# The Success of Business Failure Prediction Using Financial Creditworthy Models

**Michal Kuběnka**

[1] University of Pardubice
Faculty of Economics and Administration, Institute of Business Economics and Management
Studentská 84, 532 10, Czech Republic
E-mail: michal.kubenka@upce.cz

***Abstract:*** *Financial creditworthy models are popular for their simplicity and fast applications. Above all, quantitative evaluation of financial health guarantees an unbiased assessment of company. On the other hand, these models do not take into account the soft factors. Probably, the most famous Czech financial models known as creditworthy are Credibility Index, Rudolf Doucha´s Balance analysis, and Kralicek´s Q-test. They were created for the purpose of assessing the creditworthiness usually without using statistical methods. Can they be used for prediction of business failure despite this drawback? What is their success rate? Which of these classic financial models achieves the highest accuracy? To find answers a dataset of financial statements of 92 companies in manufacturing industry was analysed. These companies went bankrupt between 2010-2014.*

*Keywords: Credibility Index, Rudolf Doucha´s Balance analysis, Kralicek´s Q-test, failure, predictive power*

*JEL codes:* G32, M10, C38

## 1 Introduction

There is a plethora of financial models for financial diagnostic and financial health prediction in the world. They are generally classified into two categories as bankruptcy models and creditworthy models. Kuběnka and Slavíček (2014) claim that although these two categories were created differently, their construction is usually similar, which means a combination of ratios and assigned weights of importance. They point out that prediction models vary predominantly in their targeting.

The purpose of bankruptcy models is to predict a default of company based on an analysis of financial statements. Probably the most famous models are made by Altman. His Z-Score (Altman (1968)) started an expansion of business failure modeling. Later, he created many more e.g. Altman (1993) or Altman, Hartzell, Peck (1995). Other well-known are Beermann test (Beerman (1976)), Springate model (Sands, Springate, (1983)), Fulmer model (Fulmer (1984)), and Taffler model (Taffler, Tisshaw (1997)). In the Czech Republic, IN95 and IN05 models are the best known bankruptcy models. IN95 accuracy is more than 70% in conformity with findings of authors Neumaierová, Neumaier (2002). Bankrupt prediction accuracy of IN05 model is 83% according to Neumaierová, Neumaier (2005).

Slavíček (2015) emphasizes that the most famous bankruptcy models are usually generic, which do not reflect the specifics of individual industries. That is why he suggested his own prediction model for small companies operating in the construction sector in the Czech Republic (a bankruptcy prediction with accuracy of 82%)

However, the finite accuracy can be affected by many factors. For instance, a success of failure prediction can be decreased also by using non-identical accounting systems. It means e.g. usage of US GAAP when creating the model and subsequently usage of IFRS or CAS system when applying the model. Accounting and differences in accounting systems are dealt with e.g. by Honková (2015) and Fosbre, Kraft, Fosbre (2009).

Many authors emphasize that taking non-financial factors into consideration can significantly increase the effectiveness of risk-management systems and decision-making

processes (Korableva and Kalimullina, 2015). Some authors even focused unconventional non-financial factors eg. (Hájek, Olej and Myšková, R., 2014) indicated eleven categories of annual reports' sentiment which can utilized as the inputs of the prediction models. However, the frequency of use in practice decreases with the increasing complexity of the method (Stříteská, 2012). Financial prediction models use only quantitative and easily available financial data. That is reason why the financial prediction models are so popular.

While the bankruptcy models were created using samples of real enterprises, the creditworthy models are made on the basis of logical assumptions without empiric research. That is why these models usually do not have a quantified accuracy. The best known creditworthy models are Tamari risk index ((Tamari (1966), Czech IN99 model for economic value added prediction (Neumaierová (2002)), Grünwald´s index ((Grünwald, Holečková (2007)), Doucha´s Balance analysis I., II., III. ((Doucha (1996)), Credibility Index (see more Zalai, 2010), and Q-test made by Kralicek (1993) made in 1991.

The first goal of this article is to determine the success rate of creditworthy models - namely Credibility Index, Rudolf Doucha´s Balance analysis, and Kralicek´s Q-test. And the second goal is to answer the question which of these classic financial models achieves the highest accuracy.

