Comparative Analysis using Bankruptcy Prediction Models. An online computer-based system

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Abstract: Bankruptcy in general, and especially bankruptcy prediction models, have always been of great interest for both specialists and theoreticians. Though several computerized systems that allow automated bankruptcy prediction models exist, very few of them are available online. Therefore, in the current paper we propose an online computer-based system that allows a comparative analysis using Romanian and international bankruptcy prediction models which analyze and give further direction to a small or medium-sized enterprise that is interested in being studied. In the authors' opinion, the innovative feature of this system is developed by combining three technologies: web, spreadsheet and expert systems. Thus, the computer based model is accessed throughout a webpage (hosted on an Apache virtual server), is developed using Exsys Corvid and reads variables from two spreadsheet files. The website can be accessed at the following address: *http://feaa-c-24.feaa.uaic.ro/bankruptcy/index.html*.

Key-Words: - bankruptcy comparative analysis, bankruptcy prediction models, bankruptcy, SMEs, computer-based system, web technology, spreadsheet

1 Introduction

Interest in the broader area of bankruptcy, and in particular in bankruptcy prediction models, had been extensively confirmed by the increased number of materials published worldwide and nationwide (Romania). Therefore, the specialized literature, both international and domestic, provides laborious information about different types of bankruptcy prediction models.

In the process of writing the current paper, we have been wondering about the reason why the bankruptcy prediction models have not been better used in the business area and we have agreed that one possible explaination could be the complexity involved in reaching the model results. Given our conclusion, and bearing in mind the present massive use of computers, we believe that the prediction models can be made available to everyone interested, through computer based systems (CBS) that incorporate the difficult formulas. Thus, we strongly believe that this may be the right time for computerized prediction models to have their due success.

In light of the above information, the main aim of the article is to select the models that can be applied at SMEs level, to group and implement them into two different systems and finally, to make them accessible through the World Wide Web. Technologically speaking, the two different systems are developed in Exsys Corvid and each of them uses a spreadsheet file that contains the numerical values of the variables involved in determining prediction models. The two systems (based on domestic and foreign bankruptcy prediction models) are included on a webpage that is available online. The underlying motivation of the system that we are hereby proposing is that in our research of the published literature in the field, including online publications, we have not found an appropriate computer-based online system that allows, in a comparative manner, the check a SMEs situation with respect to its bankruptcy state.

2 Problem Formulation

In order to develop the computer-based system, it is required to identify the foreign and domestic bankruptcy models and to select those that are the most representative and, more significantly, that can be applied at the Small and Medium-sized Enterprise level.

2.1 Bankruptcy prediction models

The pioneers of bankruptcy prediction models are Beaver (1966) [1] and Altman who, in 1968, developed

the model that bears the latter's name. Almost all models that are considered in this paper are developed by using specific statistical techniques, namely univariate and multivariate approaches or step-wise multiple discriminate analysis. Step-wise multiple discriminate analysis [2] gives weight to the system of financial ratios used in order to differentiate or discriminate failed enterprises from successful enterprises that are being analyzed. In all cases, many ratios are used and also sufficient companies are studied in order to obtain an accurate model. For instance, the Altman model uses a system of 22 ratios and 66 companies out of which 50% were successful and 50% were bankrupted. Ultimately, after many experiments, the final model will contain a much smaller number of ratios and the most important characteristic of the model is given by its accuracy rate. To exemplify our argument, in the case of the Altman model, the final model contains 5 ratios and the rate of accuracy is considered high, namely 95%. The Fulmer model started from a set of 40 ratios based on 60 companies and the final model incorporates only 9 ratios and has an accuracy rate between 98-81%, depending on the predicted length of time.

2.2 Foreign bankruptcy prediction models

Starting with 1966, many authors were interested by the area of bankruptcy and, more precisely, by the possibilities of prediction such an unwanted economic phenomenon. Therefore, a long series of models, that predict the bankruptcy imminence, have been developed. Altman model (USA, 1968), Altman, Haldeman and Narayanan (USA 1977), Springate model (Canada, 1978), Fulmer model (USA, 1984), Blasztk system (Canada, 1984), CA-score (Canada, 1987) are only few of the traditional prediction models present as a historical approach. From a country specific approach [3], the specialized literature names the following studies on prediction models: for U.K., in 1977, by Taffler and Tisshaw; for France, in 1974, by Altman and others; for Spain, in 1988 by Fernandez; for Argentina, in 1988 by Swanson and Tybout; for Belgium, in 1982 by Verbaere&Ooghe (the study was published in 1985) and for Romania, in 1996 by Mânecuță and Nicolae.

