

ECONOMETRIC MODEL USED IN DECISION-MAKING PROCESS OF COMPANY FINANCING

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Abstract

Over time, SMEs financing resulted in many debates starting with the general economic background up to the correct interpretation of financial statements on which the financing decision is based. In a more restricted way, the financing decision is finding, in the most appropriate and fair manner, the correlations between financial data, and it concerns all Romania-based financial institutions, mindful of the lessons taught by the financial crisis, the new Basel III. Thus, banks have created internal rating models, proving the viability of the loan applicant by calculating the PD.

In this case study, we conducted an econometric modeling based on the logistic regression which, starting from a financial module consisting of 7 ratios, calculates the PD for a time horizon of 12 months, for a company applying for funding. The study highlights, both theoretically and practically, the advantages and the limits of econometric modeling. We used data from 25 Romanian-based companies, collected over a period of 4 years, from 2008 to 2011, resulting in a database consisting of 100 observations processed using the STATA statistical processing software. The results of the econometric model – the impact over the PD are interpreted and validated by calculating the odds ratio of PD.

Keywords: score function, logistic regression, credit, rating, probability of default (PD), SMEs financing

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1. Introduction

The research aims at elaborating an econometric model based on the logistic regression function, by which the creditor may determine the PD of a company, thus being able to take the correct financing decision. The article is divided into several parts, as follows:

In the first part, we make a brief presentation of previous studies in this field, the nowadays trends and the research methodology, in order to be able to theoretically and economically substantiate the econometric model.

The second part is the most consistent one, and it consists in a case study which analyzes 25 Romania-based companies, all operating in the field of transportation, over a period of 4 years, using 100 observations in order to calculate the PD. The econometric model is based on a financial module that comprises, in the author's opinion, the 7 most important financial ratios pertaining to company liquidity, solvability, profitability and activity. To make it more robust, the financial module has been transformed by means of normalizing one of the ratios and applying logarithms to another one. Then, we elaborated an OLS model based on the linear regression and we eventually made a logit model based on the logistic regression function. In order to interpret the logit function, we calculated the marginal effects and the result of the score function, which was then validated by calculating the likelihood of PD. All these were possible as the elaborated econometric model used the STATA statistical processing software.

The research ends with the presentation of the conclusions, of the model's limits and advantages.

2. Theoretical and Economical Substantiation of the Econometric Model Used in Taking the Financing Decision

For decades, specialists in the area, and especially those working in commercial banks and facing more or less demand from companies, have been interested in determining the Probability of Default (PD) and hence the lending decision. Even since the 60s, thorough studies in the area or alternatives

estimating business failure began to appear, such as the univariate and multivariate models elaborated by [Beaver, (1967)], [Altman, (1968)], by using certain financial ratios. While Beaver studied 14 financial reports, Altman used the Multiple Discriminant Analysis (MDA) in order to solve the problem of inconsistency related to Beaver's univariate analysis and to perform a much more complex financial profile of the companies studied. Thus, the multiple discriminant analysis has been used for many years by various authors, such as [Deakin, (1972)], [Edmister, (1972)], [Blum, (1974)], [Taffler și Tisshaw, (1977)], [Bilderbeek, (1979)], [Micha, (1984)], [Gombola et al., (1987)], [Lussier, (1995)], [Altman et al., (1995, 2005)], etc. Due to the limitations of this model (MDA), where the two basic assumptions of the model were breached, the ratios were standardized and they did not show the importance of the various variables, [Ohlson, (1980)] applied, for the first time, the conditional logit model in order to conduct the PD. The practical benefits of the logit methodology are that it does not require the restrictive assumptions of the MDA and it allows working with disproportionate samples. After him, most of the scholarly literature, such as the following authors: [Gentry et al., (1985)], [Keasey și Watson, (1987, 1991)], [Platt și Platt, (1990)], [Mossman et al., (1998)], [Charitou și Trigeorgis, (2002)], [Becchetti și Sierra, (2002)], used the logit models in order to predict the default of a company (PD).

Thus, a wide range of statistical methods may be used to make scoring functions, among which the most common and used over time were decision trees, neural networks and expert systems, linear regression and lately, logistic regression. This is how scoring models arose. They are used for calculating the probability of default by comparing the loan applicant financial ratios to the financial ratios of previously studied loan applicants, also taking into account how they behaved over the years in terms of loan repayment. Starting from the limitations of the scoring models used over time, nowadays the logistic regression is the method used mostly. The scoring model plays an important part in the loan granting or denying decision, as it is part of the lending policy practiced by each commercial bank.

In practice, the logistic regression is the most widely used method as it models the relation between a set of (categorical, continuous) independent variables and a (nominal, binary) dichotomous dependent variable which

usually appears when it indicates the affiliation to two categories (presence / absence, yes / no). Supposing that the values of the binary variable are coded 0/1, where value 1 generally expresses the occurrence of a certain event, it means that the result of the model is an estimate of the probability of this event actually happening, depending on the values of the independent variables.

Therefore, in this case study we assumed that the explanatory variables multiplied by the relevant coefficients are linearly correlated with the natural logarithm of the default rate [Mays, (2001)]:

$$\ln \frac{PD}{1-PD} = b_0 + \sum_{i=1}^n b_i X_i$$

(1)

where:

PD – probability of default of a company over a time horizon of 1 year,

x_i – company's financial ratios,

b_0 – constant,

b_i – coefficients of relevant financial ratios of the score function.

Generally speaking, the default is a borrower's failure to comply with the obligations undertaken in the loan contract signed with his creditor. The Basel Committee on Banking Supervisions (2006) defines the default as a situation in which at least one of the following events occurs:

- the bank determines that the borrower is unlikely to pay its obligations to the bank in full, without recourse to actions by the bank such as the realization of collateral;
- the borrower is more than 90 days past due on principal or interest on any material obligation to the bank.

In our case study, default will stand for the company's incapacity to meet its debt obligations / to pay the loans granted by the bank.