## 2 Tested models

### Kralicek´s Q-test

Q-test uses four financial ratios that are applied to a specific company. The values achieved are then subsequently compared with the scale shown in Table 1. The equity quota can be calculated as:

$$(K_1)\ \text{Equity quota} = \frac{\text{Equity}}{\text{Total assets}} * 100 \quad (1)$$

The indicator refers to the capital strength of the company. According to Sedlacek (1998), it also describes the long-term financial stability of the company and capital independence and it informs how company covers its needs with own resources. In contrast, Debt payment from cash flow expresses a length of period of time needed to pay off company debts from cash flow. It can be calculated as:

$$(K_2)\ \text{Debt payment from CF} = \frac{\text{Foreign capital} - \text{financial assets (short} - \text{term)}}{\text{Annual cash flow}} * 100 \quad (2)$$

Kralicek used the item „annual cash flow" in this ratio. Kislingerová (2005) calculates it as sum of economic result, depreciations and the change of reserves level.

Cash flow in revenues is the ratio which should be maximized. It can be calculated as:

$$(\mathrm{K}_3)\ \text{Cash flow in revenues} = \frac{\text{Cash flow}}{\text{Revenues}} * 100 \quad (3)$$

The return on assets means the profitability of total assets. It should be higher than interest rate of debts. Only in this case financial leverage can have a positive influence. This ratio is calculated in this way:

$$(\mathrm{K}_4)\ \text{Return on assets} = \frac{\text{Earnings after taxes}}{\text{Total assets}} * 100 \quad (4)$$

The resulting grade is the arithmetic average of ratings achieved in particular evaluated areas ($(K_1+K_2+K_3+K_4)/4$). The company classified with the grade 1 and 2 is considered to be prosperous, and the ones with the grade 4 and 5 are pointed to the bankruptcy. See more in Table 1.

**Table 1** Evaluation scale & grades according to Kralicek

| | Scale for evaluation (grades) | | | | | |
|---|---|---|---|---|---|---|
| | 1. Excellent | 2. Very Good | 3. Good | 4. Bad | 5. Very bad | |
| **Equity quota** | > 30% | > 20% | > 10% | < 10% | neg. | Financial stability |
| **Return on assets** | < 3 yrs. | < 5 yrs. | < 12 yrs. | > 12 yrs. | > 30 yrs. | |
| **Debt payment from CF** | > 10% | > 8% | > 5% | < 5% | neg. | Revenues situation |
| **Cash flow in revenues** | > 15% | > 12% | > 8% | < 8% | neg. | |

Source: own according to Kralicek (1993)

Q-test uses grades from 1 to 5 but for the determination of the informative value capability it is necessary to work with intervals. According to Kuběnka (2016), it is suitable to divide the scale <1;5> in five intervals. Then every interval encompasses the width of 0.8 of a grade. Under this recommendation the evaluation scale has this grades and zones:

- Grade 1 with interval <1;1.8) => classified as failure zone
- Grade 2 with interval <1.8;2.6) => classified as failure zone
- Grade 3 with interval <2.6;3.4) => classified as grey zone
- Grade 4 with interval <3.4;4.2) => classified as prosperity zone
- Grade 5 with interval <4.2;5> => classified as prosperity zone

## Credibility Index (Ic)

Compared to Q-test, Ic was created in a more sophisticated way. The author used the methodology of multivariate discriminant analysis. That is why the formula (5) includes ratios with different importance (1.5 vs. 0.08 vs. 10 vs. 5 vs. 0.3 vs 0.1). According to (Zalai, 2010) Ic formula includes six ratios in the following form:

$$I_C = 1.5X_1 + 0.08X_2 + 10X_3 + 5X_4 + 0.3X_5 + 0.1X_6 \quad (5)$$

Where $X_1$ ratio means Cash Flow / Total liabilities and Equity; $X_2$ component is proportion of Total Capital / Total liabilities and Equity; $X_3$ ratio is EBIT / Total Capital; $X_4$ ratio means EBT / Revenues; $X_5$ ratio is Inventory / Total Assets; $X_6$ ratio involves Equity / Total Capital. Then the comparison with the following rating scale must be done. In compliance with Table 2 the threshold between prosperity and bankruptcy is zero.

**Table 2** $I_C$ rating scale

| | Type of financial positon | Fin. health category |
|---|---|---|
| **$I_C \in < 3 ; \infty )$** | extremely good financial position | prosperous companies |
| **$I_C \in < 2 ; 3 )$** | very good financial position | |
| **$I_C \in < 1 ; 2 )$** | good financial position | |
| **$I_C \in < 0 ; 1 )$** | problematic financial position | |
| **$I_C \in < -1 ; 0 )$** | bad financial position | bankruptcy companies |
| **$I_C \in < -2 ; -1 )$** | very bad financial position | |
| **$I_C \in < -\infty ; -2 )$** | extremely bad financial position | |

Source: Kuběnka (2015)