When we commenced designing the system, we have thoroughly studied the above mentioned models and choose those that best fit the comparative analysis of SMEs bankruptcy situation. Thus, we decided to use Conan-Holder, Altman and National Bank of France models to form the foreign prediction system that we included in our CBS.

2.3 Romanian bankruptcy prediction models

In Romania, the pionnering authors in the field of bankruptcy prediction models were Mânecuță and Nicolae who, in 1996, developed the first score function [4] using Pearson correlation coefficient-as statistical method. We have not included this model in our CBS because the authors clearly stated that it cannot be used for enterprises that belong to a highly competitive area such as that of SMEs. Therefore, the system that we have developed for the domestic comparative system of our CBS is made out of three models, namely the models designed by Băileşteanu, Ivonciu and Anghel. As the international models are widely available and very well known, we will only focus on the Romanian models. First, Băileşteanu [5] developed the following model (1):

$$B=0,444*X_1+0,909*X_2+0,0526*X_3+0,0333*X_4+1,414 \quad (1)$$

The B score has the following signification:

- $B < 0,5$ – bankruptcy
- $0,5 < B < 1,1$ – high financial risk zone
- $1,1 < B < 2,0$ – medium financial risk zone
- $B > 2,0$ – financially appropriate zone

The ratios used in the model stand for:

- X_1 = general liquidity rate
- X_2 = solvability rate
- X_3 = clients' rotation rate
- X_4 = cost profitableness

The second model is used in the CBS belongs to Ivonciu [6] and has the following formula (2):

$$I=0,333*X_1+5,555*X_2+0,0333*X_3+0,714229*X_4+1,333*X_5+4,0*X_6-1,66032 \quad (2)$$

When $I<0$- bankruptcy is imminent

$0 \le I \le 1,5$–high bankruptcy risk with a 64-81% probability

$1,5 \le I \le 3$-uncertainty situation, with a bankruptcy probability of 46-64%

$3 \le I \le 4,5$-there is a medium risk of bankruptcy with a probability of 29-46%

$4,5 \le I \le 6$-low bankruptcy level with a 12-29% probability

$I>6$-shows a good financial state and the bankruptcy probability is very low (0-12%).

The ratio system in Ivonciu model represents:

- X_1 = total assets rotation speed
- X_2 = total income profitableness
- X_3 = debt rotation
- X_4 = debt reimbursement capacity
- X_5 = fast liquidity rate
- X_6 = financial stability limit

The third and the last model used in the domestic comparative analysis belong to Anghel [7]. It is the most recent prediction model in the Romanian literature and has the following formula (3):

$AN=5,676+6,3718*X_1+5,3932*X_2–5,1427*X_3–0,0105*X_4$ (3)

When AN<0,0 shows a high bankruptcy risk and, at the opposite pole, is the situation when AN>2,05 and it illustrates that the analyzed enterprise has a favorable financial state.
We consider that Anghel model is the most representative Romanian score function as it has one of the highest accuracy rates (97%).

3 Problem Solution

The first step in developing the system consisted in installing the Appache2TRIAD[8] software, which is a distribution of some of the most popular open-source servers that allows one to develop and provide web content by using Windows as the operating system. Once the Appache web server was installed, we developed the webpage which is currently available at http://feaa-c-24.feaa.uaic.ro/bankruptcy. The web server hosts the Corvid systems and makes it available via the options displayed on the right pane, namely the links to the two systems of comparative bankruptcy prediction model - foreign and domestic prediction models systems (Fig.1).

