# The Diagnosis of Bankruptcy Risk Using Score Function

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*Abstract:* - The current economic crisis has made the business environment to be qualified as difficult or even critical, bankruptcy risk becoming a permanent reality for many companies. Discriminant analysis can be used to assay companies and particularly to evaluate their bankruptcy risk. Score functions are based on discriminant analysis and they are formed of a linear combination with a limited number of financial ratios; they are used in financial analysis but not only to identify the companies' present situation but also to assay their future. In this paper we shall use score functions to determine the bankruptcy probability for private companies.

*Key-Words:* - Z-Score, Bankruptcy Risk, Discriminant Analysis, Financial Ratios

## 1 Introduction

The bankruptcy risk is of a major interest for banks, financial institutions, clients, etc but also for investors and for the firms' managers. During the time, the diagnosis of bankruptcy risk had an impetuous development due to the use of statistical methods in the risk analysis. One of these is the scoring method which aims to provide predictive models for assessing the bankruptcy risk of an enterprise. The scoring method is based on statistical techniques of discriminant analysis and involves observing a set of companies that consists of two distinct groups: one group of enterprises with financial difficulties (bankrupt) and a group of financial-relaxed companies (non-bankrupt). Observation is based on the calculation of some financial ratios determined for both groups of companies. The significance of indicators and the way of combining them depend on the specific interest of each analyst. This combination of indicators forms a linear function "z" called "score function" determined for each enterprise. The distribution of different scores allows the separation of enterprises in non-bankrupt and bankrupt.

The advantage of discriminant analysis is that many characteristics can be combined into a single score. So, to build an analysis model based on scoring method the following steps have to be followed [11]:

1. the analyst selects the financial indicators that best reflect the financial health of a company;

2. the evolution of the selected indicators is compared on two categories of companies within the same field of activity, some of them in distress and others financially relaxed;

3. the predictive function z is developed by combining those financial ratios that have a strong and constant action;

4. the cut-off values of z function are determined in order to establish the interpretation of the z - score that reflects the occurrence probability of bankruptcy risk.

The z - score for each enterprise is calculated as follows [1], [2]:

$$z = v_1x_1 + v_2x_2 + \ldots\ldots\ldots + v_nx_n \qquad (1)$$

where:
$x_j$ = independent variables
$v_j$ = discriminant coefficients.

The discriminant function transforms the individual variable values to a single discriminant score or z value which is then used to classify the analyzed company.

# 2 Analysis Models Based on Score Function: Altman and Conan et Holder

In economic theory and practice there were several developed analysis models based on score function of which we shall approach Altman and Conan et Holder models, and investigate their suitability for eastern companies.

## 2.1 Altman Model

The use of discriminant analysis in business failure prediction has been widely accepted since 1968 when Edward Altman published the results of his researches [14]. Altman developed a model for predicting the likelihood that a firm would go bankrupt. This model uses five financial ratios which are derived from the financial statements as reported by bankrupt (prior to bankruptcy) and non-bankrupt companies [7]. The ratios are then combined in a specific way to produce a single number. This number, called z-score is a general measure of corporate financial health.

Within the American business environment, Professor Edward Altman used those five indicators that have enabled the prediction of 72% of the firms' bankruptcies with two years prior their occurrence. He used a sample of 66 firms of which 33 had financial difficulties and 33 were financially relaxed (analysis was performed from 1946 - 1965) [1].

The studies conducted by William H. Beaver [4] and Edward I. Altman [1], [2] revealed the fact that a synthetic indicator consisting of a battery of ratios allows an early detection of a company's difficulties and, consequently, facilitate the search of prevention measures at the first sign of vulnerability.

The better the economic and financial situation of a company is the higher risks taken with an increasing probability for company of obtaining great results (earnings); but there are necessary cover-resources in case of failure [12].

