of an organisation and is a reflection of the changing nature of this function over time. Traditionally, the financial function has been seen in terms of financial reporting and control. The modern approach is to consider the financial function in terms of financial policy and financial decision-making. This includes the management of the corporate operational, business and economic risks.

The issue of the management of financial risks reveals many possible ways of coping with the risk that affects the financial aspects of companies. One of them is to predict the future financial situation of the company.

Thus, the main aim of the paper was to introduce and identify significant determinants which influence the future financial development of the company and their further use in the regression model of the bankruptcy prediction. The calculation was done using the database of 62,533 Slovak companies. Firstly, we calculated 14 financial indicators for every company in the database, using their financial statements. Secondly, the stepwise multiple regression was done to identify the least significant variables in the model. The final regression model includes nine financial ratios, which are statistically significant: net return on capital, cash ratio, quick ratio, current ratio, net working capital, RE/TA ratio, current debt ratio, financial debt ratio and current assets turnover based on which the decision about the future default can be made. These factors are significant enough to manage financial risks, to affect the profitability and prosperity of the company and

to decide which of them can be later used in the model to predict the default of Slovak companies.

The research has some limitation, which is the choice of the statistical method. The method of the linear regression may not be perceived positively, but despite that we were able to identify crucial predictors to be used in the further research and also to quantify the future prosperity of Slovak companies. A complex prediction model in the specific conditions of the Slovak economic conditions has not been developed yet, thus the significant predictors identified in the research may be used as the predictors in the formation of the generally accepted bankruptcy model.

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Annex

Table 1. Selected financial ratios and their algorithms

	Profitability ratios	Algorithm
R1	Return on capital (net)	EAT / total liabilities
R2	Return on capital (gross)	(EBIT + cost interests) / total liabilities
R3	Return on corporate revenues (net)	EAT / revenues
	Activity ratios	**Algorithm**
A1	Asset turnover	Revenues / total assets
A2	Current assets turnover	Revenues / current assets
	Liquidity ratios	**Algorithm**
L1	Cash ratio	Cash and cash equivalents / current liabilities
L2	Quick ratio	(Cash and cash equivalents + account receivables) / current liabilities
L3	Current ratio	Current assets / current liabilities
L4	Net working capital ratio	Net working capital / total assets
	Ratios of indebtedness and capital structure	**Algorithm**
Z1	RE/ TA ratio	Retained earnings / total assets
Z2	Debt ratio	Liabilities / total assets
Z3	Current debt ratio	Current liabilities / total assets
Z4	Financial debt ratio	(Bank loans + issued bonds) / total assets
Z5	Debt - equity ratio	Total liabilities / equity

Table 3. Result of the stepwise regression analysis

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0,195216417	0.002981285	65.48062	0	0.189373092	0.201059742
R1	-0.00019083	3.31492E-05	-5.75675	8.61485E-09	-0.000255804	-0.00012585
L1	-0.00014211	2.46474E-05	-5.7658	8.16503E-09	-0.000190421	-9.3803E-05
L2	0.000150366	6.50599E-05	2.311198	0.020825182	2.28487E-05	0.000277884
L3	-0.00015096	6.50497E-05	-2.32079	0.020301357	-0.000278464	-2.3469E-05
L4	-0.06105255	0.003769299	-16.1973	6.94476E-59	-0.068440388	-0.05366472
Z1	-0.00011487	2.55846E-05	-4.48969	7.14534E-06	-0.000165013	-6.4721E-05
Z3	-0.06117342	0.003769598	-16.2281	4.21728E-59	-0.068561843	-0.05378501
Z4	0.002049307	0.00024319	8.426777	3.62752E-17	0.001572655	0.00252596
A2	9.34083E-08	3.59201E-08	2.600445	0.009312494	2.30048E-08	1.63812E-07

Table 4. Result of the model significance

ANOVA	*df*	*SS*	*MS*	*F*	*Significance F*
Regression	9	56,99506592	6.332785	49.2718348	1.54038E-89
Residual	62,524	8,035.924065	0.128527		
Total	62,533	8,092.919131			

Table 2. Regression analysis of 14 selected financial ratios

ANOVA

	df	SS	MS	F	Significance F
Regression	14	57.42555685	4.101825	31.91315177	3.61131E-86
Residual	62,518	8,035.493574	0.128531		
Total	62,533	8,092.919131			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.195365825	0.002983427	65.48369	0	0.189518302	0.201213349
R1	-0.000182865	0.000218445	-0.83712	**0.402526544**	-0.000611017	0.000245287
R2	-2.38383E-05	0.000250955	-0.09499	**0.924322741**	-0.000515711	0.000468034
R3	-3.08563E-09	3.69581E-08	-0.08349	**0.933462107**	-7.55235E-08	6.93522E-08
L1	-0.000142228	2.46479E-05	-5.77039	7.94593E-09	-0.000190538	-9.3918E-05
L2	0.000152684	6.50804E-05	2.346076	0.018975331	2.51259E-05	0.000280241
L3	-0.000147467	6.50962E-05	-2.26537	0.023493301	-0.000275056	-1.9878E-05
L4	-0.061214732	0.003771507	-16.2308	4.03408E-59	-0.068606893	-0.05382257
Z1	-0.000138235	4.19264E-05	-3.29708	0.000977514	-0.000220411	-5.6058E-05
Z2	-6.51373E-05	6.37351E-05	-1.022	**0.306785284**	-0.000190058	5.97837E-05
Z3	-0.061295081	0.003771821	-16.2508	2.918E-59	-0.068687857	-0.0539023
Z4	0.002054351	0.000243297	8.443808	3.13644E-17	0.001577489	0.002531213
Z5	-5.95205E-06	4.1282E-06	-1.4418	**0.14936297**	-1.40433E-05	2.13923E-06
A1	-9.70891E-11	5.52894E-09	-0.01756	**0.985989788**	-1.09338E-08	1.07396E-08
A2	9.33727E-08	3.63752E-08	2.566936	0.010262466	2.20773E-08	1.64668E-07