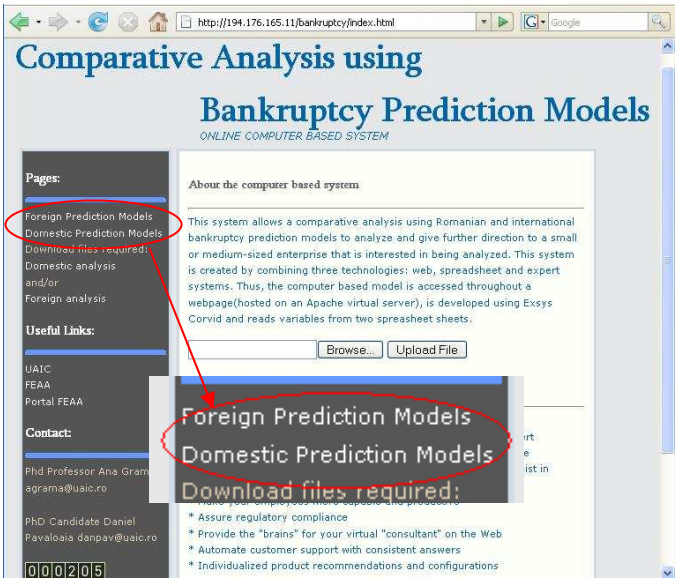

Fig.1 The index page of the online CBS

The code of the index page was modified and made compatible in order to allow the Corvid Applets to be run under the web server. For more examples regarding the HTML codes, please contact the authors as there are space limitations that did not allow the inclusion of HTML code examples in this article.
In order to run the application, the user needs to follow three steps. First, users need to upload the spreadsheet files, available for download on the right side of the index page (Fig.1). Second, they need to update the files with the proper information regarding their business (the variable values required by the ratios). Third, they need to upload the two files on the web server by using the form available on the index page (Fig.1). Once all these steps are completed, they can start running the systems.

3.1 Implementation of the bankruptcy prediction models

The two prediction systems based on foreign and Romanian prediction models were developed by using Exsys Corvid. The numerous numbers of variables that the two systems require acquire their values from a spreadsheet file that is integrated in Exsys Corvid.

3.1.1 Implementation of the Romanian prediction model by using Exsys Corvid

In order to implement the prediction models, we have developed a system in Exsys Corvid that is made up of numerous variables. All of these variables are connected through logic blocks that perform the reasoning of the system. For instance, Băileşteanu's score function (1) is implemented in a logic block illustrated in Fig.2.

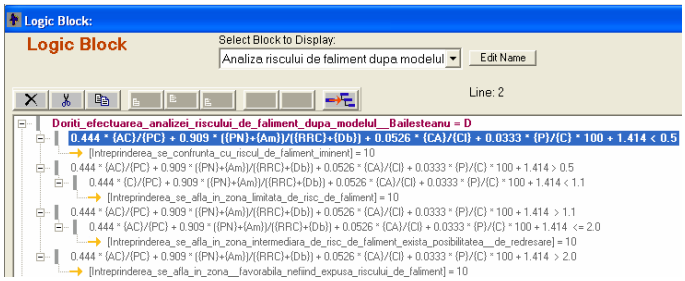

Fig.2 The logic block that contains Băileşteanu's score function

The rationing logic, in Exsys Corvid, can also be seen as production rules. Fig.3 illustrates one of the branches of the logic block presented in Fig.1, namely the one that defines the favorable situation by using the Bailesteanu model (for the case when B score has a value > 2).

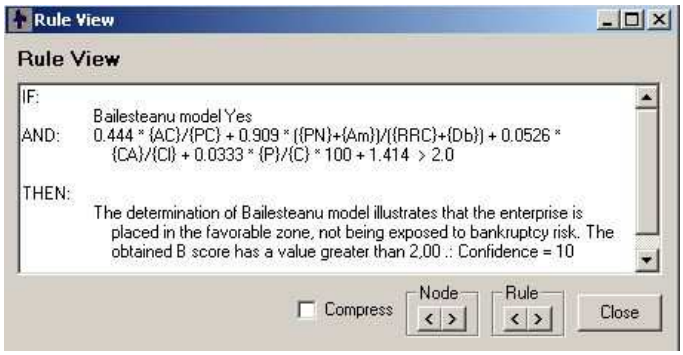

Fig.3 An example of production rule for Bailesteanu's model

The models that determine the value of score functions were similarly implemented for the cases of Ivonciu and Anghel models. Thus, the domestic prediction system has a total of three logic blocks, one for each model, and the variable's values that are required for model calculation are all read from an external file, namely a spreadsheet file (see Fig.4).

