

Analysis of bankruptcy models for predicting the future state of the company

Lucie Klištincová¹

Abstract: This paper deals with the issue of corporate financial health. In theoretical and practical terms, it works with selected bankruptcy models on which the financial analysis of enterprises can be shown. The paper includes a search of financial health from the perspective of various authors of important theoretical publications. Among other things, the paper aims to compare whether the selected bankruptcy models have sufficient predictive power, which is done in the later parts of the thesis. In the first part, it mentions specific bankruptcy models that are widely used in mainstream economics. The Altman model, Douch's balance sheet analysis, the Springate model, and the Index IN05 are discussed. In the practical phase of the paper, the reliability of the selected bankruptcy models is evaluated on a sample of about 6,000 firms from the manufacturing industry. The thesis concludes that the selected models are suitable for the evaluation and overall prediction of the future financial situation of companies. However, the thesis also concludes that the selected models have different predictive abilities in practical terms. Thus, the selection of specific models depends, among other things, on the needs of the chosen analysis. To determine the reliability of the prediction of the future state of the company will be used descriptive statistics. The thesis also concludes that the selected models are suitable as a complement to the needs of financial analysis, as they provide good information on the overall assessment of the financial and economic situation of the enterprise and provide the necessary entities with early warning.

Keywords: financial health, bankruptcy models, financial analysis, Altman model, Douch's balance sheet analysis, Springate model, Index IN05

JEL Classification: G33, G01, G10

1 Introduction

Financial health

First of all, it is necessary to define what a financially healthy firm is. In this context, it should be stated that it is a firm that can achieve a certain level of appreciation of the capital invested at a given point in time, and one that is proportional to the level of risk of the business (Růčková, 2011).

The study by Sayidah says, that that the SOEs that have good asset capability tend to have better financial health, especially because efficient opportunities are supported by the control of resources and a more economical business scale because the subsidy is significant and negatively affects financial health, which means that the financial health of the SOEs is getting down when funding is still maintaining subsidy every year (Sayidah, 2019).

Baglan says, that there is a positive and significant relationship between financial health and the intensive margin of trade. The magnitude of this positive relationship is shown to depend on several firm characteristics, where the effects of financial health on firm-level exports are larger for firms with higher levels of export, bigger size (measured by assets), higher productivity (measured by value added per worker), and moderate levels of financial health (measured by cash flow over total assets) (Baglan, 2018).

The financial health of businesses and their continued profitability and competitiveness in the market are significantly affected by higher profits achieved. Businesses are forced to show the best possible results to demonstrate financial strength and competitiveness and to provide good accounting to investors and creditors, which can lead to profit manipulation (Valaskova, 2022).

The financial health hypothesis argues that the valuation multiple of the book value of equity (earnings) increases (decreases) as financial health decreases (Ertugrul, 2021).

¹ University of South Bohemia in České Budějovice, Faculty of Economics, Studentská 13, 370 05 České Budějovice, Czech Republic, klistl00@ef.jcu.cz.

Bankruptcy models

Bankruptcy models are purposeful selections of indicators, they are constructed based on comparative-analytical or mathematical-statistical methods. The aim is to compile such a selection of indicators that could qualitatively diagnose the financial situation of the company, i.e. its financial health, or predict its financial distress.

Bankruptcy, or prediction, models represent early warning systems, as they indicate a possible threat to financial health according to the behavior of the selected indicators (Kubíčková a Jindřichovská, 2015).

These models have been derived based on real data for companies that have gone bankrupt or, on the contrary, have prospered in the past. They are based on the assumption that certain anomalies occur in a firm several years before bankruptcy, which are symptoms of future problems and are characteristic of firms at risk. They are useful not only for current but also for future decision-making, allowing management to isolate and correctly interpret indicators of possible future problems and to identify and adjust them in time before serious problems or even bankruptcy occur (Vochozka, 2021).

Bankruptcy models belong to ex-ante analysis and aim to prolong the current situation into the future, to predict how the company will develop in the next 3 to 5 years, and to point out in advance any potential threats to financial health (Růčková, 2011).

