PREDICTION OF CORPORATE BANKRUPTCY IN ROMANIA THROUGH THE USE OF LOGISTIC REGRESSION

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Abstract *The purpose of this paper is to test weather data from synthetic financial statements publically available in Romania can be employed within a logistic regression model to accurately predict the corporate bankruptcy probability over the economic crisis period.*
The population initially subjected to our study included all the 26,980 companies from the Timis County that submitted financial statements for 2007 to the public authorities. As this population proved very heterogeneous, we focused on a more homogeneous group, composed of 4,327 companies. The target population was chosen by employing both economical and statistical criterions.
The data from the synthetic financial statements was used to build 12 ratios, 5 of which have proven to be significant within a logistic model for predicting corporate bankruptcy.
It was clear that other sources of information could help improve the accuracy of the predictions, but these sources are not easily accessible to most of the stakeholders. As the synthetic financial statements are publically available, evaluating their utility in the prediction of corporate bankruptcy was one of the main objectives of this research.
The proposed model offers an in-sample overall 70.3% accuracy in the prediction of the bankruptcy event over a 5 – year period, with an out of sample overall accuracy of 67.6%.
Under these circumstances, the model is considered to be of immediate practical utility, as it can represent a tool for performing a fast estimation of the bankruptcy probability of a company that fits the profile of the target population.
As theoretical contributions, the research proves that the companies that filed for bankruptcy during the crisis period showed signs of weaknesses before the beginning of the crisis. Financial ratios that show relevance in the prediction of corporate bankruptcy at local level have been identified and their correlation with the bankruptcy probability has been evaluated. The model is expected to maintain its accuracy with minimal or no additional calibration for companies from the entire Romanian economy that fit the profile of the target population.

Keywords: *bankruptcy; financial statement analysis; economic crisis; logistic regresion; accuracy rate.*

JEL classification: *G33, C21, M41.*

1. Introduction

At the present time, Romania has just over 1 million active companies. All statistics show that the occurrence of the economic crisis has increased the failure risks at corporate level. Reports of the National Trade Register Office show a growth in the number of corporate bankruptcies in the first 2 years following the acknowledgement of the economic crisis in Romania, with a moderate decrease in 2011 and 2012.

Reports of the National Bank of Romania reflect a continuous increase of the rate of non-performing loans in the corporate sector nationwide, placing Romania on the 4th position within the EU, and on the 5th position worldwide (in a list of only 70 countries published by the International Monetary Fund).

Accepting the idea that the economic crisis has increased the failure frequency, it was assumed that the companies for which the failure risks have materialised showed particular weaknesses. The current research was set to determine whether signs of such weakness were reflected in the synthetic financial statements of the future bankrupt firms before the beginning of the economic crisis.

The population initially subjected to our study contained all companies from the Timis County that submitted financial statements to the Public Finance Administration in 2007 (26.980 companies).

”Company failure” was defined as the declaration of bankruptcy according to the Romanian law of bankruptcy. In this research, the authors focused on the occurrence of bankruptcy during the crisis period (2008 – 2012).

2. Methodology

The literature in the field of bankruptcy prediction offers a large variety of models after the elaboration methods:

- discriminant analysis (Altman E., 1968);
- hazard models (Schumway T., 2001);
- stationary financial distress models (Emel Kahya and Panayiotis Theodossiou, 1999);
- logistic regression (Mine Ugurlu and Hakan Aksoy, 2006).

Other models (Adnan A., Dar H., 2006) include artificially intelligent expert system models, univariate models, linear probability models, probit models, cumulative sums models, partial adjustment processes, recursively partitioned decision trees, case-based reasoning models, neural networks, genetic algorithms, rough sets models. The most popular statistical methods in the prediction of corporate bankruptcy (Hatem B. et al., 2005) are discriminant analysis and logistic regression.