The score function developed by Altman has got the following formula [1], [3]:

$$z = 1.2\, x_1 + 1.4\, x_2 + 3.3\, x_3 + 0.6\, x_4 + 1.0\, x_5 \quad (2)$$

where:

$x_1$ = Working capital / Total assets;
$x_2$ = Retained earnings / Total assets;
$x_3$ = Gross outcome of exploitation/Total assets;
$x_4$ = Market value equity / Book value of total debt;
$x_5$ = Turnover / Total assets

The discriminant coefficients (the constants) express the share of economic and financial indicators in assessing the bankruptcy risk, the level of an indicator being the best as the highest absolute values.

The overall value of z-score indicates as follows [3]:

$z < 1.81$ = Zone I – Distress Zone - High probability of bankruptcy for the firm;
$1.81 < z < 2.99$ = Grey area – uncertain zone;
$z > 2.99$ = Zone II – Safe zone - Low probability of bankruptcy for the firm.

Since 1968, Edward Altman has tested the z-score model for several companies and during the time he tried to improve the z-score. In 1976 he developed another model called „zeta". Though, as he says the z-score original model has retained its reported high accuracy and is still robust despite its development over 30 years ago.

The original z-score model was applicable only to publicly traded entities (for which the stock price data is required when calculating $x_4$ variable), that for Altman tried to find a solution to apply the model to firms in the private sector. So, he revised the z-score, substituting the book value of equity for the market value. The result consisted in the following z'-score [2], [5]:

$$z' = 0.717\, x_1 + 0.847\, x_2 + 3.107\, x_3 + 0.420\, x_4 + 0.998\, x_5 \quad (3)$$

The single variable that changed is $x_4$ which became:
$x_4$ = Book value of equity / Book value of total debt.
The overall value of z'-score indicates as follows:

$z' < 1.23$ = Zone I - Distress Zone - High probability of bankruptcy for the firm;
$1.23 < z' < 2.90$ = Grey area – uncertain zone;
$z' > 2.90$ = Zone II - Safe zone - Low probability of bankruptcy for the firm.

## 2.2 Conan et Holder Model

The model has been elaborated in France by Joel Conan and Michel Holder using the discriminant analysis. Through this model, the probability that a company can reach a bankruptcy status can be determined. Conan and Holder observed 31 ratios in a sample of 190 small and middle enterprises (within 10-500 employees), 50% of which got bankruptcy between 1970-1975 years. The two authors concluded that five ratios among the 31 are most significant thus for the score function has got the following formula for industrial enterprises [8], [13], [15]:

$z = 0.24 x_1 + 0.22 x_2 + 0.16 x_3 - 0.87 x_4 - 0.10 x_5$ (4)
where:

$x_1$ = Gross outcome of exploitation / Total debts;

$x_2$ = Permanent capital / Total assets;

$x_3$ = Quick assets / Current liabilities = Circulating assets – Inventory / Current liabilities;

$x_4$ = Financial expenses / Turnover;

$x_5$ = Staff expenses / Turnover.

The bankruptcy probability is established according to the value of the z - score function as the data shown in Table 1 [15].

Unlike Altman model, Conan et Holder model does not distinguish between listed and unlisted companies on the stock exchange. We may notice hat the higher value of z decreases, the more increases the vulnerability of the company.

## 2.3 Study Case

For the study case we selected a middle size private industrial company (Alpha Ltd) that operates on the Romanian market of metallic buildings and whom financial profile is shown in Table 2. Using the indicators shown in Table 2 we calculated the value of z – score function as follows:

**Year 2006**

**Altman Model**

$z' = 0.717 x_1 + 0.847 x_2 + 3.107 x_3 + 0.420 x_4 + 0.998 x_5$
$x_1 = 0.04$
$x_2 = 0.08$
$x_3 = 0.26$
$x_4 = 1.23$
$x_5 = 1.01$

It results that $z' = 0.717 * 0.04 + 0.847 * 0.8 + 3.107 * 0.26 + 0.420 * 1.23 + 0.998 * 1.01 = 2.44$
The z' value indicates that the company is in a grey area, a zone of incertitude regarding firm's bankruptcy.