Eventually, calculating the PD means calculating a score, according to the formula (2) below, which normally determines the rating of each loan applicant and depending on this and on the classification in certain rating categories / intervals one also determines the probability of default over a 12 month horizon.

$$PD = \frac{1}{1 + e^{-b_0 - \sum_{i=1}^n X_i Y_i}}$$

(2)

Within the calculated score, the most important rating is (greatly) held by the financial ratios and that is why, further on, we shall only refer to these ones, as they can be precisely calculated and the results obtained are accurate and not influenced by subjective factors. Financial ratios are considered financial risk factors and together they make up the financial module, which is the most important when it comes to assess the customer risk. Financial ratios summarize the financial reports used to calculate a customer rating. Out of the important financial ratios, I chose 7 that I considered the most relevant and that I used as variables in order to see how they affect a bank's financing decision.

The 7 financial ratios taken into account and selected as components of the financial score module are:

a) from the solvency ratios category:

Gearing = [ST Interest Bearing Debt (ST Bank Loan + Other ST Loans) + LT Interest Bearing Debt (LT Bank Loans + Other LT Loans) – Cash & Bank Deposits] / Equity;

Gearing is a general term describing a financial ratio where the denominator is a form of capital belonging to the owner (or capital) and the numerator represents the borrowed funds. Gearing measures the effect of financial leverage, which demonstrates the degree to which the activities of a company are financed from funds of owner as compared to funds of creditor.

Leverage III = Debt / Assets;

Interest Coverage = EBITDA / Interest Expense;

b) from the profitability ratios category:

Return of Equity = net profit / equity;

EBITDA Margin = Earnings before interest, tax, depreciation and amortization / total revenues;

c) from the liquidity ratios category:

Quick Ratio = (Cash + ST Receivables) / Current Liabilities;

d) from the category of ratios showing the company's activity:

$$\text{Inventory Ratio} = \text{Inventories} / \text{Sales} \times 365.$$

Grading and the expected theoretical impact of the 7 financial ratios over the PD are presented in table no. 1.

Table no. 1: Financial ratios used in scoring model and their expected / assumed impact over the PD

Ratio	Definition	Notation	PD (Expected)
Gearing	$\frac{[\text{ST Interest Bearing Debt (ST Bank Loan} + \text{Other ST Loans)} + \text{LT Interest Bearing Debt (LT Bank Loans} + \text{Other LT Loans)} - \text{Cash \& Bank Deposits}]}{\text{Equity}}$	R12	+
Leverage III	$\frac{\text{Debt}}{\text{Assets}}$	LRL	+
Interest coverage	$\frac{\text{EBITDA}}{\text{Interest expences}}$	R14	-
Return of equity	$\frac{\text{net profit}}{\text{equity}}$	ROE	-
EBITDA MARGIN	$\frac{\text{Earnings before interest, tax, depreciation and amortisation}}{\text{total revenues}}$	Ebitda _margin	-
Quick ratio	$\frac{\text{Cash} + \text{ST Receivables}}{\text{Current Liabilities}}$	rli	-
Inventory ratio	$\frac{\text{Inventories}}{\text{sales}} \times 365$	Inventory _ratio	+

Source: author's compilation

In terms of economic theory, the interpretation of Table no. 1 shows that:

- liquidity ratios show the company's capacity to pay short-term debts and generally, higher liquidity equals a lower probability of default;

- solvency ratios show the company's capacity to pay long-term debts and generally, the higher the debt burden, the greater the probability of default of the company;
- profitability ratios show the company's capacity to make profit, and the higher this capacity, the smaller the PD;
- activity ratios show how efficiently the company uses various inputs, generally having different effects on the PD; the "+" sign showing that the higher the ratio, the higher the PD, while the "-" sign shows that the higher the ratio the smaller the PD.

3. Case Study Conducted by Applying the Econometric Model and Determining the PD of Romania-based Loan Applicants Activating in the Field of Transportation

In the case study below, we built an econometric model which calculates, based on a financial module considered a basic one and consisting of 7 financial ratios, the probability of default on a time horizon of 12 months, for a SME that applied for financing and that operates in the road transportation area.

According to this econometric model, it is assumed that the explanatory variables represented by the 7 financial ratios, multiplied by relevant coefficients, are linearly correlated with the natural logarithm of the default rate, so that by using the function (1) described in chapter 2 above, the amount of the left is called the logit transformation of the probability of default (PD).

Afterwards, this equation is used in order to obtain the formula of the probability of default. The formula may be transcribed using the logit curve by applying formula (2) presented above in chapter 2.

As to the financial score, financial ratios based on accounting data are considered as explanatory variables. The model uses a dummy dependent variable (0/1) built with value 1 for companies in default and with value 0 for viable companies, which means that the score obtained in the econometric model corresponds to the probability of a company to face default.

In the practical part of the case study we used data collected from 25 companies operating in the field of transportation, financed by a top Romanian-based European bank. The data were taken from the financial statements of the companies, processed by the bank during 2008 – 2011, and therefore we have a

database consisting of 100 observations (25 companies x 4 years = 100), that we are going to present in the tables bellow.