In order to find a relation between available financial indicators in 2007 and the event of bankruptcy between 2008 and 2012, the method of logistic regression has been chosen (also known as logit). After scatter plot inspection of the relation between the 20-quantiles (vingitiles) of the independent variables and the bankruptcy rate, the variable *Ewc (Equity working capital)* was detected to present a u-shape relation. To count for this u-shape relation, both *Ewc* and its square should be entered in the model. All the other variables have been hypothesized to affect the bankruptcy probability linearly or, at least, monotonically. The relationship between *Ewc* and the Bankruptcy rate is described in Chart 1.

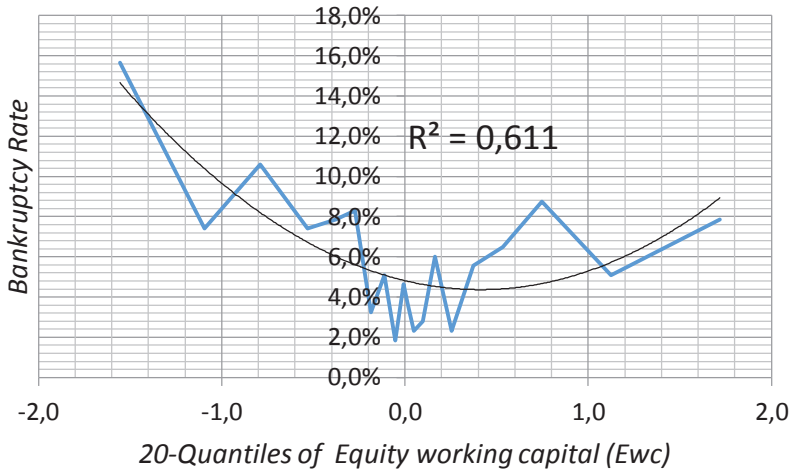

Chart 1: U-shape relation between Equity working capital (Ewc) and Bankruptcy Rate

3. Population

The population initially subjected to analysis included all companies in the Timis County (Romania) that submitted financial reports for 2007. Thus, data from 26,980 companies was evaluated, 1,933 of which would go bankrupt within the 2008 – 2012 period.

No new companies have been included over the crisis period, so specified numbers refer only to companies active at the end of 2007 which became insolvent in the following five years.

Of the non-bankrupt firms, 6,108 (24.4%) registered no sales in 2007 while 13,129 (52.4%) registered losses, thus consuming equity. Of the entire non-bankrupt population, 30.1% had no employees (7,549 companies) and 33.0% had public arrears (8,275 companies).

Of the bankrupt firms, 345 (17.8%) registered no sales in 2007 while 973 (50.3%) registered losses. Of the entire bankrupt population, 22.4% had no employees (433 companies) and 5.1% had public arrears (98 companies).

Preliminary evaluation of the data suggested important lack of homogeneity, which demanded for a more focused analysis.

After making adjustment for missing observations and unreasonable values, several filters have been applied in order to increase the level of homogeneity in the target population. Companies reporting values of *Atr, Fatr, Icr, Crcp, Far, Ewc* and *Roe* outside ±1.5* interquartile range from Tukey's Hinges have been removed in order to reduce extreme and mild outliers which we consider to be standard procedure. However we think that the interval of ±3* interquartile range also deserve much attention even if not analysed here. Companies with a negative *Ar* have also been removed. Regarding profitability, only companies with *Pr* between 0 and 50% have been retained. Even if this filtering procedure may be rightly criticised for keeping for estimation only a comfortable around mean population we think however that it

makes sense and useful insights may be obtained if further compared with other, more extreme, group of companies.

