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Actuality of Bankruptcy Prediction Models used in Decision Support System

M. Crăciun, C. Raţiu, D. Bucerzan, A. Manolescu

Mihaela Crăciun, Dominic Bucerzan
"Aurel Vlaicu" University of Arad
Faculty of Exact Sciences
Department of Mathematics-Informatics
România, 310330 Arad, 2 Elena Drăgoi
E-mail: qbt@rdslink.ro, dominic@bbcomputer.ro

Crina Raţiu
DARAMEC srl, Arad
România, Sofronea FN
E-mail: ratiu_anina@yahoo.com

Adriana Manolescu
Agora University, Oradea, Romania
Piata Tineretului nr.8, 410526
E-mail: adrianamanolescu@univagora.ro

Abstract:
In the current conditions, the global economy is in a crisis situation. In terms of crisis management this article supports the Romanian companies. This article analyses some classical bankruptcy prediction models used in Decision Support Systems in order to validate or invalidate them in the actual Romanian economical conditions. It is essential to take the right decision at the right time, to help the company overcome an eventual moment of crisis, such as insolvency or even bankruptcy. Our study is based on the financial ratio of 60 Romanian companies, between 2005 and 2009. The firms are classified in two categories: bankrupted companies (B) and non-bankrupted companies (N-B).
Keywords: bankruptcy prediction models - BPM, multiple discriminant analysis - MDA, decision support system - DSS, crisis management

1 Introduction

The economic crisis initially appeared in 2007, in the United States of America and Japan. It expanded to almost every country, becoming a global phenomenon, whose negative outcomes are also present in the Romanian economy. The crisis is the consequence of an economic boom, which lasted over 25 years and it emerged when Japan and the United States began to reduce interest rates to avoid recession, measure that lead to the increase of the asset price worldwide.

This article analyses some classical bankruptcy prediction models used in Decision Support Systems in order to validate or invalidate them in the actual Romanian economical conditions.

Here are a few aspects that triggered the economic crisis of 2008:

- February 1, 2007 – The law of increasing the minimum wage was passed (Fair Minimum Wage Act of 2007) fact that blocked investments and by default, loans;
- February 17, 2007 – British bank Northern Rock is nationalized;
- September 7, 2008 – the largest mortgage banks in the United States - Freddie Mac and Fannie Mae - are placed under federal supervision;

- September 16, 2008 – U.S. central bank Federal Reserve and U.S. government nationalized the largest insurance group in the world, American International Group (AIG), threatened with bankruptcy, and brought in aid of 85 billion;
- September 28th – Fortis Group is nationalized by the authorities of Netherlands, Belgium and Luxemburg, to avoid closing down;
- October 13th – Great Britain nationalized three banks: Royal Bank of Scotland (HBS), Lloyds and HBOS;
- December 1, 2008 – U.S. announces that it was a year in recession.

The economic crisis in Romania is mainly a domestic crisis caused by bad macroeconomic policies mix from recent years. The economic growth appears to be unhealthy because the domestic growth relied on consumption financed by debt. The flax tax of 16% has stimulated consumption, which was assured by imports and did not lead to the increase of production capacity of Romanian companies. Variants had to be found to stimulate domestic production and exports. Most consumption credits went to imports [8]. Vulnerabilities of an unbalanced economy, with many delayed structural reforms have now become obvious. The risk of bankruptcy is present and it grows. Considering this aspect, analysis of 165 bankruptcy prediction studies published from 1965 till present reveals trends in bankruptcy prediction models development. [7].

It is important that the difficulties in discharging obligations and the economic and financial structural fragility should be determined at an early stage in order to avoid the bankruptcy by declaring insolvency. The state of insolvency can be defined as an inability of companies to deal with outstanding payments, i.e. their inability to repay the borrowed sums on time as determined by mutual agreement with third parties under an economical contract or credit [9].

Even if the terms bankruptcy or failure are used to describe the different situations of companies in difficulty, it should be noted that bankruptcy is a process that begins financially and ends legally. In the following we intend to tap the first part of the statement.