	A	B	C	D	E	F	G	H	I	J	K
1	AC	PC	PN	Am	RRC	Db	CA	Cl	P	C	VRAT
2	1230000	1230000	1450000	450000	560000	89600	10000000	400000	1500000	9000	2
3											
4	PVT	VRCT	CRDT	LR	MRSF	V	CF	A	O	D	
5	600000	2	500000	800000	3	1500000	750000	1000000	680500	500000	

Fig.4 The structure of the external file *Tabel_extern.xls*

When users select, from the index page, to use the domestic prediction model, they need to select the model to be applied. In Fig.5 the screen contains the three options that users have. The light color frame from that page is directly run by Exsys Corvid through a Java Applet.

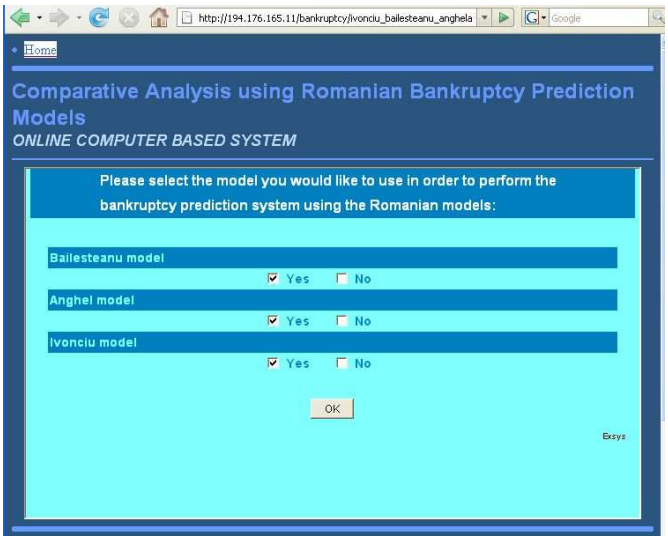

Fig.5 The main screen for Romanian prediction model

Once users have made their selections (in our case we opted for the analysis of all three models), Exsys reads the spreadsheet file (presented in Fig.4), obtains all the values required by the model's variables and infers the conclusions (Fig.6).

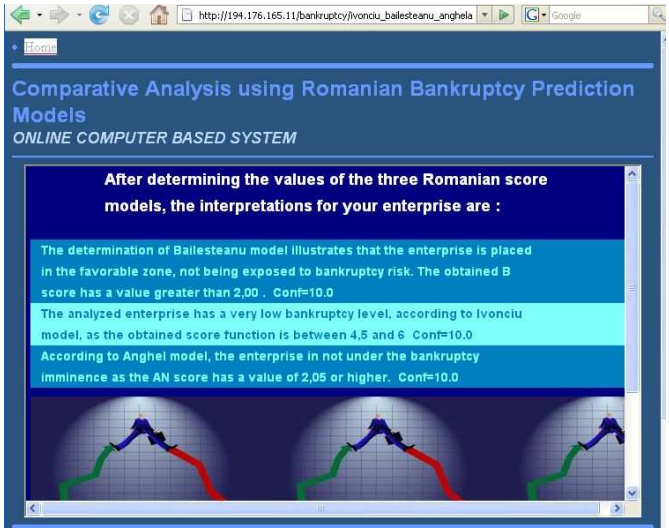

Fig.6 The interpretations obtained by using the Romanian prediction model CBS

3.1.2 Development of the foreign prediction model

As far as the implementation of the foreign bankruptcy prediction models are concerned, the technical procedure is very much similar to the one illustrated for domestic prediction model. However there are particular features, which mainly refer to the models used and their formula. For instance, the logic block (followed by the production rule view) that implements the rationing for the Conan-Holder model can be seen in Fig.7.