Table 1: Data selection process

Data sets	Description	Number of companies active at the end of 2007	Decrease - relative to the initial population	Number of companies insolvent in 2008 -2012
Initial Population	All companies from Timis county which submitted financial reports for 2007	26,860	-	1,907
Adjusted Population	Companies with missing observations and unreasonable values were removed	16,158	40%	1,315
Target Population	Fatr, Far, Icr, Crcp, Ewc and Roe within +/- 1.5* Interquartile Range; Ar>0; 0<Pr<50%	4,327	84%	266

4. Explanatory Variables

The selection of the financial ratios that would be tested for their prediction of bankruptcy capacity was done considering the recommendations of the literature, as well as the limitations of the data available. In this matter, the attention of the authors was not focused on obtaining all data recommended by existing literature. The main purpose of the research was to test if the public financial data existent in Romania can be used efficiently in the estimation of the bankruptcy probability through a loggit model.

We thus used the financial data of the Timis County companies that was publicly available to build 11 ratios.

Table 2 Ratios tested as explanatory variables

No	Ratios	Symbol	Formula
1	Fixed assets turnover ratio	*Fatr*	Sales / Fixed Assets
2	Inventory conversion ratio	*Icr*	(Inventory / Sales) x 360
3	Costumer receivables collection period	*Crcp*	(Receivables / Sales) x 360
4	Fixed assets ratio	*Far*	Fixed Assets / Total Assets
5	Current assets ratio	*Car*	Current Assets / Total Assets
6	Autonomy ratio	*Ar*	Equity / Total Assets

No	Ratios	Symbol	Formula
7	Debt ratio	*Dr*	Debt / Total Assets
8	Solvency ratio	*Sr*	Total Assets / Debt
9	Equity working capital (100,000 RON)	*Ewc*	Equity - Fixed Assets
10	Profitability ratio	*Pr*	Net profit / Sales
11	Return on equity	*ROE*	Net profit / Equity

Our initial hypothesis was that a high total assets turnover ratio is associated with high return on assets (Liesz, 2002) and, as a consequence, with high profits, high autonomy ratio and low bankruptcy risks.
In addition, high total assets turnover ratios should have the potential of generating economies of scale, thus stimulating the profitability ratio, the second factor that determines the level of the return on assets in the Du Pont view.
First tests performed on the initial population suggested differently: the average total assets turnover ratio for bankrupt firms (0.99) was superior to the average total assets turnover ratio for the healthy firms (0.78).
The fixed assets turnover ratio is an indicator of the efficiency of the fixed assets management. Financing sources invested in fixed assets take a longer period of time until recovery, while their recovery is subjected to higher risks. We thus hypothesized that low fixed assets turnover ratios generate liquidity problems, and would therefore be positively correlated to the bankruptcy risk.
On the other hand, companies with financial difficulties would be expected to take different measures to regain proper liquidity, including the sale of fixed assets. From this perspective, low values of the fixed assets and high values of sales at low profitability ratios and long costumer receivables collection periods could be positively correlated to the bankruptcy risk.
The inventory conversion ratio represents an estimation of the period that begins with the acquisition of raw materials or merchandise and ends with the sale of finished goods / merchandise. A high inventory conversion ratio forces the company to hold large values of inventory at each moment. This is expected to be correlated with a high working capital need, which could be financed from working capital or from short – term financial debt. We hypothesised that high inventory conversion ratios generate liquidity problems and involve higher debt ratios.
The costumer receivables collection period is a ratio that attempts to estimate the average duration in which the receivables are being collected from costumers. It is calculated based on the hypothesis of the uniformity of sales and collections throughout the duration of the year. A long collection period induces higher trade credit, thus affecting in a negative manner liquidity.
A study performed by Don B. Bradley III and Michael J. Rubach (Bradley III D., Rubach M., 2002) on 131 American companies filing for bankruptcy indicated that 66% of the studied population accused the difficulties in cashing the receivables as an important cause of their financial problems. The conclusion of the study is that failure to collect trade credit stands for an important factor of bankruptcy, alongside with general poor management of the working capital.