The following models were used for the article: IN index 05, Balance analysis of Rudolf Douch, Altman's model for s.r.o. and Springate's model.

The models used were selected based on several criteria. The first of them was the simplicity of the calculation and subsequently the usability of the models in practice (e.g. Altman's model is one of the most basic models). Getting to know the wider public. Applicability of models for most business entities.

IN index 05

Mrs. Inka and Mr. Ivan Neumaier have compiled the IN Credibility Index based on a set of 100 Czech companies verified by selected statistical and mathematical methods. This index reflects the peculiarities of Czech financial statements and the economic situation in the Czech Republic. The IN Credibility Index contains standard ratios of activity, profitability, indebtedness, and liquidity. Over time, four variants of the credibility index have been developed, but only the most recent one, the IN index 05, is included in this paper.

The IN05 index is the last known index of Inka and Ivan Neumaier so far. This index is an update of the IN01 index based on tests on industry data from 2004.

$$IN05 = 0,13 * A + 0,04 * B + 3,97 * C + 0,21 * D + 0,09 * E \quad (1)$$

Where:

A = assets / foreign capital

B = EBIT / interest expense

C = EBIT / total assets

D = total / total assets

E = current assets / current liabilities

If:

IN05 > 1,6, then the enterprise forms a value

IN05 < 0,9, then the enterprise does not create value (destroys)

IN05 between 0,9 and 1,6, then the so-called "grey zone" (the financial situation of the company cannot be assessed)

Balance analysis of Rudolf Douch

The system of balance sheet analyses was compiled in the 1990s by the Czech financial analyst Rudolf Douch. Its construction in the conditions of the Czech Republic should lead to reliable results without being distorted by other economic environments. The model can be used in any company, regardless of its business sector or size.

The balance sheet analysis I provides the analyst with an indicative view of the situation of the enterprise, therefore it is not suitable for fundamental decisions and comparisons in space. This level of analysis consists of four ratio indicators and one overall indicator.

$$C = \frac{2*S+1*A+5*R+4*L}{12} \quad (2)$$

Where:

Stability ratio (S) = equity / fixed assets

Activity indicator (A) = performances / (2 * total liabilities)

Profitability ratio (R) = (8 * EAT) / equity

Liquidity ratio (L) = (financial assets + receivables) / (2.17 * short-term liabilities)

If:

$C > 1,0$, then the enterprise forms a value

$0,5 < C < 1,0$, then the so-called "grey zone" (the financial situation of the company cannot be assessed)

$C < 0,5$, then the enterprise does not create value (destroys)

Altman's model for s.r.o.

Altman's model is a typical example of a summary rating index. It is extremely popular in the Czech Republic, probably due to its simplicity of calculation. It is the sum of the values of five common ratios, which are assigned different weights. The profitability of total capital has the highest weight.

This model was invented in 1968 by Edward Altman, a professor of finance at the New York University School of Business. For his analysis, Professor Altman used a direct statistical method (discriminant analysis) to estimate the weights in a linear combination of individual ratios, which he included in his model as variable variables. He developed this model on an empirical basis, based on a sample of data from companies, half of which were bankrupt. However, in addition to quantitative indicators, he also included in his methodology the so-called financial philosophy, i.e. the attitudes, approaches, and consistency of management behavior with the financial capabilities of the company (Mrkvička & Kolář, 2006).

In the original 1968 study, he used data from 33 bankrupts and an equal number of non-bankrupt industrial publicly traded companies in the U.S. Initially, Altman selected 22 indicators, but after repeated testing, he narrowed this selection to five indicators that best characterized the financial distress of the firm.

$$Z = 0,717 * X_1 + 0,847 * X_2 + 3,107 * X_3 + 0,42 * X_4 + 0,998 * X_5 \quad (3)$$

Where:

X_1 = (current assets - short-term liabilities) / sum of assets

X_2 = retained earnings / total assets

X_3 = profit before tax and interest / sum of assets

X_4 = equity / (long-term liabilities + short-term liabilities + bank loans and assistance)

X_5 = sales / sum of assets

If:

$Z > 2,9$, then the enterprise forms a value

$1,2 < Z < 2,9$, then the so-called "grey zone" (the financial situation of the company cannot be assessed)

$Z < 1,2$, then the enterprise does not create value (destroys)

Springate's model

The model was developed and published in 1978 by Gordon L. V. Springate in his doctoral thesis. Springate used discriminant analysis to design the model. He worked with a sample of forty companies from two classes, each containing twenty companies, one bankrupt and the other non-bankrupt. He used the companies not only for model development but also as the first test set. All of the companies were Canadian and predominantly in the manufacturing sector. Companies with comparable amounts of assets were represented in both groups, with the average amount being C\$30.8 million for the failed companies and C\$35.6 million for the successful ones. The classes of businesses also had analogous representations of industry sectors. For example, they included companies in the apparel, food, and foundry sectors.

$$S = 1,03 * A + 3,07 * B + 0,66 * C + 0,4 * D \quad (4)$$

Where:

A = net working capital / total assets

B = EBIT / total assets

C = EBT / current liabilities

D = sales / total assets

If:

$S < 0,862$, then problems can be expected in the company.

2 Methods

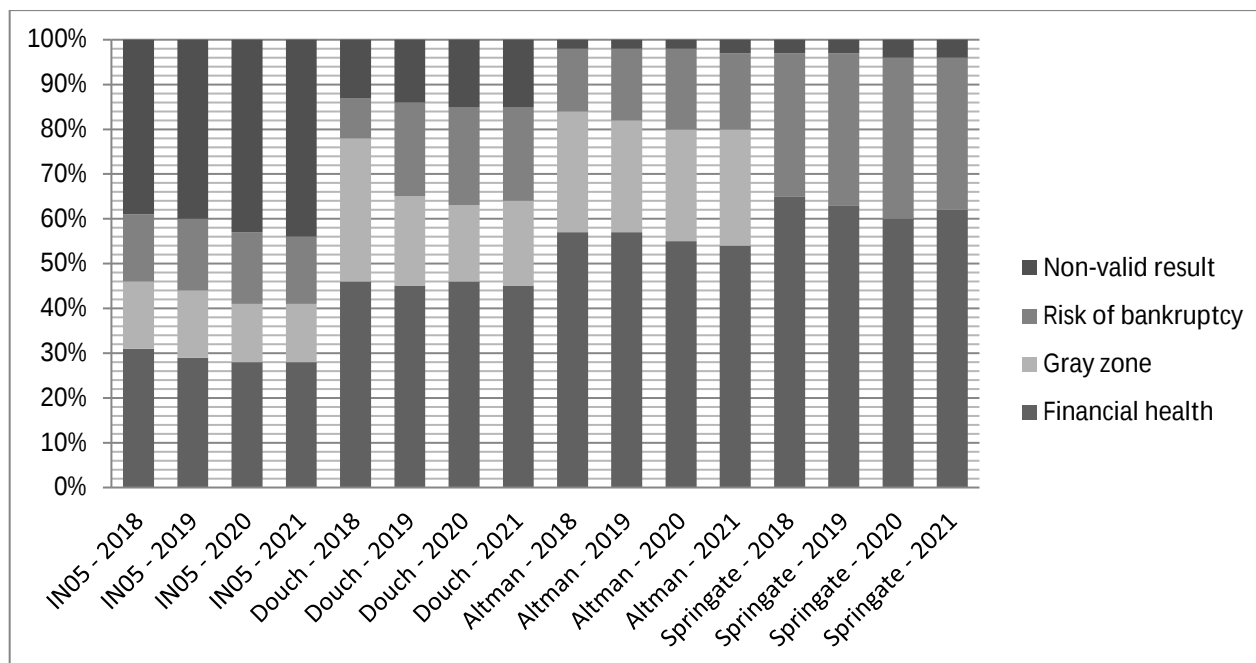
The main aim of the presented paper is to evaluate the financial health of manufacturing firms. Within the theoretical part, this thesis presents different perspectives of key authors on this topic. It describes the different bankruptcy models and provides a sufficient theoretical basis for the practical part of the thesis.

