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THE STATISTICAL ASSESSMENT OF FINANCIAL DISTRESS RISK IN THE CASE OF METALLURGICAL COMPANIES

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The erosion of both the position and the financial performance of companies usually occurs in times of financial crisis, leading to the incidence of the financial distress. The purpose of this study was twofold: firstly, to estimate the time-to-failure for companies in the metallurgic sector differentiated by sub-sectors and secondly, to estimate the influence of the factors that lead to the risk of financial distress. Survival analysis was applied with the aim to estimate the time-to-failure after the crisis and the influence of determinant factors on the financial distress risk. The results of this study were obtained on a sample of 248 companies. They showed that steel production sub-sector is the most sensitive to the occurrence of financial distress risk.

Keywords: metallurgic industry, financial distress risk, financial crisis, Kaplan-Meier method, Cox model

INTRODUCTION

Metallurgy is one of the most important industries in the world economy [1], for the reason that it creates added value, it provides jobs, and it generates investments in the financial markets [2]. Worldwide, metallurgy is strongly connected with other sectors so that any disruptive event in this particular industry can affect the entire economy [3].

The recent global financial crisis had effects not only on the financial markets but also on the main industries, and therefore on the metallurgical industry [4]. The collapse of major corporations was followed by rising unemployment and jam in the real estate market and in the automotive industry. They have negatively influenced the metallurgical companies' ability to purchase the production factors, to market their products and to recover their debts [3]. In these circumstances, the metallurgical companies' ability to continue their operations was affected and, consequently, the engendered financial distress led to insolvency or bankruptcy.

Avoiding financial distress can be achieved by implementing effective financial management policies within companies. These policies should guarantee financial balance of funds raised and profitable investments to cover the cost of debts [5].

This study aims to assess the occurrence of financial distress risk for companies in the metallurgical industry listed on the major international financial markets in Amsterdam, London, Nasdaq, NYSE and Paris. First of all, the time to continue as going concerns without facing financial distress, after the current global financial crisis, was estimated. Moreover, the influence of financial factors in predicting financial distress was estimated.

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FINANCIAL DISTRESS RISK AND ITS DETERMINANTS

The financial distress that a company may face at any given time is defined by the occurrence of insolvency or bankruptcy [6]. Some experts consider that financial distress of a company can be revealed by negative net assets and high debts ratio, inability to pay debts; unpaid dividends on preference shares and deferred losses. In case of insolvency, financial distress condition is described by insufficient assets to cover debts, together with diminished cash flows from operating results that could be used to repay debts [7].

For a company, the risk of financial distress may arise either from the financing choice or the destination of borrowed capital [8]. Given that resources are used to support operations activities and to get profit, an optimal financial structure will allow remitting the current debts, reimbursing the capital cost, and paying the dividends to shareholders. If the operations activities record losses or the operating results are insufficient to reimburse the loan capital, then the company can enter into the financial distress state.

To estimate the risk of financial distress as a result of insolvency, a number of financial ratios of liquidity, solvency, leverage, and profitability are used [9]. These ratios are calculated from the information reported in the company's financial statements, whose role is mainly to describe fairly the company's financial position and performance.

STATISTICAL METHODS FOR DISTRESS RISK ASSESSMENT

The main statistical methods used to estimate the risk of financial distress are discriminant analysis [6],

logistic regression analysis [10], probabilistic regression analysis [11], and survival analysis [12].

Kaplan-Meier estimator and Cox model used in the analysis

In this paper, the risk of financial distress is estimated using duration models based on Kaplan-Meier estimator and Cox model. Using Kaplan-Meier nonparametric method allows estimating the survival probability of metallurgical companies which entered into financial distress as a result of the recent global financial crisis. Cox model estimates the hazard function of firms that entered into financial distress. The estimation and validation of hazard function coefficients are achieved using a combination of financial predictors.

The Kaplan-Meier (KM) survival probability at time t_j is obtained from the equation [13, 14]:

$$\hat{S}\left(t_j\right)=\prod_{t_j\le t}\frac{n_j-d_j}{n_j} \quad (1)$$

where: n_j is the number of companies at risk of financial distress at t_j; d_j is the observed number of financially distressed companies at t_j.

In order to compare the survival pattern among the companies from various metallurgical subsectors, the survival probabilities are plotted, by industry subsector, using the KM curves.

The Cox model is based on the hazard rate, *h(t)*. The formula for the Cox model is [13]:

$$h\left(t,X\right)=h_0\left(t\right)e^{\beta_1X_1+\ldots+\beta_iX_i+\ldots+\beta_pX_p} \quad (2)$$

where: X is the $p\times1$ vector of covariates (explanatory variables), $X = (X_1, X_2, \ldots X_p)$; $h_0(t)$ is the baseline hazard rate, the hazard rate when all the explanatory variables are equal to 0 (it is a unspecified function of t and does not involve the X); $e^{\beta_1X_1+\ldots+\beta_iX_i+\ldots+\beta_pX_p}$ is the exponential expression of the linear sum over the time-invariant explanatory variables (it does not involve t).