**Conan et Holder Model**

$z = 0.24 x_1 + 0.22 x_2 + 0.16 x_3 - 0.87 x_4 - 0.10 x_5$
$x_1 = 0.57$
$x_2 = 0.56$
$x_3 = 0.07$
$x_4 = 0.07$
$x_5 = 0.53$

It results that $z = 0.24 * 0.57 + 0.22 * 0.56 + 0.16$

Table 1 Cut-off Values for Conan et Holder z – score

| Score values | Probability of bankruptcy |
|---|---|
| - 0.21 | 100 |
| - 0.05 | 90 |
| 0.002 | 80 |
| 0.03 | 70 |
| 0.05 | 60 |
| 0.07 | 50 |
| 0.09 | 40 |
| 0.11 | 30 |
| 0.13 | 20 |
| 0.16 | 10 |

Table 2 Financial profile of Alpha Ltd - EUR -

| Indicators | 2006 | 2007 | 2008 |
|---|---|---|---|
| Circulating assets | 98,013 | 192,745 | 96,553 |
| Inventory | 92,695 | 178,777 | 73,113 |
| Total assets | 479,838 | 567,604 | 462,919 |
| Book value of equity | 269,351 | 318,300 | 252,643 |
| Current liabilities | 77,001 | 87,569 | 39,411 |
| Working capital | 21,012 | 105,177 | 57,142 |
| Book value of total debt | 219,630 | 249,303 | 125,458 |
| Turnover | 484,337 | 791,230 | 935,190 |
| Staff expenses | 258,003 | 285,621 | 366,002 |
| Financial expenses | 32,709 | 53,848 | 62,176 |
| Gross outcome of exploitation | 125,851 | 183,607 | 145,891 |
| Retained earnings | 36,497 | 53,246 | 43,137 |
| Number of employees | 43 | 49 | 61 |

$* 0.07 - 0.87 * 0.07 - 0.10 * 0.53 = 0.16$
The z value indicates that the financial situation of the company is very good; the bankruptcy risk is less than 10%.

**Year 2007**

**Altman Model**

$z' = 0.717 x_1 + 0.847 x_2 + 3.107 x_3 + 0.420 x_4 + 0.998 x_5$
$x_1 = 0.18$

$x_2 = 0.09$
$x_3 = 0.32$
$x_4 = 1.28$
$x_5 = 1.39$

It results that z' = 0.717 * 0.18 + 0.847 * 0.09 + 3.107 * 0.32 + 0.420 * 1.28 + 0.998 * 1.39 = 3.13

The z' value indicates that the company is in a safe area with a low probability of bankruptcy for the firm.

### Conan et Holder Model

$z = 0.24\ x_1 + 0.22\ x_2 + 0.16\ x_3 - 0.87\ x_4 - 0.10\ x_5$
$x_1 = 0.74$
$x_2 = 0.56$
$x_3 = 0.16$
$x_4 = 0.07$
$x_5 = 0.36$

It results that z = 0.24 * 0.74 + 0.22 * 0.56 + 0.16 * 0.16 – 0.87 * 0.07 – 0.10 * 0.36 = 0.23

The z value indicates that the financial situation of the company is very good; the bankruptcy risk is less than 10%.

### Year 2008

### Altman Model

$z' = 0.717\ x_1 + 0.847\ x_2 + 3.107\ x_3 + 0.420\ x_4 + 0.998\ x_5$
$x_1 = 0.12$
$x_2 = 0.09$
$x_3 = 0.32$
$x_4 = 2.01$
$x_5 = 2.02$

It results that z' = 0.717 * 0.12 + 0.847 * 0.09 + 3.107 * 0.32 + 0.420 * 2.01 + 0.998 * 2.02 = 4.02

The z' value indicates that the company is in a safe area with a low probability of bankruptcy.