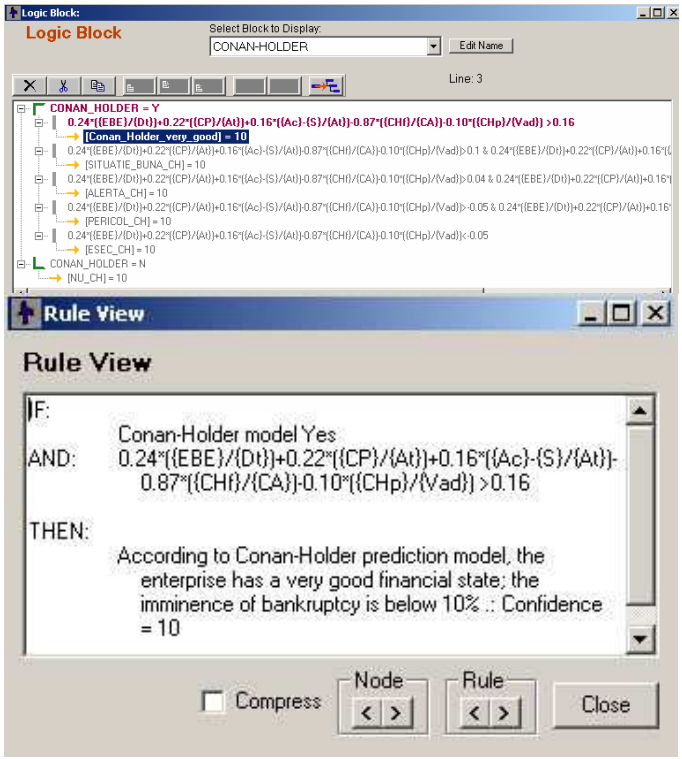

Fig.7 The Conan-Holder logic block and production rule

If users select, from the index page (Fig.1), the foreign prediction model link, then the screen presented in Fig.8 appears.

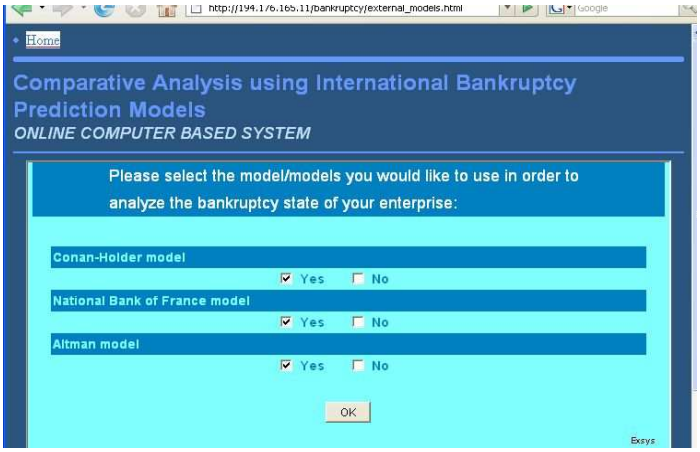

Fig.8 The main screen of the foreign prediction models' link

When all the three models are selected, Exsys Corvid system, through the Java Applet integrated in the web server, applies the rationing implemented in the logic blocks and reads the required variable values from the external file, presented in Fig.9.

	A	B	C	D	E	F	G	H	I
1	EBE	Dt	CP	At	Ac	S	CHf	CA	CHp
2	50000	105000	60000	90000	35200	10000	10000	100000	20000
3									
4	Vad	CAF	SMF	CMF	Vad1	Cc	Inv	Vad0	
5	45000	16800	60000	200000	45000	80000	324	42000	

Fig. 9. The external spreadsheet file required by the domestic prediction models system

The interpretation of the three international models that we used is presented in fig.10 and it reflects the enterprise's financial values (fig.9). Once can notice that the enterprise analyzed is in good shape as all three models show that there is no bankruptcy risk (Conan-Holder) or a very low bankruptcy risk (Bank of France).