The practical part of the thesis focuses on measuring the reliability of bankruptcy models and determines whether individual firms can be classified as financially sound or financially unsound. It examines a sample of 6,000 firms from the database Albertina.

3 Research results

To determine the reliability of the prediction of the future state of the company will be used descriptive statistics. Previous models were applied to approximately 6,000 companies for the years 2018-2021. For each year, the proportion of companies that are financially healthy according to the given model, that are in the so-called gray zone, that are at risk of bankruptcy, and for which we could not obtain information because the formula contained division by zero was calculated. The following graph shows the calculations for 2018 - 2021. Sub-calculations of the monitored indices in the monitored sample were carried out, and then there was a percentage redistribution and the creation of the offered chart.

Figure.1 Breakdown of businesses by financial health for the period 2018-2021



Source: own processing

If we compare the previous graph over time, we will see that the number of companies at risk of bankruptcy practically does not change. But if we compare the bankruptcy models with each other, we will see that each model indicates a relatively different proportion of companies that are at risk of bankruptcy and that are financially sound.

Tab.1 Statistical values

	N valid	Average	Median	Standard deviation	Variance
IN05	3642	20,60	1,60	273,47	74787,52
Douch	5509	2,14	1,08	38,99	1520,59
Altman	6350	6,17	3,18	119,09	14181,88
Springate	6282	0,23	1,25	36,12	1304,98

Source: own processing

Now we will proceed to the analysis of the calculated values. First of all, it should be noted that the data will be evaluated through two lenses. The first of them is the arithmetic mean, which will be used for the primary assessment of the financial health of the observed sample.

The second way of evaluation will be through medians, as the middle value of this set. This lens will provide a theoretical value for the classification of financially healthy and unhealthy businesses in the observed sample.

Based on the calculated average in the monitored sample for the period 2018-2021, we can say that the companies are financially healthy because the average of the IN05 index is 20,6. However, based on the calculated median in the observed sample for the period 2018-2021, we can say that half of the enterprises are financially healthy and half are below the threshold because the median of the IN05 index is 1,6 (If $IN05 > 1,6$, then the enterprise forms a value).

Based on the calculated average in the monitored sample, we can say that the companies are financially healthy because the average of the balance analysis of Rudolf Douch is 2,14. However based on the calculated median in the observed sample, we can say that half of the enterprises are financially healthy and half are below the threshold because the median of the balance analysis of Rudolf Douch is 1,08 (If $C > 1,0$, then the enterprise forms a value).

Based on the calculated average in the monitored sample, we can say that the companies are financially healthy because the average of Altman's model is 6,17. However, based on the calculated median in the observed sample, we can say that more than half of the enterprises are financially healthy and less than half are below the threshold because the median of the Altman's model index is 3,18 (If $Z > 2,9$, then the enterprise forms a value).

Based on the calculated average in the monitored sample, we can say that the companies are not financially healthy because the average of the Springate's model is 0,23. However, based on the calculated median in the observed sample, we can say that more than half of the enterprises are financially healthy and less than half are below the threshold because the median of Springate's model index is 1,25 (If $S < 0,862$, then problems can be expected in the company).

Based on all the medians of the observed indices, we can say that the monitored sample is more than 50% healthy on which all bankruptcy models agree.

Due to the high dispersion of the data, it is necessary to verify the arithmetic mean with the Wilcoxon reliability test.

Tab. 2 Wilcoxon test

Model	Statistic	p	Note. $H_0: \mu \neq$
IN05	3.92e+6	<0,001	1,6
Altman	9.00e+6	<0,001	1,0
Douch	1.20e+7	<0,001	2,9
Springate	1.33e+7	<0,001	0,862

Source: own processing

It has been statistically proven that we cannot work with average calculated values. The main conclusion is based on the median, because the average methodically takes into account outliers and thus distorts them.

4 Conclusions

In conclusion, the paper has succeeded in meeting the necessary objective. A comparison of the different models has been made on the example of the selected 6,000 firms. It has been possible to distinguish the different bankruptcy models from each other, both in theory and in practice. The history, their reliability, and the discussion between the authors were presented. The represented firms were ranked from the side of each model.

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