Table no. 2: Econometric model ratios for 2008

Company Id	Year	R12	R14	ROE	ri	Inventory _ratio	LRL	Ebitda _margin	Dummy variable 1 = default 0 = viable
		X	X	%		days	%		
1	2008	2.01	6.93	0.08	0.55	27.90	76.26	0.1239	0
2	2008	0.34	9.79	2.52	2.01	13.97	65.65	0.1450	0
3	2008	3.47	8.58	16.87	0.35	11.77	83.84	0.2128	0
4	2008	1.10	4.90	8.77	0.81	3.42	78.00	0.0890	0
5	2008	0.55	7.84	2.75	0.52	12.53	42.52	0.1044	0
6	2008	2.25	2.92	0.06	0.19	37.44	74.57	0.1750	0
7	2008	2.20	5.90	32.00	0.50	1.00	85.90	0.1150	0
8	2008	0.45	8.19	37.86	0.74	34.69	47.04	0.3401	0
9	2008	4.50	3.24	1.71	0.42	48.20	86.64	0.1107	0
10	2008	0.91	10.49	46.95	1.15	7.97	69.18	0.1156	0
11	2008	3.03	5.72	36.16	0.35	3.96	81.11	0.2725	0
12	2008	1.71	10.03	0.70	0.68	0.29	66.63	0.1233	0
13	2008	0.42	14.19	46.26	1.34	9.27	50.55	0.2001	0
14	2008	7.33	5.51	40.80	0.46	13.07	95.35	0.0395	0
15	2008	2.11	6.67	23.89	0.75	2.45	72.04	0.2902	0
16	2008	4.74	6.25	5.50	1.16	5.15	90.11	0.1914	0
17	2008	2.23	3.28	12.35	0.79	81.04	74.55	0.2062	0
18	2008	0.16	328.68	110.97	0.61	82.71	88.51	0.0552	0
19	2008	3.91	6.57	7.70	0.67	2.41	87.84	0.1997	0
20	2008	3.84	5.11	0.51	1.24	999.90	82.65	0.2207	0
21	2008	26.11	5.00	42.74	0.99	14.45	97.57	0.1671	0
22	2008	-1.36	4.39	81.16	0.64	237.71	78.34	0.3193	1
23	2008	1.83	10.77	11.31	0.76	13.94	73.16	0.1597	0
24	2008	3.34	10.76	13.90	0.76	6.13	96.55	0.0237	0
25	2008	4.19	3.35	55.28	0.13	119.89	91.73	0.1067	1

Source: author's compilations based on the companies' financial statements

Table no. 3: Econometric model ratios for 2009

Company Id	Year	R12	R14	ROE	rti	Inventory _ratio	LRL	Ebitda _margin	variable 1 = default 0 = viable
		X	X	%		days	%		
1	2009	2.59	10.71	-30.84	0.52	29.13	78.43	0.2017	0
2	2009	0.13	18.91	0.80	1.25	9.19	64.94	0.1918	0
3	2009	2.05	8.68	11.89	0.46	18.29	77.90	0.1904	0
4	2009	0.60	11.44	15.71	0.71	3.57	75.21	0.1400	0
5	2009	0.31	7.41	1.12	1.02	25.55	37.48	0.1341	0
6	2009	1.76	1.72	-20.21	0.14	38.24	71.74	0.0757	0
7	2009	2.50	4.70	17.50	0.90	3.00	81.30	0.1108	0
8	2009	0.78	5.51	8.31	0.46	89.01	58.48	0.2785	0
9	2009	3.22	4.33	0.46	0.40	93.70	85.76	0.1472	0
10	2009	0.50	12.51	8.03	1.25	8.89	63.33	0.0830	0
11	2009	1.73	6.47	6.26	0.39	22.24	73.78	0.2863	0
12	2009	1.93	3.71	-21.90	0.69	0.01	71.90	0.0688	0
13	2009	0.43	17.38	12.81	2.09	6.95	45.72	0.1492	0
14	2009	8.94	3.70	2.03	0.35	5.43	93.66	0.0363	0
15	2009	1.87	4.34	-22.42	0.64	3.79	73.82	0.3205	0
16	2009	6.50	0.07	-217.77	1.47	6.28	93.08	0.0017	0
17	2009	1.62	7.39	18.29	0.86	101.73	70.23	0.2863	0
18	2009	-0.09	94.25	94.47	1.05	68.44	76.73	0.0659	0
19	2009	2.98	6.87	59.98	1.38	1.33	82.99	0.2398	0
20	2009	6.41	2.94	16.94	1.51	12.70	90.59	0.1255	0
21	2009	17.20	5.66	51.59	1.30	13.99	97.61	0.1146	0
22	2009	0.32	33.82	53.24	0.15	253.05	65.97	0.2748	1
23	2009	1.93	6.68	0.43	0.75	14.25	73.69	0.1443	0
24	2009	1.03	12.08	79.18	0.75	3.17	85.33	0.0533	0
25	2009	1.45	4.71	45.95	0.26	106.60	84.56	0.1383	1

Source: author's compilations based on the companies' financial statements

Table no. 4: Econometric model ratios for 2010

Company Id	Year	R12	R14	ROE	rli	Inventory _ratio	LRL	Ebitda _margin	variable 1 = default 0 = viable
		X	X	%		days	%		
1	2010	2.17	6.63	22.83	0.68	27.61	74.24	0.1491	0
2	2010	-0.17	24.31	1.99	3.21	16.95	69.31	0.1328	0
3	2010	0.96	23.25	22.85	0.57	11.39	75.76	0.1785	0
4	2010	0.29	26.20	23.13	1.50	6.41	68.88	0.1627	0
5	2010	0.09	15.99	10.11	2.59	25.98	14.83	0.1622	0
6	2010	2.16	3.54	-7.03	0.35	28.40	75.88	0.1474	0
7	2010	2.40	4.57	0.31	0.69	4.58	81.17	0.1023	0
8	2010	0.58	4.65	2.83	0.83	46.02	48.50	0.1929	0
9	2010	2.31	7.69	0.17	0.31	75.35	84.13	0.1409	0
10	2010	0.76	13.62	7.79	1.59	11.32	65.81	0.0903	0
11	2010	1.09	10.80	12.78	0.48	7.64	61.00	0.2701	0
12	2010	1.58	2.32	3.18	0.74	3.80	69.27	0.1346	0
13	2010	0.11	11.96	16.42	3.40	7.66	22.59	1.2918	0
14	2010	8.54	4.18	4.64	0.36	8.09	92.39	0.0296	1
15	2010	0.82	8.51	24.40	0.83	6.48	59.75	0.2874	0
16	2010	3.68	7.47	36.25	1.07	2.86	90.94	0.1271	0
17	2010	1.23	6.80	9.36	0.75	116.11	66.43	0.2136	0
18	2010	-0.08	207.90	42.42	1.18	59.11	63.08	0.0687	0
19	2010	1.45	16.56	42.92	1.19	0.05	72.84	0.1695	0
20	2010	4.76	2.62	11.11	1.29	6.57	90.82	0.0526	0
21	2010	3.02	9.02	81.73	1.27	18.01	90.02	0.0971	0
22	2010	0.49	137.45	5.68	0.40	167.95	62.64	0.1865	1
23	2010	0.90	8.23	18.54	0.92	9.11	66.67	0.1157	0
24	2010	1.88	31.79	56.72	0.48	5.09	79.57	0.0425	0
25	2010	1.48	7.76	16.45	0.19	110.10	82.19	0.1315	1