The literature (Bradley III D., 2004) mentions working capital problems as an important cause of bankruptcy, especially in the case of small and medium size companies.
The fixed assets ratio reflects the percentage of the fixed assets in the total value of the assets. Seen in the view of the financing process, this ratio shows the proportion in which the financing sources were invested in long-term resources. The long-term resources would be exploited for a long period of time and would release the financing sources gradually, over their economic lifespan.
We hypothesized that high fixed assets ratios would induce rigidity, making it for the company harder to adapt to changes that affect the volume of activity. In order for the financing sources invested in fixed assets to be fully recovered in the form of cash, the fixed assets need to be exploited at maximum capacity over their economic lifespan. A decrease in the level of activity (generated for example by a decrease of market demand) could keep a part of the financing sources invested in fixed assets from ever being recovered.
At the same time, fixed assets usually generate fixed costs, which increase the breakeven point and with it, the operating risks.
The current assets ratio reflects the percentage of the current assets in the total value of the assets. Ignoring the existence of prepaid expenses, the some of the fixed assets ratio and the current assets ratio is equal to 1.
We believed that higher current assets ratios / lower fixed assets ratios would be associated with lower probabilities of bankruptcy, based upon the assumption of a higher flexibility of the investments made by the company.
The autonomy ratio shows the percentage of equity in total financing sources. The autonomy ratio and the debt ratio are perfectly correlated, as the autonomy ratio = 100% - the debt ratio. Under these circumstances, we decided to only use the autonomy ratio for further testing. Based on the principle of the financial leverage, a company should raise its debt ratio if it would have the capacity to generate a sustainable positive difference between its return on assets and the cost of debt. For an indebted company, the return on assets should allow the coverage of the cost of debt, while the liquidity of the assets in which the debt was invested should allow for sufficient cash flows to make the principal payments. We expected a lower autonomy ratio / higher debt ratio to be associated with higher bankruptcy frequency.
The solvency ratio shows the capacity of the total assets to cover the total debt. It is correlated to the autonomy ratio and the debt ratio and thus is expected to be lower for bankrupt companies.
The profitability ratio shows the capacity of the sales to generate profits. Low profitability ratios could be a cause for cash-flow problems, as the profit represents an important factor in the generation of cash. On short-term, we also take into account the possibility of cash-flow problems leading to low profitability ratios, as the company could reduce the profitability ratio in an attempt too boost sales. On a market that is significantly price-sensitive, low prices could be one of the main factors for increasing sales. Low prices would sustain low profitability ratios, but high sales could convert in scale economies (with positive impact on the profitability ratio).

5. Results

As the fixed assets ratio and the current assets ratio are strongly correlated, only the fixed assets ratio was put to further use in the research. In the same manner, from the autonomy ratio, the debt ratio and the solvency, only the autonomy ratio was retained.
The selection procedure of the significant discriminant variables is basically a one step approach. Firstly the logit regression is estimated including all the candidate variables *Fatr, Crcp, Far, Ar* and *Ewc* proved to be significant at the 0.05 significance level. On the other hand *Icr, Pr* and *Roe* fail the significance test at the 0.05 level and thus are excluded.
The estimated model has the following form:

$$P(Bankruptcy = 1) = \frac{1}{1 + e^{-z}}$$

Where:

$$Z = a + b_1 Fatr + b_2 Crcp + b_3 Far + b_4 Ar + b_5 Ewc$$

The estimated coefficients, Wald test and e^{β} values for the estimation sample are presented in the following table.

Table 3 Variables in the Equation

	b	Standar Error	Wald Test	df	Sig. (p-value)	e^b	95% Confidence interval for e^b	
							Lower	Upper
Fatr	-0.031	0.013	5.563	1	0.018	0.969	0.944	0.995
Crcp	0.004	0.001	9.036	1	0.003	1.004	1.001	1.006
Far	-3.155	0.623	25.619	1	0.000	0.043	0.013	0.145
Ar	-2.198	0.474	21.495	1	0.000	0.111	0.044	0.281
Ewc	-0.302	0.153	3.885	1	0.049	0.739	0.548	0.998
Const.	-0.853	0.379	5.059	1	0.025	0.426		