The effect of the covariates is expressed by the hazard ratio ($e^{ß_i}$) obtained by exponentiating the estimated coefficient ßi for a variable X_i [14].

Sample and analyzed variables

The target population included all the metallurgical companies listed on the largest stock exchanges in the world, comprising a total of 5208 listed companies during 2006-2013. The sample considered in the paper included 248 companies grouped into three subsectors: mining and processing of gold, silver and other precious metals (44,00%), steel production (14,50%), and extraction of other minerals (41,50%).

The main variables used for the estimation of Kaplan-Meier survival function and Cox model hazard function are: *duration from the start of the crisis* (in 2007) *to the occurrence of the event* (financial distress), and *company's status at the end of period* (in 2013) (either financial distress or going concern). The occurrence of the event (financial distress) happens when a company records simultaneously: high financial leverage (debts are 2 times higher than equities: FL = 2), negative return on equity (ROE < 0), carried forward losses from previous years, and negative equity. The hazard function in the Cox model is estimated in relation to the determinant factors of the financial distress occurrence. The variables considered in the study are presented in Table 1.

Table 1 **Financial ratios considered as factors of influence on financial distress risk**

Symbol	Variable	Formula	Datastream code
FL	Financial Leverage	Total Liabilities/ Total Equities	(WC08101)
ROE	Return on Equities	Net Income/ Total Equities	(WC08301)
ROA	Return on Assets	Operating Income/ Total Assets	(WC08326)
NM	Net Margin Ratio	Net Profit/ Revenue	(WC08366)
ROIC	Return on Invested Capital	(Net Income – Dividends)/ Total Capital	(WC08376)

Data on the variables in the study were collected via Datastream Advanced 4.0, using the Thomson Financial database. Data analysis was performed using SPSS 20.0.

RESULTS AND DISCUSSIONS

The main outcomes of Kaplan Meier method applied in this study refer to the number of companies that experienced the event (financial distress), the estimated survival probabilities, and the mean and median survival time, both for the overall sample and by sub-sectors.

As can be appreciated from the data presented in Table 2, most companies that have entered into financial distress during the period from 2007 (the beginning of the crisis) to 2013 are steel-producing companies (58,33 %). This can be explained by the decline in the automotive market and in the real estate sector which are the main steel consumers.

Table 2 **Distribution of companies by industry sub-sector**

Industry Sub-sector	No. of companies	Financially distressed companies	
		No.	Percentage
Gold, silver & other precious metals	109	39	35,78
Steel production	36	21	58,33
Mineral extractors- other	103	60	58,25
Overall	248	120	48,39

(Source: own processing in SPSS 20.0)

On the opposite side, in mining and precious metals processing industry, there are a smaller number of companies that entered into financial distress. In the context

of the recent financial crisis, this situation can be explained by the investors' interests in precious metals, allowing these companies to continue their operations.

Table 3 **Kaplan-Meier surviving probabilities**

Time	Industry Subsector		
	Gold, silver & other precious metals	Steel production	Mineral extractors- other
0	0,94	1,00	0,93
1	0,87	0,94	0,83
2	0,83	0,72	0,75
3	0,83	0,69	0,73
4	0,78	0,64	0,69
5	0,72	0,61	0,53
6	0,64	0,40	0,41

(Source: own processing in SPSS 20.0)

According to the time of financial distress occurence, the surviving probabilities of metalurgical companies vary by sub-sectors as presented in Table 3.

It can be seen that, in the financial year when crisis occurred, companies entering into financial distress are companies in precious metals extraction and processing industry (6% distressed and 94% surviving) and companies in the mineral extraction industry (7% distressed and 93% surviving). The percentage of companies that have survived the first six years after the financial crisis outbreak (without facing financial distress) is approximately 64% for the extraction and processing of precious metals industry and only 40% for the steel production and 41% mineral extraction. It can be appreciated that companies in steel production and mineral extraction were more affected by the financial crisis hit, as compared to companies in precious metals extraction and processing subsector.

The Kaplan Meier survival curves are plotted in Figure 1.

Useful information about the time when the financial distress occurred can be obtained from the analysis of the mean and median survival time. The current results show that, on average, mineral extraction companies have experienced financial distress relatively soon after the beginning of the crisis. The mean survival time for mineral extractors is the lowest (about 4,45 years after the crisis outbreak), when compared with the mean survival time for companies in other metallurgical subsectors (4,60 years for steel production companies and 4,97 years for precious metals extraction and processing companies). We conclude that mineral extractors are much more likely to face financial distress than companies in other metallurgical subsectors.