It is hard to say precisely when the bankruptcy occurs. Current experience in bankruptcy prediction is based on several studies beginning with the Anglo-Saxon School (1960 - 1999), continuing with the Continental School who has made his mark between the years 1976 - 1999 and last, but not the least, the Romanian Schools 1996 to 2000. A reference model of the Anglo-Saxon School is the "Altman Model" while the "Anghel Model" represents the Romanian School. There were several methods to detect financial difficulties of the company. Altman and Anghel Models are based on the starting rates method for detecting financial difficulties of the enterprise. One of the important reasons in using the rates method is linked to the theoretical and practical developments that found connections between analysis using financial ratios and statistical techniques [1]. With financial ratios, we can compare the profitability of different sized companies from different branches [2]. Risk of bankruptcy can be determined by the so-called method of scoring. This is based on statistical techniques of discriminant analysis (DA). The score, as final of discriminant analysis, represents a method of diagnosis that consists in measuring and interpreting the future economic risks for the company. The method uses a group of significant financial ratios, resulting mainly from the annual financial statements.

2 Description of the Altman model (1968)

Altman is a reference name cited in studies concerning the prediction of bankruptcy. The model proposed by Altman considers a number of 22 potential variables (based on annual financial statements) grouped into five categories: liquidity, profitability, debt, solvency and activity.

In an article published in 1968 [1], Altman commented upon the traditional indicators and concludes that the analysis made by the researchers were unable to establish the relevance of the indicators. Altman describes how he uses statistical techniques and discriminant analysis (DA) to develop a model of financial indicators that provide enterprise bankruptcy.

In the model development, Altman has selected a group of 33 companies with financial problems; the sample included industrial (manufacturing) companies. Healthy business group companies were selected by the principle of similarity, to each of the bankrupt companies (size, industry, etc.) corresponded a healthy firm. From the initial list of 22 indicators, the author chooses the five most significant.

The first model built by Altman includes five variables, each having attached weights.

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \tag{1}$$

Where :

- X_1 = working capital/total assets,
- X_2 = retained earnings/total assets,
- X_3 = earnings before interest and taxes/total assets,
- X_4 = market value equity/book value of total liabilities,
- X_5 = sales/total assets,
- Z = overall Index or Score.

To make the model operational, the two groups of companies were analyzed and classified by Z score size, setting the two limits and the uncertainty (area between the two limits).

Altman's model works based on the following decision rules:

- $Z \leq 1.8 \Rightarrow$ imminent bankruptcy situation, the company is likely headed towards bankruptcy;
- $1.8 < Z < 2.99 \Rightarrow$ uncertainty;
- $Z \geq 2.99 \Rightarrow$ good financial situation, solvent companies; the firm is most likely safe based on the financial data. Of course, mismanagement, fraud, economic downturns and other factors may cause an unexpected reversal.

Later, Altman refined the model, the aim was to reflect, through the financial information the economic reality of the companies. He modified the variable X_4 substituting the market value with the book values of equity [4].

The following score function was obtained:

$$Z\prime = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5$$

The decision rules changed as followed:

- $Z\prime \leq 1.23 \Rightarrow$ imminent bankruptcy situation;
- $1.23 < Z\prime < 2.90 \Rightarrow$ uncertainty;
- $Z\prime \geq 2.90 \Rightarrow$ good financial situation.

Finally, from its previous models, which include a variable sensitive to the type of industry (X_5 = sales/total assets), Altman reviews the score function, retaining only four variables:

$$Z'' = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \ .$$

The decision rules became:

- $Z'' \leq 1.1 \Rightarrow$ imminent bankruptcy situation;
- $1.1 < Z'' < 2,6 \Rightarrow$ uncertainty;
- $Z'' \geq 2,60 \Rightarrow$ good financial situation.

3 Description of the Anghel model (2000)

The "Anghel Model" is the recent model developed by the Romanian School and it consist in building the function score model for the Romanian economy on multiple discriminant analysis (MDA). The score function consists of four variables, four parameters and one constant. To obtain the score function Anghel proposed the fallowing steps.

First step – Choosing the sample of companies divided in two groups: N-B group–companies without financial problems and B group - failed companies. His study is based on a sample of 276 companies from 12 branches of national economy. The companies were selected randomly. The information for each enterprize was taken from the annual financial statements for the period between 1994-1998.

Step 2 – A comparison is made over time period based on a set of significant indicators for the two groups of companies. Anghel analysis 20 financial indicators to see which of them covers a particular interest for the companies and divides them in: rates of activity, rates of liquidity, rate debt, rates of return and other economic and financial information.