### Conan et Holder Model

$z = 0.24\ x_1 + 0.22\ x_2 + 0.16\ x_3 - 0.87\ x_4 -- 0.10\ x_5$
$x_1 = 1.16$
$x_2 = 0.55$
$x_3 = 0.59$
$x_4 = 0.07$
$x_5 = 0.39$

It results that z = 0.24 * 1.16 + 0.22 * 0.55 + 0.16 * 0.59 – 0.87 * 0.07 – 0.10 * 0.39 = 0.39

The z value indicates that the financial situation of the company is very good; the bankruptcy risk is less than 10%.

As we can see, for 2006 the Altman z-score value shows that the company is in a „grey area”

which means uncertainty regarding firm bankruptcy; by the other hand, for 2006 Conan et Holder z – score value shows that the company situation is very good, bankruptcy risk being less than 10%. For the next two years (2007 and 2008) the Altman and Conan et Holder z-score values indicate that the company is in a safe area with a low probability of bankruptcy (less than 10%).

So, for the 2006 year, the situation of the company is not clearly defined if we take into account both z-score models. But for 2007 and 2008, both Altman and Conan et Holder models indicate that the probability of bankruptcy for the analyzed company is very low. The financial profile of the enterprise shows an increase of the turnover during the three analyzed years but a decrease of the gross outcome of exploitation in 2008. That for, even the analysis using z-score is showing a good situation for the company in 2007 and 2008, this does not presume that firm should not be cautious within its activities due to the recent state of the global economic environment in crisis times.

## 3  How to Apply Altman and Conan et Holder Models in Eastern Economic Environment?

Though, when using the two analytical models based on score function, the financial analyst should assume the risk that the analysis could not be 100% correct. That is because of the national character of those models that have been developed for companies operating in a certain macroeconomic climate (the American for model Altman and French for Conan et Holder model) [1], [8].

These shortcomings of traditional scoring models have determined the financial analysts to be concerned about this issue and to search for improvement solutions.

For example, Casey and Bartczak [6] and Gentry, Newbold and Whitford [10] realized in 1984 and 1985 studies that have examined whether the use of cash flow indicators as explanatory variables shall improve the performance of score function regarding the separation of enterprises in non-bankrupt and bankrupt. Both studies showed that overall there is no sensitive improvement of discrimination. This is due to the fact that score functions are passing-by the ability of enterprises to seek for survival solutions such as restructuring of business or rescheduling the payment deadlines. There are also situations when the bankruptcy of a company occurs in certain political circumstances that have nothing to do with the mechanisms or laws

of the competitive market [9].

As some authors says [13], discriminant analysis presents a major disadvantage due to the fact that the base information is reduced by selecting only the most significant ratios but enterprise should be considered as an economic-social system that acts in a complex environment influenced by much more variables. The eastern contemporary firms are influenced by many external factors specific for the current eastern economic environment and for countries with economies in transition: the law usually characterized by insufficiency, restrictive changes, prohibitive financial and staff policies, high inflation, etc. Another disadvantage is that till now, most of the proposed z-score models use only quantitative variables respectively financial ratios. But all these variables are specific for every company and they do not take into consideration the direct impact of economic/business cycles upon the firm [7]. Therefore, the analysis and prediction of bankruptcy risk occurrence should take into account macroeconomic and market variables, qualitative variables such as quality of management, quality of products, market trend and market share.

## 4   Conclusion

While in the past the financial analysts and the banks considered of great importance the firm's history, nowadays a great importance is given to the balance of active assets as they take into account a prospective approach for the identification of sources which are supposed to create great value.

When applying z-score models the analysis should be completed with the use of other indicators as mentioned above. We recommend that when developing such models there should be considered non-financial and qualitative indicators which are significant for the concerned economic sectors. The indicators should base on the main economic and social key factors appropriate for the environment in which the firm acts and which can influence its performances / results increasing thus the accuracy degree of forecast.

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