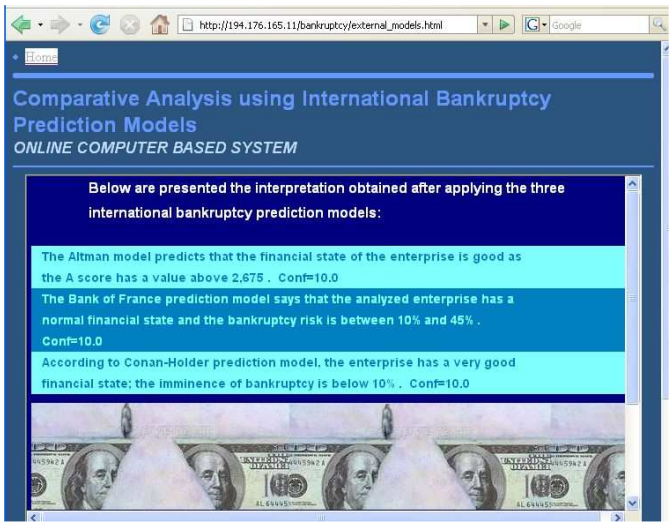

Fig.10 Interpretations obtained according to the international bankruptcy prediction models system

Mention should be made of the fact that the final screen contains special formatting instructions that allow information to be properly displayed on page. Fig.11 offers an example of the code for the final screen, reproduced in Fig.10.

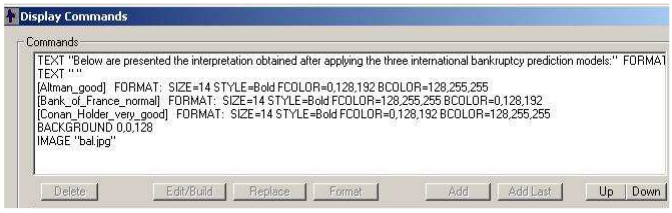

Fig.11 The formatting instructions contained by the result's screen

4 Conclusion

The Romanian bankruptcy prediction models are quite recent (Mânecuță and Nicolae, 1996) [4] in comparison with the first model that was developed in 1966, in the USA. In light of this information we can conclude that the issue of using prediction models continues to be a very topical study. For any enterprise, irrespective of its size, its financial state and bankruptcy imminence are extremely valuable information. Unlike multinationals and other large corporations, small and medium-sized enterprises do not have sufficient funds to implement sophisticated systems such as Enterprise Resource Planning and others that could signal out when their financial situation is far from normal. Therefore, we have considered it relevant to propose such an online computer-based system that would allow any SME to check its financial state and predict its bankruptcy situation. Moreover, the system allows a comparative analysis since it uses, for both domestic and foreign

systems, three models that are applicable at the SMEs level.

As we have stated in the current article, in order to develop the system, we have combined three technologies: web, expert systems and spreadsheet. We used Appache to create the web server and via HTML code, we have developed all pages of the website, including the pages that contain the Exsys Corvid Java Applet. Exsys software and its services enable businesses, government and organizations to distribute a company's most valuable asset, namely its expert knowledge to the people that call for it. All of these Exsys features are made available through powerful interactive Web-enabled expert systems [9] that can solve numerous problems and assist in the process of decision making.

With respect to the bankruptcy prediction models we point out that, in the specialized literature, there have been oppinions according to which, all the models, elaborated over the years, *are innacurate* as they *were developed using highly questionable methods and data*[11]. Other authors [12], starting from the question *Have Financial Statements Become Less Informative?,* elaborated a study in which they collected evidence regarding the ability of financial ratios to predict bankruptcy and they formulated a set of interesting results. Other interesting oppinions, related the issue of bankrutcy prediction models, were formulated by Hillegeist and others which assessed whether two popular accounting-based measures, Altman's (1968) Z-Score and an O-Score derived from Ohlson (1980), effectively summarize publicly-available information about the probability of bankruptcy. There are other interesting approaches [14],[15],[16],[17],[18] but we only mentioned the above in order to illustrate that the topic is quite variante and still exciting for researchers.

Though the specialized literature contains very variate oppinions related to the topic of bankruptcy prediction models, we stringly believe that this is an issue that is worth studying. Therefore, as further research directions, we plan to develop the current system in the following manner:

- to allow a three year comparative analysis based on prediction models;
- to improve the models, especially the foreign ones, by adapting them better to the specific conditions of the Romanian economic system;
- to add more models, and
- to perfect the upload option in order to restrict the user to upload only the necessary file type(.xls) and implement other security triggers.

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