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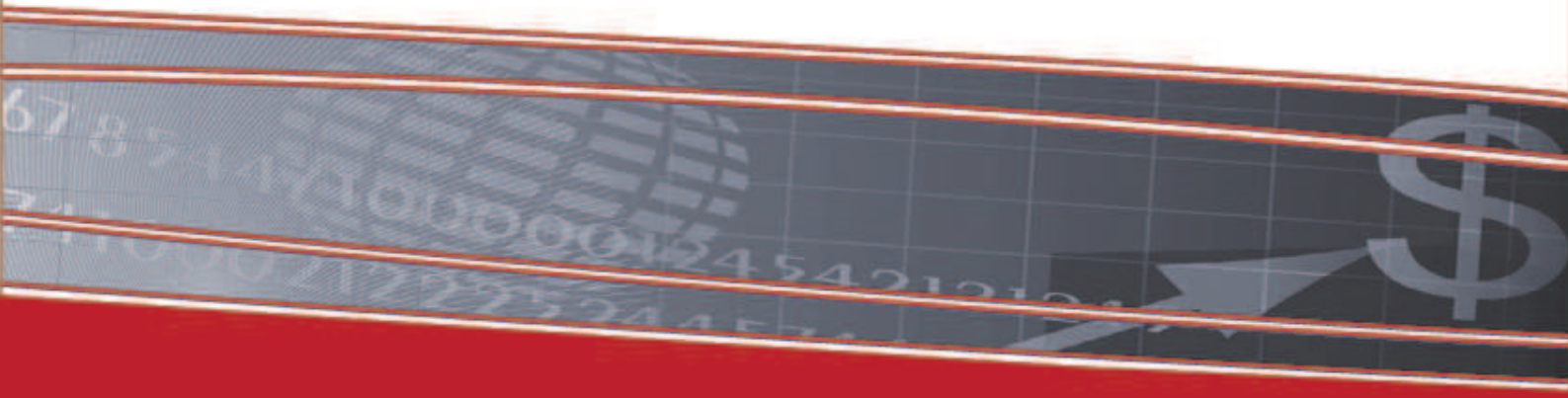

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ARTICLE

THE AGE AND SIZE OF THE FIRM AS RELEVANT PREDICTORS FOR BANKRUPTCY

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Abstract

This study analyses the potential of the age and the size of the firm for the purpose of bankruptcy prediction. Using a data base consisting of Austrian bankrupt and non-bankrupt companies for the period between 2000 and 2011 differences and similarities for these variables are analysed and some conclusions for the suitability as predictors for bankruptcies are reported.

Keywords

Business Failure Prediction; Age of the Firm; Size of the Firm; Crisis Indicators; Discriminant Analysis

INTRODUCTION

The prediction of business failures and bankruptcies has a long history in research so it was possible to determine numerous variables, which are suitable as early warning indicators within prediction models. Despite the accounting ratios and market-based variables certain non-financial variables showed a great ability for prediction. Within many studies it was shown that a combination of accounting variables with market-based variables and non-financial indicators can improve performance of prediction models, so that the inclusion of non-financial ratios is recommended for further developments (Abdiali & Harris, 1995; Barniv et al, 2002; Gudmundsson, 2002; McKee & Lensberg, 2002; Grunert et al, 2005; Muller et al, 2009; Altman et al, 2010; Madrid-Guijarro et al, 2011; Iazzolino et al, 2013; Pervan & Kuvek, 2013).

Two special "non-accounting" ratios are the age and the size of the company, which were also analysed within different studies, whereas mixed results concerning the ability as predictors were found. As it will be shown the age can be proxied by a

ratio derived from accounting figures (retained earnings/total assets). Nevertheless, the results show that its ability as proxy for the age of the firm is limited. The size of the firm can be replicated with different ratios, which are much more suitable as proxies for this task. The aim of this paper is to analyse the suitability of the age of the firm and the size of the firm for prediction purposes grounded on a data base of Austrian bankrupt and non-bankrupt companies for the period between 2000 and 2011. First, the theoretical framework is reported, which determines the ability of these factors as early warning indicators. In addition some results from prior research are presented and discussed. Second, the data base and the methodology used for the empirical part of this work are explained. The ratios for the statistical analyses are based on previous research, where these two factors have already been analysed. Within this section also the research hypotheses and research questions are posted. Third, the preliminary statistical analyses are presented, which are used to determine, whether there are differences for the chosen ratios between the two groups of companies. In order to derive the potential prediction variables a principal component analysis was applied. The remaining statistically significant ratios are then used to derive prediction models based on discriminant analysis, which are able to divide between bankrupt and non-bankrupt companies based on a computed linear combination of predictors. Finally, the results are summarized and critically reflected, compared to the existing empirical evidence, critically reflected and some recommendations for further research are given as well.

THEORY AND EMPIRICAL EVIDENCE FOR THE AGE AND THE SIZE OF THE FIRM

The Age of the Firm

The general assumption is that the higher the age of the firm is, the probability of bankruptcy decreases. The reason behind this theory is that young firms have knowledge about the average profitability, but they do not know their own potential. After they have learned about their potential profitability they can expand, contract or exit, based on the position of the distribution of profitability. This will depend on the ability of the firm to use inventions and innovations at the right time. The winners of this competition survive and remain on the market. These firms are increasing their productivity. They are also able to develop technological advantages, which are forcing losers to exit the market. Firms having passed this situation are showing a low probability of bankruptcy (Jovanovic, 1982: 650; Jovanovic & MacDonald, 1984; Bates, 1990).