## Rudolf Doucha´s Balance analysis I. (BaI.)

The last chosen model, which is very well known in the Czech Republic, is Rudolf Doucha´s Balance analysis made by Doucha (1996). It was created in conditions of the Czech Republic contrary to Q-test and Ic. This model exists in three versions differing in elaborateness and accuracy. BaI. works with these four indexes (ratios):

$$Index\ of\ stability\ (S) = \frac{Equity}{Total\ assets} \quad (6)$$

$$Index\ of\ liquidity\ (L) = \frac{(Short\ term\ financial\ property + receivables)}{2{,}17\ x\ Current\ liabilities} \quad (7)$$

$$Index\ of activity\ (A) = \frac{Gross\ revenue}{Total\ liabilities} \quad (8)$$

$$Index\ of\ rentability\ (R) = \frac{8\ x\ EAT}{Equity} \quad (9)$$

$$Total\ (T) = \frac{(2 * S + 4 * L + 1 * A + 5 * R)}{12} \quad (10)$$

Total score (T) is done as a weighted average of the achieved values as stated (10). The interpretation of ratings is the same. The total T value means a good financial situation of the company if it exceeds value 1. T value under 1 indicates a bad financial situation of the company.

## 3 Dataset & Methodology

### Data set

To test the predictive power of the models a dataset of companies operating in the manufacturing industry was chosen. It comprised of 321 companies that got into distress (bankruptcy) between 2010 and 2014. This information was drawn from a database of businesses MagnusWeb of Bisnode company. Accounting data contains information from the balance sheet, profit and loss statement one year before bankruptcy, i.e. from 2009 to 2013. Companies that had zero or very small turnover were subsequently excluded out of the sample, therefore, the data set was reduced to 285.

The author assumes that such indicia would have been clear signals about distress to a analyst. Usage of prediction model is then unnecessary. Further reduction of the sample was due to the negative equity of some companies. The author considers this fact is also a clear signal of distress. As a result of this, sample decreased to 92 companies. The accuracy of the models was evaluated on the basis of generally known methodology. It is based on analysis of historical data. The resulting value of the model at time t is compared with the fact at time t + 1.

### Methodology of success expression

A lot of prediction models were tested in history. Formerly (e.g. forefather of failure prediction E. Altman (1968)) and even now (e.g. Berzkalne and Zelgalve (2013), Huijuan (2015)) this methodology for accuracy enumeration of model in the area of bankruptcy prediction has been used.

**Table 3** $I_C$ Accuracy enumeration

| | **Prediction** | |
|---|---|---|
| | Bankrupt | Non-Bankrupt |
| **Fact: Bankrupt** | $H_1$ | α |

Source: author according to Altman (1968)

where:

$H_1$ – number of correct predictions of future bankrupt

α – Type I. error is number of bankruptcy companies mistakenly classified as non-bankrupt

Success of bankrupt prediction (SBP) in percentage terms for bankrupt companies (so called "sensitivity") can be quantified in this way:

$$Sensitivity\ (SBP) = \frac{H_1}{H_1 + \alpha}\ x\ 100 \quad (11)$$

## 4 Results and discussion

Each of tested model has a different zones for evaluation of tested companies. These zones are able to sort analysed companies into two groups (see Table 4). One group consists of companies diagnosed with a poor financial situation ("bankrupt area") and in the other group there are financially stable and prosperous companies ("creditworthiness area").

**Table 4** Bankrupt and credibility zones

| | No. of rating degrees | Threshold | Bankrupt Area | Creditworthiness Area |
|---|---|---|---|---|
| **Q-test** | 5 | 3 | > 3 | < 3 |
| **Credibility Index** | 7 | 0 | < 0 | > 0 |
| **Balance Analysis I.** | 2 | 1 | < 1 | > 1 |

