Evaluation of bankruptcy risk using econometric modelling

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Abstract: Due to the dynamism inherent to the economical-financial activity of companies, lately has been imposed like an objective necessity knowing certain information as accurate as possible regarding bankruptcy risk in a future time. The most known model used in the surveys regarding bankruptcy is the discriminant analysis. The use of this method presupposes finding certain predictor variables that are granted certain weights so that their amounts result in a global indicator, namely Z-score. In this work are presented Altman and Conan – Holder models with a view to evaluating bankruptcy risk.

Key-words: bankruptcy risk, Z score, Altman model, Conan – Holder model, rates, risk evaluation

1. Introduction

Bankruptcy risk can be defined as the impossibility of companies to face a financial-banking transaction, their incapability to reimburse in due time the amounts borrowed under the conditions established by mutual consent with third parties respectively, based on a credit contract. It can be the result of the occurrence of some difficulties which, initially, upon the analysis and in the stage of evaluation and approval of credit, could not be identifies but which, during the progress of the contract, occurred. Therefore, the process of diagnosing bankruptcy risk consists in evaluating the capacity of the company to cope with the commitments assumed towards third parties, thus in evaluating the company’s solvency [6].

The analysis of bankruptcy risk can be done with the help of equity methods, according to which the company proves its solvency if observes the equations of financial equilibrium:

Fixed assets = Permanent capital
Current assets = Current debts

The main operational instruments used in order to investigate bankruptcy risk (through equity methods) are: working capital, solvency ratios and liabilities structure ratios [2].

The analysis of bankruptcy risk can be carried out through the mediation of equity methods, according to which the company proves its solvency if observes the equations of financial equilibrium:

Fixed assets = Permanent capital
Current assets = Current debts

The method of scores has as objective the provisions of some predictor methods in order to evaluate the company’s risk of bankruptcy. Its application presupposes the study of a set of companies made of two distinct groups: a group of companies with financial difficulties and a group of companies without financial issues. For each of the two groups is established a set of ratios, then is

2. Evaluation of bankruptcy risk

2.1. Method of scores

Due to the dynamism inherent to the economical-financial activity of companies, lately has been imposed like an objective necessity knowing some information as accurate as possible regarding bankruptcy risk in a future time. This was concretized in the drawing up of a method to predict risk bankruptcy named method of scores, which knew an important development due to the use of some statistical methods of analysis of the financial situation, starting from a set of ratios.

Surveys carried out in the 1960s searched for the differences of values of indicators in high-performance companies and in bankrupted companies. Surveys showed that certain financial indicators had significant differences regarding the two categories of companies. The most usual statistical technique used in the surveys related to bankruptcy is the discriminant analysis. It is a statistical method to find some predictor variables which are granted certain weights so that their amount is a global indicator which is Z-score (the Z score) [6].

The method of scores has as objective the provisions of some predictor methods in order to evaluate the company’s risk of bankruptcy. Its application presupposes the study of a set of companies made of two distinct groups: a group of companies with financial difficulties and a group of companies without financial issues. For each of the two groups is established a set of ratios, then is
determined the best linear combination of ratios which could allow the differentiation of the two groups of companies.

As a result of the application of discriminant analysis for each company is obtained the Z-score, which is a linear function of a set of ratios. The distribution of the different scores allows the differentiation of the "healthy" companies as compared to the companies in difficulty. Z-score granted to each company is determined through the mediation of the function [5]:

\[ Z = a_1 * x_1 + a_2 * x_2 + \ldots + a_n * x_n \]  

(2.1)

where: \( x_i \) – represents the ratios involved in the analysis;  
\( a_i \) – weighting coefficient of each ratio.

**2.2. Altman and Conan-Holder models**

Another group of methods to predict bankruptcy risk are based on statistical techniques (discriminant analysis), out of which we mention: E. Altman model and J. Conan - M. Holder model. These methods are based on the method of scores to assess the bankruptcy risk, which transform information provided by the economical-financial indicators into a score according to which is assessed the entity’s success/bankruptcy.