Source: author's compilations based on the companies' financial statements

Table no. 5: Econometric model ratios for 2011

Company Id	Year	R12	R14	ROE	rit	Inventory _ratio	LRL	Ebitda _margin	variable 1 = default 0 = viable
		X	X	%		days	%		
1	2011	0.96	10.95	-1.64	0.94	20.49	72.30	0.3314	0
2	2011	-0.40	18.34	-0.94	2.72	8.36	77.83	0.0786	0
3	2011	1.18	14.54	22.23	0.28	18.27	72.57	0.1489	0
4	2011	0.73	19.11	19.13	1.23	13.45	73.60	0.1187	0
5	2011	0.42	155.48	25.48	0.99	24.77	39.19	0.1758	0
6	2011	1.76	3.59	8.29	0.36	12.93	70.51	0.1251	1
7	2011	3.09	4.61	0.69	0.76	5.63	83.44	0.0807	1
8	2011	0.42	5.09	8.77	1.15	47.40	66.48	0.1755	1
9	2011	4.15	8.67	0.31	0.22	85.18	92.29	0.1318	1
10	2011	1.69	7.86	4.16	2.62	11.16	72.63	0.0866	0
11	2011	0.82	17.77	40.58	1.03	14.90	54.08	0.2381	0
12	2011	1.13	3.22	1.74	1.66	2.79	69.46	0.0763	0
13	2011	0.40	12.52	23.39	2.00	3.04	39.92	0.1183	0
14	2011	6.56	6.09	12.45	0.66	6.37	93.36	0.0213	1
15	2011	0.23	14.04	46.18	0.84	2.98	45.85	0.2752	0
16	2011	2.20	12.10	12.05	1.29	1.51	85.94	0.1284	0
17	2011	0.61	8.51	25.03	1.32	107.72	57.51	0.2143	1
18	2011	-0.03	176.35	38.06	1.64	68.49	54.21	0.0771	0
19	2011	1.58	13.33	41.87	0.99	0.02	68.97	0.1640	1
20	2011	8.25	1.29	6.71	0.88	8.59	93.45	0.0295	1
21	2011	0.90	13.13	82.37	1.17	7.28	83.48	0.0778	0
22	2011	-0.10	135.80	65.67	1.07	13.54	52.13	0.1313	1
23	2011	0.26	18.28	49.29	1.08	16.47	54.05	1.4202	0
24	2011	-0.02	28.70	19.34	0.65	5.43	74.29	0.0317	0
25	2011	0.68	10.73	54.39	0.15	118.12	72.76	0.1253	1

Source: author's compilations based on the companies' financial statements

In order to estimate the PD using the econometric model made based on the seven financial ratios calculated according to the formula from table no. 1, three of the data used in the model were processed in relation with the initial data used so that the econometric model may become more robust, as follows:

- for the ratio R12 (gearing) we used the normalization calculated according to the formula:

$$\frac{\text{indicator} - \min}{\max - \min};$$

- for R14 (interest coverage) and Inventory_ratio (inventory ratio) a logarithm was used, because all the data of the sample are positive.

The data that resulted are presented in table no. 6.

Table no. 6: Ratios modified in order to estimate a more robust econometric model

Company Id	Year	R12 ¹	Ln R14 ²	ROE	rli	Ln Inventory_ratio ³	LRL	Ebitda_margin	dummy variable 1 = default 0 = viable
1	2008	0.122679	1.93586	0.0008	0.55	3.32862669	0.7626	0.123884186	0
1	2009	0.143793	2.371178	-0.3084	0.52	3.37176857	0.7843	0.20167876	0
1	2010	0.128504	1.891605	0.2283	0.68	3.31817803	0.7424	0.149099709	0
1	2011	0.084456	2.393339	-0.0164	0.94	3.01993696	0.723	0.33135922	0
2	2008	0.061886	2.281361	0.0252	2.01	2.63691217	0.6565	0.144992938	0
2	2009	0.054241	2.939691	0.008	1.25	2.21811594	0.6494	0.191780062	0
2	2010	0.04332	3.190888	0.0199	3.21	2.83026783	0.6931	0.132814508	0
2	2011	0.034947	2.909084	-0.0094	2.72	2.12345843	0.7783	0.078585481	0
3	2008	0.175828	2.149434	0.1687	0.35	2.46555392	0.8384	0.212766923	0
3	2009	0.124135	2.161022	0.1189	0.46	2.90635446	0.779	0.190392371	0
3	2010	0.084456	3.146305	0.2285	0.57	2.43273578	0.7576	0.178492328	0
3	2011	0.092465	2.676903	0.2223	0.28	2.90526037	0.7257	0.148889818	0

¹ for R12 (gearing) we used the normalization calculated according to the formula $\frac{\text{indicator} - \min}{\max - \min}$

² for R14 (interest coverage) a logarithm was used, because all the data of the sample are positive

³ for Inventory_ratio (inventory ratio) a logarithm was used, because all the data of the sample are positive