These findings result in the bell-shaped curve shown in Figure 1 (Jovanovic, 1982: 650; Jovanovic & MacDonald, 1994: 324; Thornhill & Amit, 2003: 499-500; Dyrberg, 2004: 9-10; Ucbasaran et al, 2010: 542-543). Another factor increasing the path of the curve is that young companies and start-ups are overconfident about their decisions.

This overconfidence encourages entrepreneurs to exploit certain opportunities, which are not always good investments at all. Additionally they make decisions under situation of undercapitalization, so that false investment choices are mostly related to business failure (Ucbasaran et al,2010: 542 and 554). Empirical evidence shows that the probability of failure for young firms is higher than for older firms (Bates 1990: 555; Chava & Jarrow, 2004: 545; Cressy, 2006: 113)

Within the study of Altman (1968) the age of the firm was a relevant indicator within his Z-score model to distinguish between failed and non-failed firms. His second ratio "retained earnings/total assets" implicitly contains the age of the firm. Young firms will have a probably low ratio due to lack of time to build up cumulative profits. A low value implies a higher chance for the related firm to be classified as bankrupt. The probability of bankruptcy is higher for firms in earlier years, which is well described by the mentioned ratio and it also follows the above shown path of the curve within Figure 1 (Altman, 1968: 595).

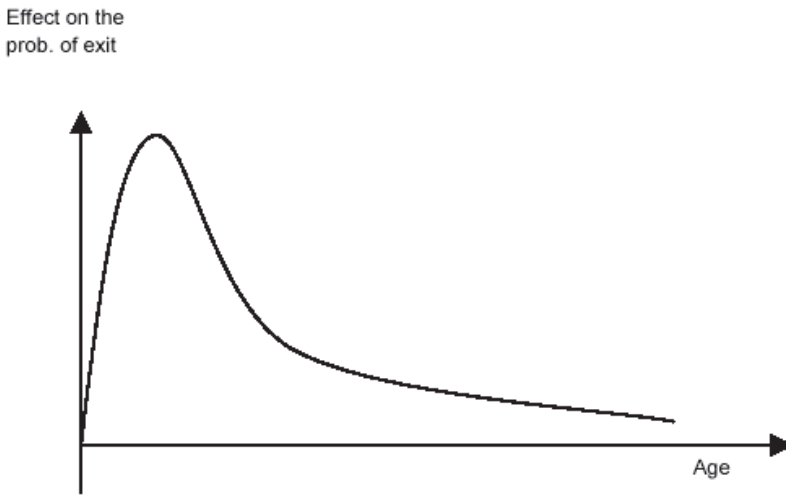

FIG 1. EFFECT OF FIRM AGE ON THE PROBABILITY OF EXIT (Dyrberg, 2004: 11)

The ratio also appeared as potential predictor within other studies. RETA (Retained Earnings to Total Assets) was able to replicate the effect visualized within Figure 1 and bankrupt firms, therefore exhibited significantly lower retained earning relative to their total assets than non-bankrupt firms (Frydman et al, 1985; Gilbert et al, 1990; Charitou et al, 2004; Chi & Tang, 2006; McKee, 2007; Altman et al, 2010; Hauser & Booth, 2011). Nevertheless it seems that this empirical evidence is not valid for all branches. Within the study of Thornhill & Amit (2003) it was found that retail and wholesale branches failures typically occur more for older firms. In food, accommodation and beverage sector generally younger firms fail (Thornhill & Amit, 2003: 504). The age of the firm was in some studies also not able to be distinguished significantly between different states of financial distress, so that its ability as

predictor seems questionable (Poston et al, 1994; Chancharat et al, 2010: 36). Therefore different viewpoints collide: theory postulates a difference between old and young firms concerning their probability of exit, some empirical results confirmed this and other results found no predictive power for the age of the firm.

The Size of the Firm

The size of a firm is an interesting measure, as it appeared in several studies of business failure prediction as statistically significant variable. Within the work of Ohlson (1980) the size of the firm was one important predictor of bankruptcy, which was significant in several periods before the event of bankruptcy. The same conclusion was for e.g. found within the studies of Theodossiou et al, (1996), McKee (2007) or Fitzpatrick & Ogden (2011), whereas the definitions for the size of the firm differed across these studies.

It is assumed that the size of the company and the age of the company are highly correlated with each other. The growth of the firm seems to be proportional to the size of the company (Jovanovic, 1982: 649; Thornhill & Amit, 2003: 504). Figure 2 presents two curves for the relation of the size of the company to the probability of business failure based on two different hypotheses. Hypothesis A shows a U-shaped curve indicating that there exists an optimal size of the firm, where the probability of financial distress is the lowest. Firms with greater size than this "optimal size" are more endangered as they are assumed to have an inflexible organisation structure. They have difficulties in monitoring managers and employess as well as they have a not perfectly functioning communication structure (Dyrberg 2004: 12).

Hypothesis B generally assumes that financial distress is decreasing with increased size of the firm. The reason behind this is primarly the fact that bigger and long established firms are having the ability to adapt to new innovations, respectively they are able to create new innovations themselves. Based on the leading innovations these firms are having advantages in opposite to their competitors, which are inherent in market success (Jovanovic & MacDonald, 1994: 322-328; Pervan & Visic, 2012: 221). Companies with innovations can differentiate in opposite to their competitors and can reduce rivalry among the industry. This reduction in rivalry is reducing the risk of financial distress (Madrid-Guijarro et al, 2011: 177).

Empirical evidence showed that an increased size of the firm is associated with a lower probability of bankruptcy (Lennox, 1999a: 355; Theodossiou et al, 1996: 711; Chava & Jarrow, 2004: 552-553). Large firms are in most cases not born at foundation. Normally it takes a lot of time, until a company has growning into a large firm. This also means that such companies have passed the critical time of early years, when many businesses fail. The constituted firm's size can therefore be seen as a measure of its past performance and also as an indicator of its future performance and its risks (Ben-Zion & Shalit, 1975: 1018). Firms growing in size are also showing

increased profitability. This aspect can be associated with higher overall efficiency and performance (Pervan & Visic, 2012: 213 and 221). Such results primarly support the validity of hypothesis B.