Step 3 – Selecting indicators that make the best discrimination. Following the selection phase he chooses the following four financial variables: revenue performance, coverage of debt to cash flow, leverage the asset and period for payment of obligations.

- X_1 – earning after taxes/incomes;
- X_2 – Cash Flow/total assets;
- X_3 – liability/total assets;
- X_4 – (liability/sales)·360 .

Step 4 – Development through discriminant analysis technique of A linear combinations of relevant indicators X_i. In case of the two groups of previous assumptions there is a function representing the best discrimination B versus N-B. Based on economic and financial information since 1998 for a total of 276 Romanian companies it was build the A score function:

$$A = 5.676 + 6.3718X_1 + 5.3932X_2 - 5.1427X_3 - 0.0105X_4 \ . \tag{2}$$

Step 5 – Choosing a point (or points) of inflection which makes predictive classification of companies in the two groups. Computing the A score for each enterprize from the sample and sorting ascending the information obtained for the A score results a situation for all companies.

Step 6 – A-priori analysis of the success rate of A score by comparing the predictive classification with the known situation of companies in the sample. The assessment is based on the following classification:

- $A \leq 0 \Rightarrow$ imminent bankruptcy situation;
- $0 < A < 2.05 \Rightarrow$ uncertainty;
- $A \geq 2.05 \Rightarrow$ good financial situation.

Step 7 – A-posteriori analysis of the success rate of the function A by analyzing the degree of relevance for another sample of companies.

A sample of companies was considered, separated in the two groups B and N-B, and the subject of analysis was the prediction accuracy that the function A performs. The sample used to validate the proposed model includes 55 companies, 28 from the N-B and the other 27 from group B. Companies in the test sample were similar in size and industry sectors with the initial sample.

Under these conditions the prediction success rate similar to the a-priori, the author report a prediction with the value of 97.8%. This allowed the assessment that the score A was effective and could be applied to companies in the Romanian economy (retaining the limits in order to built the model).

4 The applicability of the Anghel and Altman models in the actual crisis conditions

In this paper we test the suitability of the statistical models in key economic context changes during the period between 2006 and 2010. Our hypothesis is that the functionality of the models of a previous period is questioned by the specific economic conditions in a time of crisis.

To test the applicability of the models in the actual economic conditions we proceed as follows.

First of all, we select groups of companies. Companies were chosen from a population of 200 Romanian companies, at random. The data collected is real; the Romanian companies used in our study exist and operate. We worked with a sample of 60 companies classified into two groups:

- Group 1 – non-bankrupt companies, see table position 1-30;
- Group 2 – bankrupt companies, see table position 31-60.

Analysis retains information for 2005-2009.

The second step is related to the classification of the companies presented in table. Classification was done according to the indicators resulting from the annual financial statements.

The next step consisted in computing the financial ratios of companies.

In the Anghel prediction model, we used the following indicators:

- X_1 – earning after taxes/incomes;
- X_2 – Cash Flow/total assets;
- X_3 – liability/total assets;
- X_4 – (liability/sales)·360 .

In the Altman prediction model we used as statistical indicators the following:

- X_1 = working capital/total assets,
- X_2 = retained earnings/total assets,

- X_3 = earnings before interest and taxes/total assets,
- X_4 = market value equity/book value of total liabilities,
- X_5 = sales/total assets

In this paper we test two models listed as: the Altman prediction model which is a reference model in the literature and the Anghel bankruptcy prediction model which is the latest Romanian model.

As a next step we calculated the score functions from the two prediction models, as follows:

- the Angel's score function (2);
- the Altman's score function (1).

Please note that the calculation of coefficients in the Anghel model was performed according to the author notes [5]. The model coefficients in Altman's model were calculated according to his details [1].

For the table the meaning of the heading table is the following:

- Year - represents the year for which the prediction is made;
- P - the current situation (related to year 2009) for the company: N-B or B;
- ET/I - represents the ratio Earning after Taxes / Incomes;
- CF/TA - represents the ratio Cash Flow / Total Assets;
- L/TA - represents the ratio Liability / Total Assets;
- (L/S)·360 - represents the ratio (Liability/Sales)·360;
- A - represents the results of the Anghel score function;
- AN - represents the prediction of Anghel's model;
- Z - represents the results of the Altman score function;
- ALT - represents the prediction of Altman's model.

In columns AN and ALT the symbol "U" represents uncertainty.