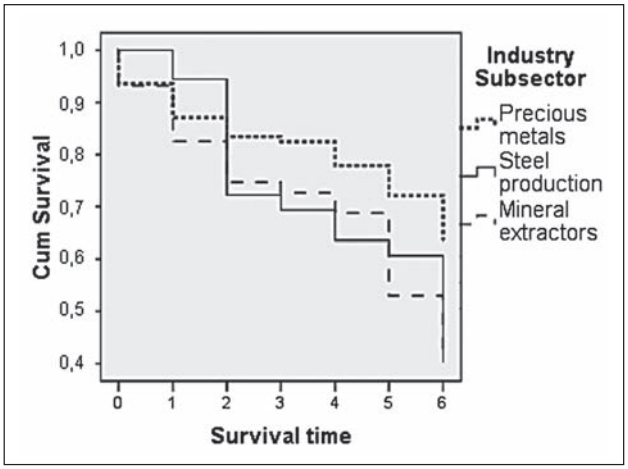

Figure 1 Survival curves by industry subsectors
(Source: own processing in SPSS 20.0)

To verify if the differences among the survival probabilities of companies in the three subsectors are significant, the log-rank test was performed. The results reveal significant differences among survival probabilities for the three groups of companies.

The results obtained in the present study for the Cox model show the estimation of the influence of financial ratios on the financial distress risk. The descriptive statistics for the explanatory variables (financial ratios) included in the model are reported for the overall sample in Table 4. They are defined at time (*t-1*), that is in the financial year that precede the event.

Table 4 **Descriptive statistics for financial ratios**

Variables	Mean	Std. Dev.	Min.	Max.
NM_{t-1}	0,0055	0,2238	- 0,6349	0,3590
ROA_{t-1}	- 0,0878	0,2441	- 0,8555	0,1857
FL_{t-1}	1,6715	0,7114	1,0200	3,6200
ROE_{t-1}	- 0,0921	0,3353	- 1,0905	0,4000
$ROIC_{t-1}$	- 0,0954	0,3164	- 1,0905	0,2847

(Source: own processing in SPSS 20.0)

The Cox model to be estimated is the following:

$$\ln h(t, X) = \ln h_0(t) + \beta_1 NM_{t-1} + \beta_2 ROA_{t-1} + \beta_3 FL_{t-1} + \\ + \beta_4 ROE_{t-1} + \beta_5 ROIC_{t-1} \quad (3)$$

Using the Cox model for the estimation of the hazard rate, the variables found to have significant influence on the financial distress risk occurrence are: NM_{t-1}, FL_{t-1} and ROE_{t-1}. The estimated β coefficients, the estimated standard errors (*SE*), the Wald statistic used to test for significance of the coefficients (*Wald*) with the corresponding probability value (Sig.), and the estimated hazard ratios (*Exp (β)*) are reported in Table 5.

Table 5 **Estimated coefficients for the Cox model of financial distress risk**

Model	β	SE	Wald	Sig.	Exp(β)
NM_{t-1}	- 1,045	0,401	6,784	0,009	0,352
FL_{t-1}	0,774	0,116	44,378	0,000	2,168
ROE_{t-1}	- 0,666	0,271	6,035	0,014	0,514

(Source: own processing in SPSS 20.0)

The effects of financial ratios on the financial distress risk are expressed by the hazard ratios (*Exp (β)*). Increases in the financial leverage (FL) have an aug-

menting effect on the financial distress risk, while increases in ROE and NM cause the dropping of the financial distress risk. High financial leverage measured by FL values larger than 1, can erode the company's financial position and put pressure on the repayment of debts. In these circumstances, the company becomes unattractive for investors while the capital cost increases, thus raising the financial distress risk. However, if based on sales, the company is able to obtain a sufficient profit margin after covering both the costs of goods sold and the interest payments which should cover the dividend payments to shareholders, then the company's financial performance helps reducing the risk of financial distress.

The coefficients of the explanatory variables suggest that a 100″% increase in the Net Margin ratio (NM) and in the Return on Equities ratio (ROE) in the current year results in a reduced financial distress risk in the next financial year by 64,8 % and 48,6 %, respectively. In addition, an increase of 100 % of FL in the current year causes an increase of 116,8 % of the financial distress risk.

CONCLUSIONS

This study has shown that listed companies in the metallurgical industry can face financial distress at different time, depending on the degree of erosion of the financial position and performance.

Analysis of the survival time using the Kaplan-Meier method show that financial distress risk occurrence is different among the metallurgical sub-sectors. Most companies that became financially distressed after the crisis outbreak are in steel production industry, while fewest distressed companies are in extraction and processing of precious metals industry.

The results of the Cox model indicate that financial ratios have a significant influence on the financial position and performance of metallurgical companies. Thus, a raise in financial leverage in the current year is increasing the financial distress risk in the next year. In case of high profit margins, which could cover borrowing costs and dividend payments to shareholders, financial distress risk may be significantly reduced.

The findings from this study may be useful to investors in times of financial crisis in the strategic decision making on choosing the best portfolios of metallurgical companies to invest in. Moreover, the current findings may be useful to managers in estimating the financial balance between equities and debts, and establishing the profit margin, so that in the future a company is able to continue as a going concern without facing financial distress.

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Note: The responsible translator for English language is Lecturer Sorina Chiper, PhD, from "Alexandru Ioan Cuza" University of Iasi, Romania