Even in case of reorganization large firms showed better chances of survival. Due to their large and varied assets, large firms can better survive substantial losses and decreases in size compared to small firms. Large firms tend to have sufficient assets, which can be sold to provide cash for operating activities. Therefore small firms are having a higher probability of failure (Moulton & Thomas, 1993: 130; Dawley et al, 2003: 420). The arguments for the lower probability of failure for firms with increased size can be summarized as follows (Castanias, 1983: 1628-1629; Theodossiou et al, 1996: 704):

- Less business risk per dollar of assets invested;
- Less business risk per dollar of expected earnings;
- Easier access to borrowing markets;
- More tax offsets per dollar assets;
- Different marginal tax rates; and
- Lower costs of default per dollar of assets, per dollar of debt and per dollar of expected earnings.

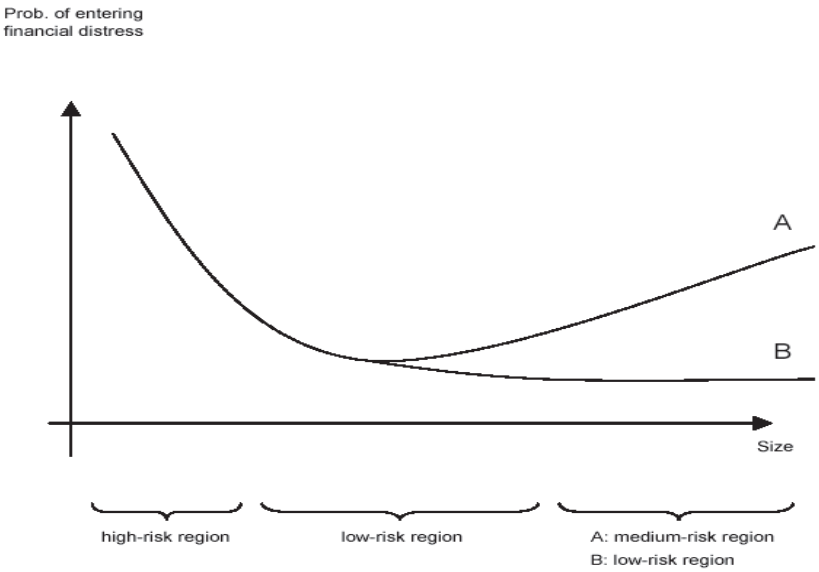

FIG. 2 EFFECT OF FIRM SIZE ON THE PROBABILITY OF EXIT (Dyrberg, 2004: 13)

DATA BASE AND METHODOLOGY

Data Base

The data base consists of Austrian companies from different industries, where they are distincted into non-bankrupt and bankrupt. The time period of observation

ranged from 2000 till 2011 and the analysis concentrated on the period of one year prior to bankruptcy. The number of companies within each group differed throughout the obsservation period. The distribution is shown in Table 1.

TABLE 1. DISTRIBUTION OF BANKRUPT AND SOLVENT FIRMS, 2000-2011

Year	Solvent firms	Bankrupt firms
2000	1,209	15
2001	1,723	15
2002	2,442	18
2003	3,276	18
2004	4,337	27
2005	5,512	28
2006	6,102	21
2007	6,713	36
2008	7,011	49
2009	7,164	49
2010	7,247	30
2011	6,809	54
Total	59,545	360

Following events were assumed as bankruptcy:

- The firm declared bankruptcy under Autrian bankruptcy law;
- The firms openend a compensation under Austrian bankruptcy law;
- The firm was declared bankrupt after unsussessfull compensation;
- The firm opened a reorganization procedure;
- The firm faced a rejection of a creditor's petition for insolvency proceedings or bankruptcy due to insufficient assets; and
- The firm faced a rejection of a debtor's application for opening insolvency proceedings or a rejection of a petition for bankruptcy of the debtor due to insufficient assets.

Ratios Measuring the Age and the Size of the Firm

There are different possibilities to measure firm age and firm size. Following equations provide a selected overview about already used approaches for this task.

$$\text{FirmSize} = \text{Ln}(\text{Total Assets}) \tag{1}$$

$$\text{FirmSize} = \text{Ln}(\text{Sales}) \tag{2}$$

$$\text{FirmSize} = \text{Ln}(\text{Sales})^2 \tag{3}$$

$$\text{FirmAge} = \text{RETA} = \frac{\text{Retained Earnings}}{\text{Total Assets}} \tag{4}$$

$$\text{Firm Age} = \text{Age of the Firm in Years} \tag{5}$$

The shown equations were found in following studies:

- Equation 1: Chi & Tang (2006) and Pervan & Visic (2012);
- Equation 2: Chancharat et al (2010);
- Equation 3: Chancharat et al, (2010);
- Equation 4: Altman (1968), Frydman et al, (1985), Gilbert et al, (1990), Charitou et al, (2004); and
- Equation 5: Chi & Tang (2006) and Chancharat et al, (2010).

The number of employees was used in the study of Lennox (1999a and 1999b) as potential proxy for the size of the firm. Within this work the natural logarithm of this ratio is used to replicate the size of the firm. The problem of absolute ratios is that they can range extremely and therefore some statistical problems can arise. In order to avoid this, the transformation for the number of employees is applied. It is also consistent with the transformations for total assets and sales, so that a better comparison to these variables can be made.

$$\text{FirmSize} = \ln(\text{Number of Employees}) \tag{6}$$

Methodology, Hypotheses and Research Questions

In order to test the effect of firm size and age on bankrupty, tests for differences in means and in variances were applied. As an 11-year history is observed, these tests were made for each year and for the whole observation period. To assess the dependence of the different variables to each other, correlation analysis and principal component analysis were conducted. At last discriminant analysis is applied in order to develop models for the prediction of bankruptcy.