In 1966 Altman selected a sample of 66 corporations, out of which 33 have filed the documentation for bankruptcy in the last 20 years and 33 did not. The size of the share capital for all corporations varied from $1 million to $26 million, approximately $5 million to $130 million [1]. Altman has calculated 22 financial ratios, the same for the 66 corporations (for bankrupted companies, he used the financial situations issued one year before the bankruptcy). His purpose was to choose a small number of such ratios which could at best distinguish between a bankrupted or a healthy company. In order to do this selection, Altman used a statistical technique, namely the discriminant analysis. This approach allowed to emphasize their characteristics and proportions which can be used at best to determine in which category is encompassed each corporation: bankruptcy versus non-bankruptcy, rich versus poor, etc. The advantage of the model is that many characteristics may be combined in one single purpose. A low score implies the appurtenance to a group, a higher score implies the appurtenance to another group, and a middle score creates uncertainties related to the membership group. Eventually, in order to test the model, Altman calculated Z-scores for new groups of bankrupted and non-bankrupted companies. For non bankrupted companies he chose the corporations which reported deficits in the past years. His purpose was to discover how Z-score could better distinguish between companies with recovery potential and companies without chance to be recovered. Altman found out that 95% of the insolvent companies were correctly classified as in condition of bankruptcy and approximately 80% of the non-insolvent companies were correctly classified as being non insolvent.

The American professor E.I. Altman has elaborated in 1968 one of the first functions of score used in the analysis of the bankruptcy risk [1]. The function used by Altman has the following form:

\[ Z = 1,2 * x_1 + 1,4 * x_2 + 3,3 * x_3 + 0,6 * x_4 + 0,999 * x_5 \]  

(2.2)

The used ratios are as follows:

- \( x_1 \) = Working capital / Total assets  
- \( x_2 \) = Retained earnings / Total assets  
- \( x_3 \) = Earnings before interest and tax / Total assets  
- \( x_4 \) = Market value of equity / Total liabilities  
- \( x_5 \) = Sales / Total assets

Subsequently, Altman developed the model from 1968 by elaborating a z-function for manufacturing private firms and for non manufacturing firms [3]. In order to classify companies held in private property, Altman revised the initial score model and substituted the market value of its own share capital for the book value. This modification significantly changed the weighting coefficients for all other ratios:

\[ Z = 0,717 * x_1 + 0,847 * x_2 + 3,107 * x_3 + 0,42 * x_4 + 0,998 * x_5 \]  

(2.3)

For z values lower than 1,3 the companies are heading for bankruptcy, the gray area (uncertainty) is 1,3-2,9, and scores above 2,9 indicates that the companies are unlikely to enter bankruptcy.

The next modification made in z functions was the elimination of \( x_5 \) ratio. Altman considered that this ratio is sensitive to the type of industry, so the model is applicable to all branches [7].

The new score function has the form:

\[ Z = 6,56 * x_1 + 3,26 * x_2 + 6,72 * x_3 + 1,05 * x_4 \]  

(2.4)

The gray area is between 1,1 and 2,6, for values lower than 1,1 the companies are heading for bankruptcy and for values above 2,6 the companies are unlikely to enter bankruptcy.

Being a function defined 53 years ago, professor Altman continued to improve it, the last being published in 1993 in the second edition of the book "Corporate Financial Distress and Bankruptcy". Subsequent to this model of analysis have been elaborated several variants with applications in different industrial branches and with
a number of ratios ranging from 4 to 8. The basic function has 5 ratios and uses 8 variables of the companies’ financial situations.