No.	Year	P	ET/I	CF/TA	L/TA	$(L/S) \cdot 360$	A	AN	Z	ALT
1	2006	N-B	0.356	0.029	0.765	777.708	-4	B	2	U
2	2009	N-B	0.001	0.205	0.786	181.925	1	U	2.4	U
3	2009	N-B	-0.026	-0.002	0.903	729.009	-7	B	2	B
4	2009	N-B	-0.444	0.008	1.168	1078.548	-14	B	0	B
5	2008	N-B	0.053	0.255	0.987	76.220	2	U	9	N-B
6	2009	N-B	-0.379	-0.006	1.342	1031.039	-15	B	0	B
7	2009	N-B	-0.562	0.019	1.403	855.857	-14	B	0	B

8	2008	N-B	0.307	0.987	0.107	13.907	12	N-B	11	N-B
9	2008	N-B	0.038	0.462	0.738	45.367	4	N-B	5	N-B
10	2009	N-B	-1.673	-0.047	0.997	2871.865	-41	B	0	B
11	2006	N-B	0.043	0.001	1.175	770.832	-8	B	2	B
12	2009	N-B	0.255	-0.002	0.142	214.982	4	N-B	4	N-B
13	2005	N-B	0.026	0.001	0.316	322.215	1	U	3	U
14	2009	N-B	-0.502	-0.006	1.590	1170.032	-18	B	0	B
15	2009	N-B	-1.410	-0.027	2.654	1219.977	-30	B	-4	B
16	2009	N-B	-0.039	0.000	1.166	692.457	-8	B	1	B
17	2009	N-B	0.013	0.011	1.474	533.522	-7	B	2	U
18	2009	N-B	-2.576	0.032	1.498	2710.456	-47	B	-1	B
19	2009	N-B	-0.492	0.139	1.675	425.326	-10	B	0	B
20	2009	N-B	-0.073	-0.005	1.550	266.427	-6	B	2	U
21	2009	N-B	0.011	-0.007	0.996	260.631	-2	B	2	U
22	2005	N-B	-0.947	0.165	0.575	16249.367	-173	B	1	B
23	2008	N-B	0.550	0.994	0.049	10.577	14	N-B	16	N-B
24	2006	N-B	0.030	0.149	0.474	41.178	4	N-B	5	N-B
25	2006	N-B	0.378	-0.047	0.356	331.038	3	N-B	3	U
26	2009	N-B	0.028	0.004	1.295	156.400	-2	B	4	N-B
27	2006	N-B	0.070	0.155	0.590	124.184	3	N-B	3	U
28	2006	N-B	0.012	-0.001	0.130	141.843	4	N-B	5	N-B
29	2009	N-B	-0.806	-0.113	5.977	935.200	-41	B	-7	B
30	2008	N-B	0.126	1.486	0.128	6.800	14	N-B	7	N-B
31	2006	B	0.204	0.108	0.757	546.183	-2	B	1	B
32	2008	B	-0.104	-0.005	1.078	497.157	-6	B	1	B
33	2008	B	-111.611	-0.036	1.404	227585.775	-3103	B	-1	B
34	2008	B	-0.564	0.108	13.052	745.531	-72	B	-6	B
35	2008	B	-0.304	-0.001	0.784	260.837	-3	B	0	B
36	2009	B	-0.082	-0.045	1.911	732.504	-13	B	-2	B
37	2008	B	-0.043	0.000	1.014	455.619	-5	B	1	B
38	2009	B	-0.086	0.157	1.086	336.851	-3	B	1	B
39	2007	B	-1.741	-0.001	1.294	2209.021	-35	B	-1	B
40	2009	B	-0.154	0.084	1.207	551.230	-7	B	1	B
41	2005	B	-4.503	0.277	4.306	1892.400	-64	B	-11	B
42	2008	B	-1.101	0.727	10.073	6276.031	-115	B	-10	B
43	2009	B	0.006	0.291	0.994	520.669	-3	B	1	B
44	2007	B	0.017	0.001	0.985	423.434	-4	B	1	B
45	2007	B	-0.478	-0.212	1.051	1921.361	-24	B	0	B
46	2008	B	0.136	-0.002	2.317	347.256	-9	B	0	B
47	2009	B	-3.694	-0.050	0.906	6164.473	-88	B	-1	B
48	2008	B	0.066	0.019	0.502	259.779	1	U	2	B
49	2008	B	-0.055	0.000	1.082	254.628	-3	B	1	B
50	2009	B	-0.121	-0.016	1.216	288.245	-4	B	1	B
51	2009	B	-0.359	-1.091	1.999	257.014	-15	B	-0.358	B
52	2008	B	-190.552	-3.129	9.518	60004.8	-1904	B	-36	B
53	2008	B	0.437	0.025	0.591	955.082	-4	B	1	B
54	2008	B	0.124	0.001	0.873	327.058	-1	B	2	B
55	2009	B	-1.997	0.000	1.428	3233.721	-48	B	-1	B
56	2006	B	-1.431	-0.022	6.249	3129.140	-69	B	-5	B