Based on the theoretical framework following research hypotheses are posted:

- H1: The age of the firm is statistically different between bankrupt and non-bankrupt companies for the the whole observation period.
- H2: The age of the firm is statistically different between bankrupt and non-bankrupt companies for the different years of observation period.
- H3: The size of the firm is statistically different between bankrupt and non-bankrupt companies for the the whole observation period.
- H4: The size of the firm is statistically different between bankrupt and non-bankrupt companies for the different years of observation period.

Besides that it is of interest, which of the used ratios and measures presented within this work are more suitable to determine differences between bankrupt and non-bankrupt firms. It is also to answer, whether the age and the size of the firm are relevant explanatory variables for the different years of the observation period.

RESULTS

Preliminary Statistical Analyses

The preliminary analyses concentrate on test for normality of data, tests for differences in means and in variances. These tests were applied twofold. First, the whole observation period was analyzed. Second, each year of the observation period was analyzed separately. This differentiation is necessary as several studies showed that explanatory variables are not stationary over time. This means that there are certain external factors, which are affecting their stability. A certain ratio can be an effective predictor in one year, but can loose its predictability in another time period.

TABLE 2. RESULTS FOR MEANS AND MEDIANS

		Age		ln(Total Assets)		ln(Sales)		ln(Sales)²		ln(Empl.)		RE/TA	
Year	Group	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
2000	non-bankrupt	34.186	22.000	16.210	16.118	16.198	16.132	265.276	260.242	4.248	4.382	0.027	0.004
	bankrupt	19.933	9.000	15.015	15.065	14.992	15.390	226.814	236.857	3.912	4.317	0.015	0.014
2001	non-bankrupt	33.250	21.000	16.068	16.019	16.028	16.013	260.401	256.412	4.076	4.248	0.026	0.010
	bankrupt	15.133	5.000	13.975	14.651	14.446	14.672	213.680	215.262	3.080	3.401	0.021	0.015
2002	non-bankrupt	31.776	19.000	15.925	15.945	15.949	15.924	257.453	253.562	3.963	4.094	0.022	0.007
	bankrupt	27.556	20.000	14.596	15.352	14.988	15.331	228.334	235.027	3.593	3.902	0.017	0.010
2003	non-bankrupt	32.373	19.000	15.864	15.891	15.879	15.829	255.278	250.569	3.881	4.052	0.016	0.004
	bankrupt	27.556	8.000	13.996	14.814	14.836	15.325	222.785	234.855	3.100	3.478	0.031	0.001
2004	non-bankrupt	32.571	19.000	15.926	15.953	15.987	15.905	258.606	252.954	3.932	4.094	0.013	0.000
	bankrupt	20.000	11.000	14.135	14.662	14.211	14.200	204.525	201.648	2.911	2.708	0.001	0.000
2005	non-bankrupt	33.064	20.000	15.958	15.981	16.011	15.946	259.405	254.275	3.929	4.094	0.010	0.000
	bankrupt	23.536	14.500	14.245	14.308	14.549	14.867	214.965	221.040	3.047	3.198	0.006	0.000
2006	non-bankrupt	33.296	21.000	15.977	16.004	16.037	15.968	260.355	254.963	3.910	4.094	0.009	0.000
	bankrupt	31.429	13.000	14.023	14.006	14.505	14.322	212.381	205.121	2.925	3.045	0.003	0.000
2007	non-bankrupt	32.998	21.000	16.000	16.043	16.045	15.982	260.596	255.439	3.865	4.060	0.009	0.000
	bankrupt	23.917	13.000	14.068	14.464	14.316	14.861	208.577	220.840	3.135	3.314	0.009	0.000
2008	non-bankrupt	33.427	21.000	16.065	16.104	16.119	16.076	262.941	258.442	3.887	4.094	0.008	0.000
	bankrupt	31.102	18.000	14.909	15.077	15.222	15.294	234.963	233.912	3.585	4.078	0.013	0.000
2009	non-bankrupt	34.271	22.000	16.050	16.131	16.041	16.027	260.490	256.868	3.884	4.094	0.009	0.000
	bankrupt	18.551	10.000	14.408	15.290	15.041	15.175	229.621	230.277	3.115	3.178	0.002	0.000
2010	non-bankrupt	34.958	23.000	16.163	16.209	16.150	16.120	263.995	259.856	3.962	4.159	0.011	0.000
	bankrupt	30.867	19.000	14.433	14.824	15.054	15.244	228.951	232.373	3.352	3.293	0.002	0.000
2011	non-bankrupt	35.909	24.000	16.279	16.292	16.283	16.217	268.200	263.002	4.053	4.248	0.010	0.000
	bankrupt	25.500	15.000	14.856	15.295	15.359	15.494	242.041	240.071	3.308	3.541	0.003	0.000
2000 - 2011	non-bankrupt	33.726	21.000	16.049	16.080	16.075	16.025	261.531	256.815	3.937	4.094	0.011	0.000
	bankrupt	24.928	13.000	14.452	14.836	14.870	15.049	224.836	226.474	3.253	3.418	0.008	0.000

Several studies found this problem for different variables and also confirmed that the prediction power of these changed over time (Mensah, 1984; Doukas, 1986; Gombola et al, 1987; Begley et al, 1996; Sung et al, 1999; Grice & Dugan, 2001; Nam & Jinn, 2000; Berg, 2007; Hol, 2007; Nam at al, 2008; Sarlija & Jeger, 2011).