Used variables:

- \( v_1 \) – Total Debt/ Total Assets (Earnings before interest and tax (correct interpretation for taxes being profit income);
- \( v_2 \) – Net sales / Total assets
- \( v_3 \) – Market value of equity / Total liabilities (Market value of equity /number of shares x market value of the shares);
- \( v_4 \) – Working capital / Total assets (Net working capital is calculated as the difference between current assets and current liabilities);
- \( v_5 \) – Retained earnings / Total assets (Retained earnings: retained profit; undistributed profit; reinvested profit).

Calculation relation:

\[
Z = 3.3 \times v_1 + 0.99 \times v_2 + 0.6 \times v_3 + 1.2 \times v_4 + 1.4 \times v_5
\]

(2.5)

Interpretation:

- \( Z < 1.5 \) : imminent bankruptcy;
- \( Z = 1.81 - 2.70 \) : liquidity deficit;
- \( Z = 2.71 - 2.99 \) : solvency, decreased risk;
- \( Z > 3 \) : increased solvency, inexistent risk;

We consider a set of data for two companies A and B with a view to exemplifying the modality of applying Altman model:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Company A</th>
<th>Company B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net fixed assets - Total</td>
<td>12,000 lei</td>
<td>10,000 lei</td>
</tr>
<tr>
<td>Working assets - Total</td>
<td>14,000 lei</td>
<td>9,000</td>
</tr>
<tr>
<td>Total assets / liabilities</td>
<td>20,000 lei</td>
<td>14,000 lei</td>
</tr>
<tr>
<td>Debts - Total, out of which:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short term liabilities (current)</td>
<td>13,000 lei</td>
<td>28,000 lei</td>
</tr>
<tr>
<td>Equity</td>
<td>9,000 lei</td>
<td>-2,000 lei</td>
</tr>
<tr>
<td>Profit and loss account (simplified)</td>
<td>SC A</td>
<td>SC B</td>
</tr>
<tr>
<td>Net turnover</td>
<td>130,000 lei</td>
<td>53,000 lei</td>
</tr>
<tr>
<td>Interest expenses</td>
<td>4,000 lei</td>
<td>4,000 lei</td>
</tr>
<tr>
<td>Gross result</td>
<td>11,000 lei</td>
<td>6,000 lei</td>
</tr>
<tr>
<td>Net result of the accounting period</td>
<td>5,000 lei</td>
<td>-2,000 lei</td>
</tr>
<tr>
<td>Other information</td>
<td>SC A</td>
<td>SC B</td>
</tr>
<tr>
<td>Earned profit</td>
<td>4,000 lei</td>
<td>0 lei</td>
</tr>
<tr>
<td>Earnings before interest and taxes (EBIT)</td>
<td>14,000 lei</td>
<td>9,000 lei</td>
</tr>
</tbody>
</table>

Working capital 3,000 lei -4,000 lei

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>VAR</th>
<th>SC B</th>
<th>SC B</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEBT / total assets</td>
<td>V1</td>
<td>0,423</td>
<td>0,680</td>
</tr>
<tr>
<td>Net sales / Total assets</td>
<td>V2</td>
<td>5,000</td>
<td>3,786</td>
</tr>
<tr>
<td>Market value of equity / total liabilities</td>
<td>V3</td>
<td>0,692</td>
<td>0,070</td>
</tr>
<tr>
<td>Working capital / Total assets</td>
<td>V4</td>
<td>0,115</td>
<td>0,290</td>
</tr>
<tr>
<td>Retained earnings / Total assets</td>
<td>V5</td>
<td>0,154</td>
<td>0</td>
</tr>
</tbody>
</table>

Bankruptcy risk ("Z" TEST) 6,452 3,120

The companies obtained above 3 points by applying Altman model, thus the bankruptcy risk is inexistent.

Canon – Holder model developed by the two authors is encompassed in the statistically tested methods [4]. The model is applied to industrial enterprises having 10 to 500 employees.