Because *b* coefficients are difficult to interpret, e^b is computed. This value shows how many times the odds of bankruptcy are multiplied if the independent variable varies by one unit. The overall goodness-of-fit was tested by using the Hosmer-Lemeshow test. The test is chi-square distributed and is obtained by calculating the Pearson chi-square statistic on the observed and expected frequencies for ten groups of the predicted probability. The value of the test is 6.921 (p-value= 0.545) so the null hypotheses of equality between observed and predicted frequencies cannot be rejected. Another useful test is the difference between the values of -2Log Likelihood for the estimated model and a baseline model including only the constant. The value of the test, also chi-square distributed, obtained in our case is 109.99 (p-value =0.000) with five d.f.
The model may be further improved if the square of *Ewc* is added. As shown is Chart 1 *Ewc* has a U-shape relation with the probability. It follows that a quadratic transformation, *Q (Ewc), containing both Ewc and* Ewc^2*, will* generate a new variable variable which will relate the probability in a monotonic fashion. Indeed by adding Ewc^2

the pseudo R-square coefficient (Nagelkerke R-square) rise from 0.13 to 0.15 Another important change is that the *Ewc* loses significance, (p=0.89), in favour of Ewc^2 which is significant at all levels, (p=0.000).
An optimal cut-off point for the probability of 0.071 has been used. This value was estimated by optimizing the difference between sensitivity and the false positive rate (1-specificity).
The costumer receivables collection period shows a positive correlation to the bankruptcy probability in the proposed model, which suggests that higher bankruptcy probabilities are associated to the companies with high costumer receivables collection periods.
The fixed assets ratio, the fixed assets turnover ratio, the equity working capital and the autonomy ratio showed negative correlations to the estimated probability of bankruptcy, which suggests that high values of these ratios are associated with low bankruptcy probabilities.
In order to validate the model on a spatial out-of-sample basis, the companies from the target population have been randomly split in two approximately equal groups: estimation group (2165 companies) and validation group (2162 companies).
The model generated through logistic regression offers an in-sample overall 70.3% accuracy in the prediction of the bankruptcy event, with an out of sample overall accuracy of 67.6%. The accuracy rate on validation sample rises slightly to 67.9% if Ewc^2 is added.

Table 4 Classification Table

Observed		Predicted					
		Estimation sample			Validation sample		
		Company State		%	Company State		%
		Healthy	Bankrupt	Correct	Healthy	Bankrupt	Correct
Company State	Healthy	1432	592	70.8	1377	660	67.6
	Bankrupt	52	89	63.1	40	85	68.0
Accuracy Rate				70.3			67.6

As reflected in Table 5, some of the explanatory variables are correlated, but their independent effects on the bankruptcy probability justified their inclusion in the model.

Table 5 Correlations

Pooled Within-Groups Matrices									
		Fatr	Icr	Crcp	Far	Ar	Ewc	Pr	Roe
Correlation	Fatr	1.000	0.078	-0.067	-0.680	0.002	0.326	-0.129	0.118
	Icr	0.078	1.000	-0.058	-0.239	-0.266	-0.050	-0.278	-0.156
	Crcp	-0.067	-0.058	1.000	-0.200	-0.083	0.043	0.082	-0.051
	Far	-0.680	-0.239	-0.200	1.000	-0.001	-0.458	0.028	-0.101
	Ar	0.002	-0.266	-0.083	-0.001	1.000	0.462	0.522	-0.173
	Ewc	0.326	-0.050	0.043	-0.458	0.462	1.000	0.230	-0.013
	Pr	-0.129	-0.278	0.082	0.028	0.522	0.230	1.000	0.402
	Roe	0.118	-0.156	-0.051	-0.101	-0.173	-0.013	0.402	1.000

6. Conclusions

The fixed assets ratio, the fixed assets turnover ratio, the equity working capital and the autonomy ratio showed negative correlations to the estimated probability of bankruptcy, while the costumer receivables collection period was positively correlated to the estimated probability of bankruptcy.