The means and medians for the different variables and groups are displayed in Table 2. As it can be seen, several means are differing substantially from the medians, so that departures from normality could be expected. This expectation is confirmed by the analysis for normality of data discussed below and presented in Table 4.

The data of means for the age of the firm are plotted for both groups for the obsveration period. This graph is shown in Figure 3. From these findings it can be seen that there are only certain years, where the age of the firm between non-bankrupt and bankrupt companies was markably different. In the years 2002, 2003, 2006, 2008 and 2010 the differences in means for the two groups were relatively low compared to the other years. Such a tendency implies that the age of the firm can not be a potential predictor of bankruptcy. It is also not fully consistent with the descpritions of the theoretical framework concerning the age of the firm. Generally, all means of the bankrupt firms are lower than those of the non-bankrupt firms. Therefore the overall statement that bankrupt firms are in mean younger than non-bankrupt companies is true. This conclusion is not valid, when medians are observed. In the year 2002 the median age of bankrupt companies was higher than of non-bankrupt companies. From these analyses it could be concluded that the age of the firm is not a reliable predictor for bankruptcies in all years, respectively it is not the case that the means and median age of companies are differing substantially. This aspect is analysed further, when observing the differences in means and variances.

TABLE 3. MEAN AGE OF BANKRUPT AND SOLVENT FIRMS FOR OBSERVATION PERIOD

Year	Mean Age of Bankrupt Firms	Mean Age of Solvent Firms
2000	19.93	34.19
2001	15.13	33.25
2002	27.56	31.78
2003	27.56	32.37
2004	20.00	32.57
2005	23.54	33.06
2006	31.43	33.30
2007	23.92	33.00
2008	31.10	33.43
2009	18.55	34.27
2010	30.87	34.96
2011	25.50	35.91

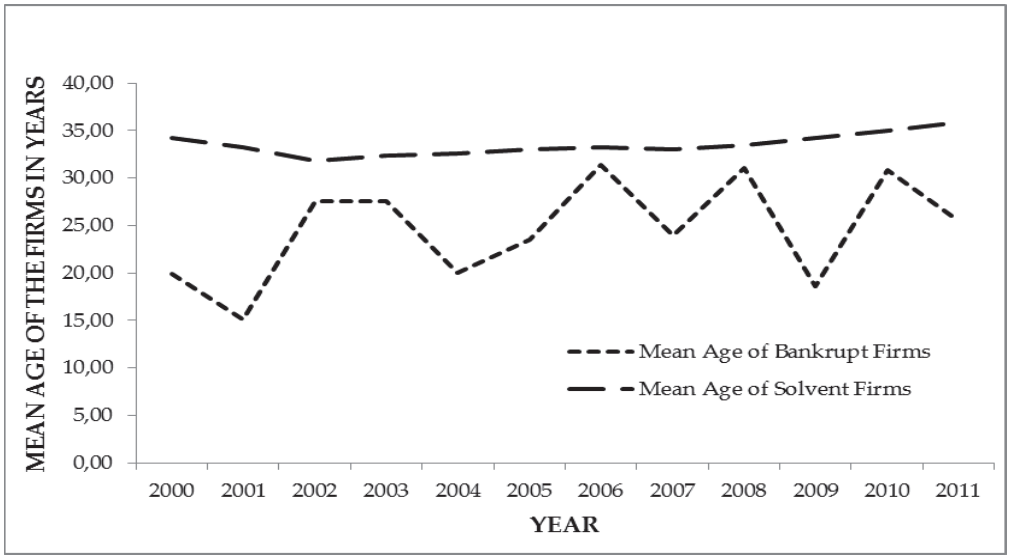

FIG. 3 MEAN AGE FOR BANKRUPT AND NON-BANKRUPT FIRMS

TABLE 4. TESTS FOR NORMALITY OF DATA

		Age	ln(Total Assets)	ln(Sales)	ln(Sales)²	ln(Empl.)	RE/TA
Year	Group	Sign.	Sign.	Sign.	Sign.	Sign.	Sign.
2000	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	**0.200**	0.005	0.009	0.000	0.001
2001	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.001	**0.200**	**0.200**	**0.200**	**0.200**	**0.118**
2002	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.026	**0.110**	**0.200**	**0.200**	**0.200**	0.019
2003	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	0.033	**0.148**	**0.141**	**0.200**	0.000
2004	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	**0.144**	**0.200**	**0.200**	**0.200**	0.000
2005	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	**0.200**	**0.200**	**0.200**	**0.200**	0.000
2006	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	**0.200**	**0.200**	**0.200**	**0.194**	0.000
2007	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	**0.200**	0.027	**0.093**	**0.200**	0.000
2008	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	0.019	0.030	**0.200**	0.004	0.000
2009	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	0.003	**0.200**	**0.200**	**0.200**	0.000
2010	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.007	**0.166**	**0.200**	**0.200**	**0.200**	0.000
2011	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	0.015	**0.200**	**0.200**	**0.200**	0.000
2000 - 2011	non-bankrupt	0.000	0.000	0.000	0.000	0.000	0.000
	bankrupt	0.000	0.000	0.001	**0.067**	0.000	0.000

*) values in bold denote variables, which are normally distributed with significance of 5%

The test for normality of data was applied based on Kolmogorov-Smirnov at the 5% level. The results for each year and for the whole observation period are shown in Table 4, where the p-values of the statistic are reported. Mixed results can be found here, but generally it must be concluded that the assumption of normality is hardly given as the majority of the p-values were lower than 0.05. It is interesting to note that for the group of non-bankrupt companies normality for the different variables never applied, whereas for the bankrupt group for certain variables and for certain years normality was given. It is conspicuous that the age of the firm never had a normal distribution for the different years and also for the whole observation period. A similar conclusion can be made for RETA, where this ratio was only normally distributed in 2001 for the bankrupt group.