The model has as basis the following function:

\[
Z = 0.24 \times x_1 + 0.22 \times x_2 + 0.16 \times x_3 - 0.87 \times x_4 - 0.1 \times x_5
\]

(2.6)

Where:

- \( x_1 \) = EBE (Gross operating surplus)/Total debts
- \( x_2 \) = Equity/Total liabilities
- \( x_3 \) = Working assets- Stocks/Total liabilities
- \( x_4 \) = Financial expenses/ Turnover
- \( x_5 \) = Personnel expenses/ Net present value

Interpretation:

- \( z > 0.16 \) – situation of the enterprise: very good – probability of a risk bankruptcy lower than 10%
- \( 0.1 < z < 0.16 \) – situation of the enterprise: good – probability of a risk bankruptcy ranging 10%-30%
- \( 0.04 < z < 0.1 \) - situation of the enterprise: alert – probability of a risk bankruptcy ranging 30%-65%
- \( -0.05 < z < 0.04 \) – situation of enterprise: danger – probability of a risk bankruptcy ranging -65%-90%
- \( z \leq -0.05 \) – situation of enterprise: failure – probability of a risk bankruptcy ranging – over 90%

This model is similar to that elaborated by professor Altman, but emphasizes the internal sources of the company, not being constrained by psychological external factors as it does not take into consideration the market value. Or, it is known that market value is more a psychological value than an accounting value. From our standpoint this model reflects more accurately reality than the Altman model.

The model has been revised and has the following form:
\[ Z = 16 * v_1 + 22 * v_2 - 87 * v_3 - 10 * v_4 + 24 * v_5 \]  
\hspace{1cm} (2.7)

where:

- \( v_1 \) - (Debts + Cash and cash equivalent) / Current debts
- \( v_2 \) - Permanent capital / Total liabilities
- \( v_3 \) - Financial expenses / Turnover
- \( v_4 \) - Personnel expenses / Added value
- \( v_5 \) - Gross operating surplus / Added value.

Interpretation:
- \( Z < 3.99 \) : imminent bankruptcy;
- \( Z = 4.00 - 6.49 \) : liquidity deficit;
- \( Z = 6.50 - 8.99 \) : solvency, decreased risk;
- \( Z > 9.00 \) : increased solvency, inexistente risk.

3. Conclusions

"The method of scores" only provides with a highly reduced degree of fulfilment of a possible bankruptcy risk in the next period, period estimated at 2 years. Subsequently, the calculation of bankruptcy risk for a previous period longer than two years is useless. Just because at the date of carrying out this analysis and because is not in a bankruptcy condition, this can be a decisive fact. Each used ratio is weighted by a certain coefficient, coefficient which has been modified during years, depending on the importance which the financial specialists attached to different positions out of the financial situations and branch situations where the analysis is applied. Depending on the importance you attach, you can substitute the weights granted implicitly by the application by your own weights. Another issue which may arise in calculating scores is the type of used period: month, trimester, semester or year. If the risk bankruptcy shall be calculated taking into consideration the months at the beginning of the year, the bankruptcy risk shall be much higher than considering the second period of the year or the entire year. The explanation is simple: with high assets is carried out a decreased turnover and profit and only at the end of the year the situation is balanced when, practically, with the same assets increase the results, the turnover, etc. Or, it may occur the reverse phenomenon if there exist losses (with high assets you obtained decreased results). This issue regarding the fact of relating effects (results) in the first part of the year to increased efforts (assets) has repercussions on other indicators in the financial analysis, too.

It is recommended that in the analyses carried out during periods up to the 3rd trimester not to use bankruptcy risk. It can be insignificant for the activity developed and the obtained results. Instead, it can be taken into consideration if the comparison is made to data pertaining to concurrent companies, as the periods are comparable. In this case, shall be compared only the results of the test, without relating them to the risk margins, the company with the highest coefficient being in the best position in the comparative test between companies, even if the result encompasses it in a liquidity deficit condition.

Reference:

[4] Conan, Holder- Variables explicatives de performances et controle de gestion dans les P.M.I., Universite Paris Dauphine, 1979

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