4	2008	0.089552	1.589235	0.0877	0.81	1.22964055	0.78	0.08896348	0
4	2009	0.071351	2.437116	0.1571	0.71	1.2725656	0.7521	0.139952818	0
4	2010	0.060066	3.265759	0.2313	1.5	1.85785927	0.6888	0.162747047	0
4	2011	0.076083	2.950212	0.1913	1.23	2.59897911	0.736	0.118671779	0
5	2008	0.06953	2.059239	0.0275	0.52	2.52812577	0.4252	0.104381733	0
5	2009	0.060794	2.00283	0.0112	1.02	3.24063732	0.3748	0.134137068	0
5	2010	0.052785	2.771964	0.1011	2.59	3.25732701	0.1483	0.162188142	0
5	2011	0.064798	5.046517	0.2548	0.99	3.20963324	0.3919	0.175762358	0
6	2008	0.131416	1.071584	0.0006	0.19	3.62273965	0.7457	0.174987698	0
6	2009	0.113578	0.542324	-0.2021	0.14	3.64388209	0.7174	0.075727769	0
6	2010	0.12814	1.264127	-0.0703	0.35	3.34638915	0.7588	0.147363991	0
6	2011	0.113578	1.278152	0.0829	0.36	2.55955019	0.7051	0.125071221	1
7	2008	0.129596	1.774952	0.32	0.5	0	0.859	0.114995491	0
7	2009	0.140517	1.547563	0.175	0.9	1.09861229	0.813	0.11078782	0
7	2010	0.136877	1.519513	0.0031	0.69	1.521699	0.8117	0.102289563	0
7	2011	0.161995	1.528228	0.0069	0.76	1.72810944	0.8344	0.080735391	1
8	2008	0.06589	2.102914	0.3786	0.74	3.54645146	0.4704	0.340144899	0
8	2009	0.077903	1.706565	0.0831	0.46	4.48874872	0.5848	0.278549883	0
8	2010	0.070622	1.536867	0.0283	0.83	3.82907608	0.485	0.192945957	0
8	2011	0.064798	1.627278	0.0877	1.15	3.85862223	0.6648	0.175454325	1
9	2008	0.213324	1.175573	0.0171	0.42	3.87535902	0.8664	0.110655492	0
9	2009	0.166727	1.465568	0.0046	0.4	4.54009819	0.8576	0.14722461	0
9	2010	0.1336	2.039921	0.0017	0.31	4.32214393	0.8413	0.140930394	0
9	2011	0.200582	2.159869	0.0031	0.22	4.44476666	0.9229	0.131751834	1
10	2008	0.082636	2.350422	0.4695	1.15	2.07568449	0.6918	0.115600541	0
10	2009	0.06771	2.526528	0.0803	1.25	2.18492705	0.6333	0.082969594	0
10	2010	0.077175	2.611539	0.0779	1.59	2.42657107	0.6581	0.090306188	0
10	2011	0.11103	2.061787	0.0416	2.62	2.41233596	0.7263	0.086617378	0
11	2008	0.159811	1.743969	0.3616	0.35	1.37624403	0.8111	0.27247194	0
11	2009	0.112486	1.867176	0.0626	0.39	3.10189247	0.7378	0.286290847	0
11	2010	0.089188	2.379546	0.1278	0.48	2.0333976	0.61	0.27007957	0
11	2011	0.079359	2.877512	0.4058	1.03	2.70136121	0.5408	0.238085732	0
12	2008	0.111758	2.305581	0.007	0.68	-1.2378744	0.6663	0.12334857	0
12	2009	0.119767	1.311032	-0.219	0.69	-4.6051702	0.719	0.068772236	0
12	2010	0.107026	0.841567	0.0318	0.74	1.33500107	0.6927	0.134613247	0
12	2011	0.090644	1.169381	0.0174	1.66	1.0260416	0.6946	0.076290623	0
13	2008	0.064798	2.652537	0.4626	1.34	2.22678338	0.5055	0.200140907	0

13	2009	0.065162	2.85532	0.1281	2.09	1.93874166	0.4572	0.149216328	0
13	2010	0.053513	2.481568	0.1642	3.4	2.03601198	0.2259	1.291761331	0
13	2011	0.06407	2.527327	0.2339	2	1.11185752	0.3992	0.118330417	0
14	2008	0.316345	1.706565	0.408	0.46	2.57031953	0.9535	0.039520992	0
14	2009	0.374954	1.308333	0.0203	0.35	1.69193913	0.9366	0.03632637	0
14	2010	0.360393	1.430311	0.0464	0.36	2.09062873	0.9239	0.029645477	1
14	2011	0.288315	1.806648	0.1245	0.66	1.85159947	0.9336	0.021322025	1
15	2008	0.12632	1.89762	0.2389	0.75	0.89608802	0.7204	0.290186501	0
15	2009	0.117583	1.467874	-0.2242	0.64	1.33236602	0.7382	0.320514902	0
15	2010	0.079359	2.141242	0.244	0.83	1.86872051	0.5975	0.287352024	0
15	2011	0.057881	2.64191	0.4618	0.84	1.0919233	0.4585	0.275196952	0
16	2008	0.22206	1.832581	0.055	1.16	1.63899671	0.9011	0.191389305	0
16	2009	0.28613	-2.65926	-2.1777	1.47	1.83736998	0.9308	0.001716722	0
16	2010	0.183473	2.010895	0.3625	1.07	1.05082162	0.9094	0.127118213	0
16	2011	0.129596	2.493205	0.1205	1.29	0.41210965	0.8594	0.12835303	0
17	2008	0.130688	1.187843	0.1235	0.79	4.39494286	0.7455	0.206249677	0
17	2009	0.108482	2.000128	0.1829	0.86	4.62232224	0.7023	0.286271492	0
17	2010	0.094285	1.916923	0.0936	0.75	4.75453802	0.6643	0.213634871	0
17	2011	0.071715	2.141242	0.2503	1.32	4.67953527	0.5751	0.21431985	1
18	2008	0.055333	5.795085	1.1097	0.61	4.41534051	0.8851	0.055162717	0
18	2009	0.046232	4.545951	0.9447	1.05	4.22595745	0.7673	0.065917945	0
18	2010	0.046596	5.337057	0.4242	1.18	4.07940011	0.6308	0.068747978	0
18	2011	0.048416	5.172471	0.3806	1.64	4.22668775	0.5421	0.077051427	0
19	2008	0.191846	1.882514	0.077	0.67	0.87962675	0.8784	0.199741918	0
19	2009	0.157991	1.927164	0.5998	1.38	0.28517894	0.8299	0.239794623	0
19	2010	0.102293	2.80699	0.4292	1.19	-2.9957323	0.7284	0.169474959	0
19	2011	0.107026	2.590017	0.4187	0.99	-3.912023	0.6897	0.163963795	1
20	2008	0.189297	1.631199	0.0051	1.24	6.90765527	0.8265	0.220710521	0
20	2009	0.282854	1.07841	0.1694	1.51	2.54160199	0.9059	0.125479425	0
20	2010	0.222788	0.963174	0.1111	1.29	1.88251383	0.9082	0.052608716	0
20	2011	0.349836	0.254642	0.0671	0.88	2.15059874	0.9345	0.029514364	1
21	2008	1	1.609438	0.4274	0.99	2.67069441	0.9757	0.167104498	0
21	2009	0.675646	1.733424	0.5159	1.3	2.63834279	0.9761	0.114592741	0
21	2010	0.159447	2.199444	0.8173	1.27	2.89092716	0.9002	0.097113755	0
21	2011	0.082272	2.5749	0.8237	1.17	1.98513086	0.8348	0.077787265	0
22	2008	0	1.479329	0.8116	0.64	5.47105144	0.7834	0.319335059	1
22	2009	0.061158	3.521052	0.5324	0.15	5.5335871	0.6597	0.274772835	1