The negative correlation between the fixed assets ratio and the bankruptcy risk is contrary to our initial expectations. A high fixed assets ratio involves the investment of a high percentage of the company's financing sources in long – term assets, leaving a low percentage of financing sources to be invested in current assets. While current assets are either in the form of cash, or they convert to cash in a short period of time, the conversion of fixed assets into cash takes years and it can only fully happen in the current assets are being constantly used at full capacity.

Data analysis showed that for the group of companies with fixed assets ratios lower that 40%, the bankruptcy frequency was higher than the average, while over the 40% fixed assets ratio limit the bankruptcy frequency became lower than the average. A possible explanation could be that companies with high current assets ratios have higher working capital needs which are associated in the literature with high bankruptcy risks. We were not able to verify the correlation between the current assets ratio and the working capital need due to lack of data.

The fixed assets turnover ratios proved to be negatively correlated to the probability of bankruptcy. The hypothesis that low fixed assets turnover ratios generate liquidity problems and are therefore associated with high bankruptcy risks is sustained by the results of the analysis.

The costumer receivables collection period is positively correlated to the bankruptcy probability, as initially suspected. The bankruptcy incidence is significantly lower than average for companies with costumer receivables collection periods lower than aprox. 30 days and higher for all the rest of the companies. In fact, the bankruptcy incidence is continously increasing as the costumer receivables collection period is becoming higher. This finding is consistent with the suggestions of the literature. From the financing point of view, high costumer receivables collection periods lead to large values of the receivables, which makes necessary the investment of additional financing sources in the operating cycle. From the liquidity point of view, high costumer receivables collection periods lead to the extension of the operating cycle, with negative impact on the cash-flows.

The costumer receivables collection period is calculated based on the assumption of uniformity of sales and collections throughout the year. Still, in many cases, the costumer receivables collection period is distorted by the existence of trade credits that are long overdue. Overdue tarde credits artificially increase the costumer receivables collection period, at the same creating cash – flow problems.

The economic crisis was responsible for important delays in the payment of trade credit, which led to increasments in the costumer receivables collection periods for many companies. Our findings show that companies with higher costumer receivables collection periods from before the economic crisis were more vulnerable to the bankruptcy risk.

The autonomy ratio is negatively correlated to the bankruptcy risk. Companies with autonomy ratios lower than aprox. 30% (which involve debt ratios higher that aprox. 70%) show higher than average bankruptcy risks.

The correlation between the autonomy ratio and the bankruptcy risk proved to be as initially expected. The bankruptcy state is characterised through the company's

incapacity of paying its debt. Higher leveraged companies are subjected to higher bankruptcy risks. At the same time, through the leverage effect, companies with high debt ratios and low autonomy ratios should have higher potential in terms of returns on equity. The return on the assets financed from debt should cover the cost of debt and allow a supplementary remuneration of the equity holders.

Primary analysis of the correlation between the autonomy ratio and the return on equity confirms a tendency of the return on equity increasing with the decrease of the autonomy ratio (and the increase of the debt ratio).

The last explanatory variable (the equity working capital) is negatively correlated to the bankruptcy risk. The bankruptcy risk decreases as the equity working capital increases. Still, very high values of the equity working capital are associated with higher than average bankruptcy risks. For this reason, we expect a U-shape function to be a better estimate of the relationship between the equity working capital and the bankruptcy probability than a linear one. Such a function will be tested in future research.

The equity working capital represents the equity that exceeds the fixed assets and thus remains available (after the coverage of fixed assets) for financing current assets. High values of the equity working capital are associated with high autonomy ratios and low fixed assets ratios.

The bankruptcy prediction model proposed through the use of logistic regression is considered to be of practical utility, as it is capable to accurately predict the bankruptcy event over a 5-year period. The model only employs financial data from the synthetic financial statements publically available in Romania.

Further research should test the model for companies from the other departments of Romania. We expect the model to maintain its accuracy with minimal or no additional calibration.

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