TABLE 5. TESTS FOR DIFFERENCES IN MEANS AND VARIANCES

		Age	ln(Total Assets)	ln(Sales)	ln(Sales)²	ln(Empl.)	RE/TA
Year	Group	Sign.	Sign.	Sign.	Sign.	Sign.	Sign.
2000	Mean	0.096	**0.008**	**0.007**	**0.003**	0.333	0.084
	Variance	0.158	**0.004**	**0.006**	**0.007**	0.370	0.288
2001	Mean	**0.002**	**0.002**	**0.019**	**0.017**	**0.041**	0.419
	Variance	0.071	**0.000**	**0.001**	**0.001**	**0.012**	0.683
2002	Mean	0.543	**0.009**	0.056	0.050	0.370	0.467
	Variance	0.633	**0.001**	**0.021**	**0.027**	0.311	0.884
2003	Mean	0.581	**0.001**	**0.018**	**0.013**	**0.036**	0.597
	Variance	0.609	**0.000**	**0.013**	**0.012**	**0.032**	0.195
2004	Mean	**0.016**	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**
	Variance	0.096	**0.000**	**0.000**	**0.000**	**0.001**	0.309
2005	Mean	0.160	**0.000**	**0.000**	**0.000**	**0.007**	0.193
	Variance	0.191	**0.000**	**0.000**	**0.000**	**0.003**	0.523
2006	Mean	0.854	**0.000**	**0.000**	**0.000**	**0.004**	**0.034**
	Variance	0.822	**0.000**	**0.000**	**0.000**	**0.004**	0.351
2007	Mean	0.057	**0.000**	**0.000**	**0.000**	**0.003**	0.884
	Variance	0.146	**0.000**	**0.000**	**0.000**	**0.006**	0.905
2008	Mean	0.623	**0.000**	**0.001**	**0.001**	0.122	0.581
	Variance	0.668	**0.000**	**0.000**	**0.001**	0.183	0.301
2009	Mean	**0.000**	**0.001**	**0.000**	**0.000**	**0.001**	**0.000**
	Variance	**0.005**	**0.000**	**0.000**	**0.000**	**0.001**	0.107
2010	Mean	0.479	**0.000**	**0.001**	**0.000**	**0.021**	**0.000**
	Variance	0.566	**0.000**	**0.001**	**0.001**	**0.035**	0.137
2011	Mean	**0.010**	**0.000**	**0.009**	**0.010**	**0.001**	**0.000**
	Variance	0.053	**0.000**	**0.000**	**0.001**	**0.001**	0.145
2000 - 2011	Mean	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.087
	Variance	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.153

*) values in bold denote variables, where the differences in means and variances are statistically significant at the 5% level

The next section provides the results for differences in means (Welch-test) and in variances (ANOVA). The respective significances are shown in Table 5. The results show that the differences in means and variances for the age of the firm, but also for the indirect measure of it (RETA) only showed in some years significant differences in means and variances on the 5% level. This is not suprising based on the previous analysis of means and medians, and confirms the above given statement that the age of the firm and RETA are not suitable indicators to divide between bankrupt and non-bankrupt companies.

The best ability to discriminate in all years showed the ratio ln(total assets). A similar results is given for ln(sales) and ln(sales)^2 except for the year 2002, where the differences in means of the groups were not statistically significant at the 5% level. Although, the levels of significance were almost close to the threshold of 0.05, so that the acceptance of the null hypothesis is relatively close to rejection. The ratio related to the number of employees showed mixed results, but for some years it is a relevant predictor between bankrupt and non-bankrupt companies.

These results confirm the already provided findings that the age of the firm and RETA are not relevant variables for the purpose of bankruptcy prediction and could therefore be excluded from further analyses. These results are somehow in contrast to the findings of previous research and do therefore also not confirm the theoretical framework concerning the age of the firm.

Firms with a higher age have passed the start-up phase and established a standing, a reputation and a certain market power. Normally such firms are also assumed to have a certain size, which must in practice not always be the case. There are numerous examples of small companies with a high age and a small size. Nevertheless, the age and the size of the company seem to be correlated with each other based on the theoretical framework. Therefore it is necessary to have a look at correlations of the variables for the different years in order to answer, whether this expected relation from literature is true. It is also to detect multicollinearity between data, which can be a problem for model building (Mensah, 1984; Lau, 1987; Houghton & Woodliff, 1987; Platt et al, 1994; Doumpos & Zopounidis, 1998; Liou & Smith; 2007; McKee, 2007; Gepp & Kumar, 2008; Nam et al, 2008; Vuran, 2009). Here a correlation analysis based on Pearson was applied.

The correlations of age to the ratios of size where all statistically significant at the 1% level, but the degree of correlations remained relatively low. The same appears for the correlation to the ratio RETA. Based on these results it can not be confirmed that the age and the size of the firm are highly correlated with each other like presented in the theoretical framework of this study. The same conclusion can be made for RETA as this ratio is also not showing high correlations to the variables for the size of the company. It is also interesting that there is no high correlation between the age

of the firm and RETA, although both should measure the same thing. Like demonstrated via PCA these both ratios are highly loaded on the same factor. It seems that RETA can be used as proxy for the age of the firm, but the extent to which it can replicate the age of the firm is somehow limited based on the low but statistically significant correlation coefficients.