22	2010	0.067346	4.92326	0.0568	0.4	5.12366632	0.6264	0.186483748	1
22	2011	0.045868	4.911183	0.6567	1.07	2.60564827	0.5213	0.131302436	1
23	2008	0.116127	2.376764	0.1131	0.76	2.63476241	0.7316	0.159747904	0
23	2009	0.119767	1.899118	0.0043	0.75	2.65675691	0.7369	0.144280193	0
23	2010	0.082272	2.107786	0.1854	0.92	2.20937271	0.6667	0.115675697	0
23	2011	0.058973	2.905808	0.4929	1.08	2.80154054	0.5405	1.420160397	0
24	2008	0.171096	2.375836	0.139	0.76	1.81319475	0.9655	0.02374333	0
24	2009	0.087004	2.491551	0.7918	0.75	1.15373159	0.8533	0.053291224	0
24	2010	0.117947	3.459152	0.5672	0.48	1.62727783	0.7957	0.042452448	0
24	2011	0.04878	3.356897	0.1934	0.65	1.69193913	0.7429	0.031725627	0
25	2008	0.202039	1.20896	0.5528	0.13	4.78657466	0.9173	0.106731695	1
25	2009	0.102293	1.549688	0.4595	0.26	4.66908351	0.8456	0.138343911	1
25	2010	0.103386	2.048982	0.1645	0.19	4.70138904	0.8219	0.13147669	1
25	2011	0.074263	2.373044	0.5439	0.15	4.77170106	0.7276	0.125328152	1
	average	0.13325	2.21488	0.19038	0.93890	2.51229	0.72595	0.17225	0.00000

Source: author's compilations based on the companies' financial statements

Afterwards, we built an OLS model based on linear regression, and the results are presented in table no. 7.

Table no. 7: Results of linear regression

Source	SS	df	MS		Number of obs	100
					=	
Model	3.3360599	7	.333722843		F(7, 92)	= 2.77
Residual	11.1039401	92	.120695001		Prob > F	0.0118
					=	
Total	13.44	99	.135757576		R-squared	= 0.1738
					Adj R-squared	= 0.1110
					Root MSE	= .34741
Score	Coef	Std. Err.	t	P > t	[95% Coef. Interval]	
R12	-.104073	.3421407	-0.30	0.762	-.783594	.575448
LRL	.0739799	.3084856	0.24	0.811	-.5386991	.6866589
R14	-.040036	.0449522	-0.89	0.375	-.129315	.049243
ROE	.1545935	.130882	1.18	0.241	-.1053493	.4145364
Ebitda margin	-.1203986	.2102282	-0.57	0.568	-.5379299	.2971328
rli	-.1036065	.0625121	-1.66	0.101	-.2277609	.0205479

Inventory _ratio	.0628169	.020355	3.09	0.003	.0223901	.1032437
constant	.1396044	.2875433	0.49	0.628	-.4314813	.7106902

Source: author's compilation using the STATA statistical processing software

By interpreting the results of the linear regression from table no. 7, we may conclude that for the calculated score function, the variables:

- inventory rate is significant for a significance threshold of 5% ($p=0.003 < 0.05$), and
- the current liquidity rate is significant for a significance threshold of 10 % ($p=0.101$).

However, the linear probability model has certain serious drawbacks⁴, such as:

- there are problems with the disturbance term. As usually, the value of the dependent variable of the observation has a nonstochastic component and a random component. The nonstochastic component depends on X_i and parameters. The random component is the residual term. Even if it is easy to calculate the nonstochastic component in the observation, because the distribution of the disturbance term has only two specific values (1 / 0), this means that the standard errors and the usual statistical tests are invalidated;
- another problem is that the predicted probability may be greater than 1 or less than 0 for extreme values of X_i .

Due to these disadvantages of the linear model, we built a logit model based on the logistic regression function, and therefore we present the results obtained in table no. 8.

⁴ Christofer, Dougherty. 2001. "Introduction to Econometrics", third edition, Oxford University Press

Table no. 8: Results of Logistic Regression and Significance Thresholds

Logistic regression Log likelihood = -31.466983					Number of obs =	100
					LR chi2(7) =	25.00
					Prob > chi2 =	0.0008
					Pseudo R 2 =	0.2843
Score	Coef	Std. Err.	z	P > z	[95% Conf. Interval]	
R12	1.009765	3.018666	0.33	0.738	-4.906712	6.926242
LRL	-2.185196	3.469383	-0.63	0.529	-8.985061	4.61467
R14	-.4077934	.3798857	-1.07	0.283	-1.152356	.3367689
ROE	1.742624	1.400063	1.24	0.213	-1.001449	4.486697
Ebitda margin	-9.607359	5.798962	-1.66	0.098	-20.97312	1.758398
rli	-1.772536	.92319	-1.92	0.055	-3.581955	.0368829
Inventory ratio	.8338336	.3062988	2.72	0.006	.2334991	1.434168
constant	.4434332	3.194651	0.14	0.890	-5.817967	6.704833

Source: author's compilation using the STATA statistical processing software

After interpreting the data from table no. 8 we may conclude that the last three variables (financial ratios) are the one significant for the model of estimation of the PD:

- Ebitda_margin (ebitda margin) that has a significance threshold of 10% ($p=0.098$);
- rli (quick ratio) that has a significance threshold of 5% ($p=0.055$);
- Inventory_ratio (inventory ratio) that has a significance threshold of 1% ($p=0.006$).