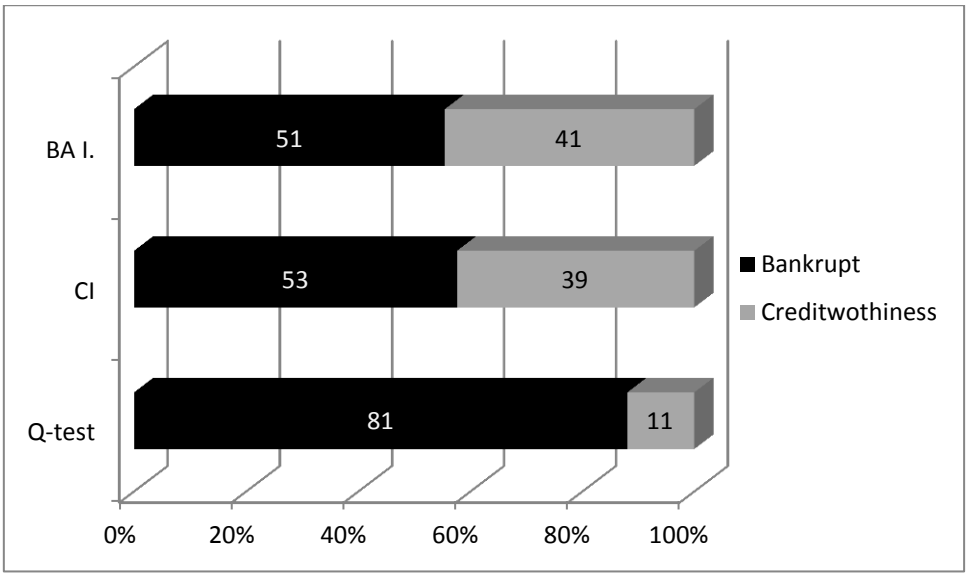
Source: own

The dataset of 92 manufacturing companies was tested using three selected creditworthy models. Each of 92 companies showed no signs of decline in the form of negative equity or zero or very low turnover. Also, 30 companies in the sample (32.61%) had a positive ROE value and 62 companies, i.e. 67.39% negative ROE value. Average of ROE value is -1.24%, median -16.78%. Maximal ROE is 6520.65% and minimal ROE value is -4453.67%. These outliers are usually caused by low values of equity.

Not only following this, the Balance Analysis I. model (BA I. in Figure 1) identified 41 companies, i.e. 44.57% as companies in good financial situation and only a little more than half, namely 55.43% (51 companies) in bankruptcy. Credibility Index (CI in Figure 1) evaluated the companies more negatively as it ranked 57.61% companies in the bankrupt area and the remaining 42.39% in creditworthiness area.

The most negative evaluation of companies and also most successful model is Q-test. It marked 88.04% (81 companies) of companies as financially troubled and only 11.96% (11 comp.) as financially healthy.

**Figure 1** Success of business failure prediction




Source: own

Table 5 area 1 indicates probability that both the models will predict bankruptcy when applied to a specific company. The most consistent are Q-test and Credibility Index (Q-t vs. CI) that identically predict bankruptcy in 61.53% of cases. The best consistency in bankruptcy prediction at the conditioned probability (Table 5 area 2 & 3) was 100% found in Quick test and Balance analysis I. (Q-t vs. CI) where conditioned conformity of Q-t vs. CI/CI was 100% and in case Q-t vs. BA/BA also 100%.

**Table 5** Agreement in bankruptcy prediction

| **Probability*** | | | **Conditioned probability* direction A** | | | **Conditioned probability* direction B** | | |
|---|---|---|---|---|---|---|---|---|
| Area 1. | | | Area 2. | | | Area 3. | | |
| Models | Abs. | Rel.* | Models | Abs. | Rel.* | Models | Abs. | Rel.* |
| **Q-t vs. CI** | 53/92 | **57.61%** | **Q-t vs. CI /CI** | 53/53 | **100%** | **CI vs. Q-t /Q-t** | 53/81 | 65.43% |
| **Q-t vs. BA** | 51/92 | 55.43% | **Q-t vs. BA /BA** | 51/51 | **100%** | **BA vs. Q-t /Q-t** | 51/81 | 62.96% |
| **CI vs. BA** | 46/92 | 50.00% | **CI vs. BA /BA** | 46/51 | 90.20% | **BA vs. CI /CI** | 46/53 | **86.79%** |

* probability of agreement in prediction of bankruptcy

Source: own

Some links between models appear to be very strong, however, it should be understood that this is a conditioned probability. For example, the strongest links Q-t vs. CI means that if CI identifies a company as bankrupt, there is 100% probability of being identified as bankrupt company by Q-test as well.

## 5 Conclusion

In order to meet the goal of this article, the classification of companies in 2009-2013 was confronted with the fact that these companies went bankrupt one year later. Balance Analysis I. showed the worst prediction power. It correctly predicted a business failure in 55.43% of cases based on the data available a year earlier. Credibility Index model was better in bankruptcy predicting, namely in 57.61% of cases, and the best one was Q-test, predicting correctly even in 88.04% of cases (i.e. 81 of 92 companies).

Generally, these financial models can be considered as an easy tool for assessment of company on the quantitative basis. However, it should be noted that the forecast of future financial condition can never be absolute.

In conclusion, we can say that the predictive power of one of the three tested creditworthy models is very high. That is why the Q-test can be recommended as a suitable model for practical use in the area of bankruptcy prediction. It even has a higher accuracy than the other mentioned bankruptcy models (IN95 70%, IN05 83%, Slavíček 82%).

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