TABLE 6. RESULTS OF CORRELATION ANALYSIS

		Age	ln(Total Assets)	ln(Sales)	ln(Sales)²	ln(Empl.)	RE/TA
	Year	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Age	2000	1.000	0.182**	0.131**	0.135**	0.229**	0.128**
	2001	1.000	0.213**	0.169**	0.173**	0.254**	0.131**
	2002	1.000	0.231**	0.185**	0.181**	0.265**	0.098**
	2003	1.000	0.216**	0.162**	0.160**	0.215**	0.123**
	2004	1.000	0.224**	0.170**	0.167**	0.225**	0.114**
	2005	1.000	0.235**	0.181**	0.178**	0.243**	0.171**
	2006	1.000	0.234**	0.179**	0.175**	0.236**	0.173**
	2007	1.000	0.236**	0.181**	0.177**	0.243**	0.143**
	2008	1.000	0.239**	0.188**	0.185**	0.248**	0.148**
	2009	1.000	0.238**	0.194**	0.191**	0.254**	0.156**
	2010	1.000	0.235**	0.188**	0.186**	0.236**	0.153**
	2011	1.000	0.230**	0.186**	0.183**	0.244**	0.115**
ln(Total Assets)	2000	0.182**	1.000	0.768**	0.776**	0.616**	0.099**
	2001	0.213**	1.000	0.748**	0.783**	0.618**	0.063**
	2002	0.231**	1.000	0.768**	0.772**	0.646**	-0.031
	2003	0.216**	1.000	0.770**	0.782**	0.627**	0.020
	2004	0.224**	1.000	0.783**	0.786**	0.618**	0.023
	2005	0.235**	1.000	0.790**	0.791**	0.633**	0.099**
	2006	0.234**	1.000	0.793**	0.792**	0.623**	0.108**
	2007	0.236**	1.000	0.783**	0.785**	0.610**	0.096**
	2008	0.239**	1.000	0.768**	0.769**	0.597**	0.105**
	2009	0.238**	1.000	0.770**	0.769**	0.613**	0.110**
	2010	0.235**	1.000	0.744**	0.753**	0.584**	0.104**
	2011	0.230**	1.000	0.758**	0.759**	0.587**	0.036**
ln(Sales)	2000	0.131**	0.768**	1.000	0.996**	0.676**	0.055
	2001	0.169**	0.748**	1.000	0.975**	0.645**	0.015
	2002	0.185**	0.768**	1.000	0.995**	0.700**	0.032
	2003	0.162**	0.770**	1.000	0.990**	0.728**	0.040*
	2004	0.170**	0.783**	1.000	0.995**	0.707**	-0.025
	2005	0.181**	0.790**	1.000	0.995**	0.719**	0.028*
	2006	0.179**	0.793**	1.000	0.995**	0.718**	0.032*
	2007	0.181**	0.783**	1.000	0.994**	0.709**	0.012
	2008	0.188**	0.768**	1.000	0.995**	0.698**	0.020
	2009	0.194**	0.770**	1.000	0.995**	0.728**	0.039**
	2010	0.188**	0.744**	1.000	0.994**	0.696**	0.036**
	2011	0.186**	0.758**	1.000	0.995**	0.701**	-0.010

		Age	ln(Total Assets)	ln(Sales)	ln(Sales)²	ln(Empl.)	RE/TA
	Year	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
ln(Sales)²	2000	0.135**	0.776**	0.996**	1.000	0.675**	0.052
	2001	0.173**	0.783**	0.975**	1.000	0.684**	0.008
	2002	0.181**	0.772**	0.995**	1.000	0.698**	0.032
	2003	0.160**	0.782**	0.990**	1.000	0.735**	0.039*
	2004	0.167**	0.786**	0.995**	1.000	0.707**	-0.021
	2005	0.178**	0.791**	0.995**	1.000	0.715**	0.025
	2006	0.175**	0.792**	0.995**	1.000	0.712**	0.029*
	2007	0.177**	0.785**	0.994**	1.000	0.703**	0.008
	2008	0.185**	0.769**	0.995**	1.000	0.693**	0.016
	2009	0.191**	0.769**	0.995**	1.000	0.722**	0.035**
	2010	0.186**	0.753**	0.994**	1.000	0.693**	0.032**
	2011	0.183**	0.759**	0.995**	1.000	0.693**	-0.007
ln(Empl.)	2000	0.229**	0.616**	0.676**	0.675**	1.000	0.123**
	2001	0.254**	0.618**	0.645**	0.684**	1.000	0.071**
	2002	0.265**	0.646**	0.700**	0.698**	1.000	0.049*
	2003	0.215**	0.627**	0.728**	0.735**	1.000	0.077**
	2004	0.225**	0.618**	0.707**	0.707**	1.000	0.014
	2005	0.243**	0.633**	0.719**	0.715**	1.000	0.070**
	2006	0.236**	0.623**	0.718**	0.712**	1.000	0.064**
	2007	0.243**	0.610**	0.709**	0.703**	1.000	0.057**
	2008	0.248**	0.597**	0.698**	0.693**	1.000	0.054**
	2009	0.254**	0.613**	0.728**	0.722**	1.000	0.060**
	2010	0.236**	0.584**	0.696**	0.693**	1.000	0.067**
	2011	0.244**	0.587**	0.701**	0.693**	1.000	0.042**
RE/TA	2000	0.128**	0.099**	0.055	0.052	0.123**	1.000
	2001	0.131**	0.063**	0.015	0.008	0.071**	1.000
	2002	0.098**	-0.031	0.032	0.032	0.049*	1.000
	2003	0.123**	0.020	0.040*	0.039*	0.077**	1.000
	2004	0.114**	0.023	-0.025	-0.021	0.014	1.000
	2005	0.171**	0.099**	0.028*	0.025	0.070**	1.000
	2006	0.173**	0.108**	0.032*	0.029*	0.064**	1.000
	2007	0.143**	0.096**	0.012	0.008	0.057**	1.000
	2008	0.148**	0.105**	0.020	0.016	0.054**	1.000
	2009	0.156**	0.110**	0.039**	0.035**	0.060**	1.000
	2010	0.153**	0.104**	0.036**	0.032**	0.067**	1.000
	2011	0.115**	0.036**	-0.010	-0.007	0.042**	1.000