In order to be able to interpret the logit function, we calculated the marginal effects and the result of the z function in table no. 9.

Table no. 9: Logit estimation. Dependent variable: score

Variable	Mean	b	Mean xb	f(z)	bf(z)
R12	0.13325	1.009765	0.134551186	0.104157541	0.105175
LRL	0.72595	-2.185196	-1.589246836	0.104157541	-0.22802
R14	2.21488	-0.4077934	-0.903144785	0.104157541	-0.04247
ROE	0.19038	1.742624	-1.829049006	0.104157541	0.181507
Ebitda margin	0.17225	-9.607359	-0.305319843	0.104157541	-1.00068
rli	0.9389	-1.772536	0.782886367	0.104157541	-0.18462
Inventory ratio	2.51229	0.8338336	1.114032794	0.104157541	0.08685
constant	1	0.4434332	0.4434332	0.104157541	0.046187
Total			-2.151856923		

Source: author's compilation using the STATA statistical processing software

The model's results confirm the relation between the 7 financial ratios selected and the company's possibility to default, so that:

$$Z = C(1) * R12 + C(2) * LRL + C(3) * R14 + C(4) * ROE + C(5) * EBITDA_MARGIN + C(6) * RLI + C(7) * INVENTORY_RATIO + C(8)$$

The score function bellow, $F(Z_i)$, which actually indicates the probability of default (PD), over a 12 month time horizon, of the company that applied for a loan, is:

$$F(Z_i) = \frac{1}{1 + e^{-Z_i}} = \frac{1}{1 + e^{-2.151856923}} = 0.104157541$$

(3)

4. Conclusions on the Model Result Interpretation, Advantages and Limits of Model Application

As a result of our research and after interpreting the results obtained, we may conclude the following:

I) As to the financial ratios previously highlighted as significant for the PD over a 12 month period:

- An increase by one percent in the ratio noted rli, representing the current liquidity rate, decreases the probability of default (PD) by 18.46%;
- An increase by one percent in the ratio noted Ebitda_margin, representing the incomes obtained before the payment of interests, fees, depreciation and amortization, decreases the probability of default (PD) by 100%;
- An increase by one percent in the ratio noted Inventory_ratio, representing the inventory turnover, increases the probability of default (PD) by 8.68%.

II) As to the financial ratios that have little influence on the PD:

- An increase by one percent in the ratio noted R12, representing the degree to which a company's activities are financed by funds of the owner as compared to the funds of the creditor, increases the probability of default 10 %;
- An increase by one percent in the ratio noted LRL, representing the ratio of liabilities and assets, decreases the probability of default by 22 %;
- An increase by one percent in the ratio noted R14, representing the ratio of EBITDA and the interest-related expenses, or, more exactly, how many times the interest-related expenses are covered by the incomes obtained before the payment of interests, fees, depreciation and amortization, decreases the probability of default by 4.2 %;
- An increase by one percent in the ratio noted ROE, representing the ratio of the net profit and equity, increases the probability of default by 18.15%;

Considering that this logistic regression econometric model was built using the STATA statistical processing software, with this software we are able to validate the results obtained above, by calculating the odds ratio of the probability of default (PD). This is possible because the econometric model built in STATA is directly related to the notion of *odds* (calculation of odds ratio), usually noted *odds report*, which indicates the probability of “success” and the probability of “failure”. Generally speaking, odds represent the calculation / ratio of the probability of success so that $y = 1$ (in our case, for the probability of default to occur), when x (in our case, the logit variables used) increases by one unit, as follows:

- if / or > 1 , than the odds report (odds ratio) for $y = 1$ increases;
- if / or < 1 , than the odds report (odds ratio) for $y = 1$ decreases.

Thus, if we ask STATA to calculate the odds ratio of PD rather than the logit function, we obtained the results presented in table no. 10.

Table no. 10: Odds Ratio of PD

Logit score R12 LRL R14 ROE Ebitda_margin RLI Inventory_ratio, or Iteration 0: log likelihood = -43.966988 Iteration 1: log likelihood = -34.793236 Iteration 2: log likelihood = -31.945642 Iteration 3: log likelihood = -31.472154 Iteration 4: log likelihood = -31.466986 Iteration 5: log likelihood = -31.466983						
Log likelihood = -31.466983				Number of obs =	100	
				LR chi2(7) =	25.00	
				Prob > chi2 =	0.0008	
				Pseudo R2 =	0.2843	
Score	Odds Ratio	Std. Err.	z	P> z	[95% Coef. Interval]	
R12	2.744956	8.286106	0.33	0.738	.0073968	1018.659
LRL	.1124557	.390152	-0.63	0.529	.0001253	100.9545
R14	.6651162	.2526682	-1.07	0.283	.3158917	1.400415
ROE	5.712313	7.997598	1.24	0.213	.3673469	88.82756
Ebitda_margin	.0000672	.0003899	-1.66	0.098	7.79e-10	5.803131

rli	.1699015	.1568514	-1.92	0.055	.0278212	1.037572
Inventory _ratio	2.302127	.7051388	2.72	0.006	1.263012	4.196153

Source: author's compilation using the STATA statistical processing software

After interpreting the data from table no. 10, as a result of asking the STATA statistical processing software to calculate the odds ratio of PD rather than the logit function, we obtain the following results:

- R12 (Gearing) > 1 , therefore the probability of default (PD) increases;
- LRL (Leverage III) < 1 , therefore the probability of default (PD) decreases;
- R14 (Interest Coverage) < 1 , therefore the probability of default (PD) decreases;
- ROE (Return of Equity) > 1 , therefore the probability of default (PD) increases;
- Ebitda_margin (EBITDA margin) < 1 , therefore the probability of default (PD) decreases;
- RLI (Quick ratio) < 1 , therefore the probability of default (PD) decreases;
- Inventory_ratio (Inventory Ratio) > 1 , therefore the probability of default (PD) increases.