57	2007	B	-0.122	-0.093	2.037	843.028	-15	B	1	B
58	2009	B	-1.765	-0.021	1.135	770.342	-20	B	-2	B
59	2006	B	-4.244	0.004	2.467	2624.353	-62	B	-5	B
60	2009	B	-5.192	1.024	3.639	2469.939	-67	B	-7	B

After processing the data presented above, we obtained results about the success rates of the prediction models and types of errors that appear in the analysis. We processed the data in order to obtain the prediction both with Anghel's and Altman's model. We obtained the following success rates for the total sample: in Anghel's case we got a success rate of 63.33% and in Altman's model the success rate was 65%. Both rates are unsatisfactory when compared to the success rates reported in initial studies. Anghel's model report a success rate greater than 97% and in the Altman's model the success rates were: 93.9% for N-B companies and 97% for B companies.

Note that, due to the dynamic economy, the success rate obtained with Anghel's model drops from 97% to 63.33%. This leads to the idea that scoring function built in year 2000 cannot accurately predict the health of the company in the present.

In case of the success rates for N-B companies the rates obtained are unsatisfying. In the Anghel model the success rate is 30% while the Altman's model for N-B yields a success rate of 30%.

The next result is related to the analysis of error rates for the companies in the sample, by applying the two prediction models. Here we refer to "type I" errors (B companies classified as N-B) and "type II" errors (N-B companies classified as B). This error classification is done according to [9]. "Type II" errors are less significant. After the analysis, from Anghel's model we obtained "type I" errors 0%, "type II" errors 60% and total errors 30%. In the Altman model we obtained the following results: 0% for "type I" errors, 43.33% for "type II" errors and 21.67% for total errors.

5 Conclusion and Future Works

The changes from the economic and social life such as the inflationary phenomena, the increased competition, the technological progress, the political environment and the economic and financial crisis, more or less influence the business outcome that is always subjected to different risks: financial policy risk, operational risk, and the risk of bankruptcy.

Analysis of accuracy of the bankruptcy prediction models suggests that multivariate discriminant analysis and neural networks are the most promising methods for bankruptcy prediction models [7].

The Altman study included a sample of 66 companies, 33 in each group. The bankrupt group (group 1) recorded failure during 1946-1965. Average assets of the sample companies were $ 6.4 million, with values between $ 0.7 million and $ 25.9 million. The non-bankrupt group (group 2) includes companies with assets between $ 1-25 million, which continued to operate in year 1966, too. The period considered for analysis was 1946 - 1965 (20 years) [3]. The source of information was Moody's Industrial Manual.

The Anghel study of building A score for the Romanian economy is based on a sample of 276 companies from 12 branches of national economy. Companies were selected randomly. The information for each company was taken from the annual financial statements for the period between 1994 and 1998. In the verification sample the success rate was 97.8%.

The models presented in this paper obtained a satisfying result for the economic period in which the models were developed. But taking into consideration our study on a sample of

companies from the present unstable economic environment we cannot recommend to use the two models mentioned above as a tool for predicting bankruptcy.

A well designed decision support system is a must have tool in the success of any enterprise. This aspect is very important considering the current economic crisis. For this purpose, our article analyses some classical bankruptcy prediction models used in Decision Support Systems in order to validate or invalidate them in the actual Romanian economical conditions.

Taking into consideration the conclusions of this study, our future work will focus on updating the score function proposed by Anghel and Altman to the current economic conditions. The purpose is to obtain an external diagnostic method that predict the risk to which the investor, the creditor and the company are exposed and ensures an optimal relation between outcome and risks on the Romanian economic market environment.

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