To conclude, the results obtained by calculating the odds ratio of PD fully validate the results obtained with the logistic regression econometric model used for calculating the PD for a time horizon of 12 months, for a SME applying for financing.

One must notice that the final results obtained are not identical to the initial expectations, formulated at the beginning of the practical research, when, in table no. 1, we mention the theoretically expected impact over the PD of the 7 financial ratios selected to build the financial module used within the logistic regression econometric model in order to estimate the PD. Our explanation for the final results obtained is the following:

- 5 financial ratios (variables), the significant variables included, record the same results as the expected ones, in terms of their impact over the PD;

- 2 financial ratios (variables), which include only the variable considered not to have a significant impact on the econometric model built, record different results as compared to the expected ones, in terms of their impact over the PD. The results are different due to the limitations of the model, and further on we shall present these limitations too, but especially due to the fact that during the period analyzed, that is 2008 – 2011, Romania went through a period of acute crisis, and freight transport was one of the most affected businesses. It is normal that during such periods modifications occur, and such modifications are not found during stability and economic growth periods, especially if one takes into account the fact that many SMEs, and especially those operating in the transportation field, aimed at obtaining as lower profits as possible (or even losses) from the accounting perspective. The purpose was to avoid payment of taxes, considered very high, especially due to the economic crisis period.

We would like to mention the following limits of this model:

- not taking into account the behavioral factors, which usually increase the predictive power. The influence of the behavioral factors on an applicant's credit decision is a very subjective one, can be interpreted in many ways and therefore it is easy to bring claims against it, and this is why it was not introduced in the model we built for calculating the PD. Still, the model is a robust one, as we also calculated the financial ratios for the companies in default, and consequently the model uses a dependent dummy variable (0/1) built with value 1 for the companies in default and with value 0 for the viable companies. As a result, the score obtained according to the model corresponds to the probability that a company defaults;

- the use of only 100 observations. Actually, they are based on the calculation of 700 relevant financial ratios, and on the calculation of 7 financial ratios for each one of the 25 companies that contracted and maintained the credit relation over 4 complete financial years (2008 - 2011) respectively. We would like to mention that in the top European bank where these observations were made, the 25 transport companies

represent the entire database that exists in the entire Romanian network of that respective bank, as we eliminated from the sample the companies for which the financial data for the 4 completed financial years were not available and the companies that were never granted credits by that bank. Fewer companies were included in the sample due to the fact that the analyzed period, namely 2008 – 2011, is a period of profound economic crisis in Romania and Europe, when transport companies encountered great financial problems, and many of them had limited activity. Some other companies disappeared, due to loss of orders or markets (especially those working for the lohn industry, one of the most affected by the crisis, and whose markets were in European countries facing major economic problems, such as Spain, Greece, Portugal, Italy), as well as due to default, as we all know their specific behavior, characterized by the purchase of many expensive vehicles mainly by leasing and bank loans;

- unexpected results obtained by two of the seven financial ratios analyzed. But none of them has an important significance threshold so they can only have little influence on the econometric model used to estimate the PD. Moreover, this is due to the fact that the analysis was performed during the crisis and to the specificity of the transport companies comprised in the sample;

- the relevance of the results estimating the PD only for the transport companies, due to the reasons presented above. The use of the model for companies operating in other fields of activity alters the PD predicting precision. But this limitation is normal, as all big European banks try to estimate the PD specifically for each industry and even taking into account the country where the company operates. When it comes to Romania, it is well known that debt burden of most transport companies is high and their net profits are small, especially reported to turnover (or many of them even intentionally record losses, from the accounting perspective).

There are many advantages of this econometric model estimating the PD of a loan applicant, and the most important ones are the following:

- homogeneity of results is a strong point of the model, as we aimed at analyzing companies that operate in the same industry, namely freight transportation, that bear the same NACE code and a yearly turnover or a group turnover not exceeding EURO 5 million, thus being SMEs (SME in the European bank where the study was conducted);
- the results are representative, as we took the financial data corresponding to financial analyses made by a leading Romania-based European bank, for all clients operating in this industry who submitted their financial statements over a 4 year period, from 2008 to 2011. The 100 observations made over the 4 completed financial years were based on final financial reports (December balance sheet indicators and indicators resulted from the calculation of related balances);
- confirmation of the link between the solvency, profitability, liquidity, activity ratios and a company business failure;
- the selection of the 7 most important financial ratios in the financial module on which the model is based, representing the most important groups: solvency, profitability, liquidity, activity;
- relatively quick and easy calculation of the 7 financial ratios (variables) which together constitute the financial score module, by which one calculates a score starting from the sole scores of the financial risk factors (financial module score). Consequently, the PD is easy to determine too.
- expressing the degree of risk of the company by the final score obtained as a result of performing a correct financial analysis concerning the loan applicant. This is directly associated with the probability of the company going bankrupt;
- compliance with the provisions on the approach based on internal rating models set out in the Basel Accord;
- fulfillment of the criteria required by the bank supervision authorities.

Whatever the advantages and the limits of the econometric model estimating the PD of a loan applicant, as a result of our research we conclude that it is

extremely important that the creditor uses it correctly, because at least it allows:

- to make the right credit decision;
- initially to maintain, and later on to increase the bank's profitability, considering the deterioration of the economic environment, the accelerated growth of bad loan portfolios which have impact on the banks' balance sheets and on the possibility to support the country's real economy through new funding, which is extremely important especially for the development of SMEs;
- calculation of Risk Weighted Assets and setting a fair price for loans: higher risk customers shall obtain more expensive loans, while lower risk customers will get less expensive funding.

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