*) significance at 5% level
**) significance at 1% level

Ln(total assets) showed high correlations to ln(sales) and ln(sales)², which are all over 0.7. This indicates a problem of multicollinearity between these variables, so that not all of them should be used for model building. Multcollinearity can cause problems in prediction models, when they are not appropriately handled. It is therefore suitable to leave out two of the three mentioned variables out in order to

receive a reliable and good prediction model. The ratio ln(employees) showed statistical significance and high correlations to the other measures of size, which were sometimes below and sometimes above 0.7%. It seems therefore that this ratio could be a potential predictor within a model, which can amend the other measures of size concerning prediction power. This assumption is also in congruence with the results concerning the differences in means and variances, where this ratio only for certain years showed the ability to differentiate between the two groups of companies.

Selection of Prediction Variables

Preliminary test principal component analysis (PCA) was applied s last for all years of observation period and on all years together. This is necessary in order to detect, how the different ratios are loaded and to which extent certain variables can be eliminated from further analyses. The results are shown in Table 7. The number of potential factors was given in advance by the restriction that only those factors should be used, whose eigenvalues are above one. It is interesting to note that with this pre-condition for all years only two factors were extracted. The shown results are based on Varimax-rotation and show the factor loadings of the ratios associated with the two factors. Additionally the percentage of variability after Varimax-rotation (variance) is given, which can be explained by the two factors.

The results show that the age of the firm and RETA are both highly loaded on the second factor for all years of the observation period, so that this factor could be assigned as the "age of the firm". This also implicates that RETA is a kind of proxy, which can be used to measure the age of the firm. Additionally this classification confirms the results from previous analyses, that the ratios for the age of the firm are not related to the size of the firm, which was not that clear at correlation analysis. The general ability of this factor as predictor is limited or even not given based on preliminary statistical results. Neither are having sufficient discriminatory power to act as reliable explanatory variables for the differences between the two groups of companies.

All the other ratios were highly loaded on the first factor, so that this one could be assigned as the "size of the firm". The related ratios are all measuring the size of the firm, so that they are proxies for this task. Such a result is also consistent with the ones from previous research. Concerning the ratios measuring the size of the firm the discriminatory power based on differences in means and variances as well as the correlations among them must be evaluated. The ratio ln(total assets) seems suitable as it showed the ability to discriminate between the groups within all years. Due to its high correlation with ln(sales) and $\ln(\text{sales})^2$ it should be sufficient to only consider this ratio for model building. As a complement the ratio ln(employees) is

appropriate because it also showed partially a good discriminatory power and could be added to ln(total assets) without causing problems of multicollinearity.

TABLE 7. RESULTS OF PRINCIPAL COMPONENT ANALYSIS

			Age	ln(Total Assets)	ln(Sales)	ln(Sales)²	ln(Empl.)	RE/TA
Year	Group	Variance	Loading	Loading	Loading	Loading	Loading	Loading
2000	1st Factor	61.68	0.116	0.882	0.956	0.958	0.787	0.000
	2nd Factor	75.77	0.710	0.094	-0.012	-0.012	0.343	0.714
2001	1st Factor	61.36	0.172	0.880	0.942	0.958	0.790	-0.051
	2nd Factor	75.19	0.690	0.100	-0.028	-0.012	0.315	0.741
2002	1st Factor	63.02	0.202	0.894	0.945	0.944	0.821	-0.081
	2nd Factor	76.17	0.640	0.009	0.046	0.043	0.268	0.790
2003	1st Factor	63.40	0.167	0.881	0.952	0.956	0.836	-0.039
	2nd Factor	76.53	0.675	0.052	0.031	0.030	0.208	0.795
2004	1st Factor	63.43	0.194	0.880	0.955	0.955	0.830	-0.077
	2nd Factor	76.30	0.681	0.107	-0.012	-0.011	0.156	0.789
2005	1st Factor	63.57	0.183	0.878	0.959	0.957	0.834	-0.028
	2nd Factor	77.36	0.706	0.150	0.005	0.001	0.171	0.799
2006	1st Factor	63.47	0.178	0.876	0.960	0.957	0.833	-0.024
	2nd Factor	77.26	0.708	0.163	0.010	0.005	0.147	0.802
2007	1st Factor	63.03	0.190	0.871	0.959	0.957	0.825	-0.041
	2nd Factor	76.55	0.683	0.160	-0.005	-0.010	0.171	0.801
2008	1st Factor	62.35	0.195	0.860	0.956	0.955	0.821	-0.040
	2nd Factor	75.96	0.679	0.179	0.000	-0.005	0.157	0.806
2009	1st Factor	63.04	0.194	0.859	0.958	0.955	0.840	-0.030
	2nd Factor	76.71	0.684	0.180	0.021	0.016	0.138	0.811
2010	1st Factor	61.70	0.188	0.849	0.952	0.954	0.822	-0.028
	2nd Factor	75.32	0.685	0.179	0.008	0.005	0.150	0.805
2011	1st Factor	62.26	0.203	0.865	0.956	0.953	0.814	-0.072
	2nd Factor	75.38	0.665	0.094	-0.007	-0.008	0.219	0.790
2000 - 2011	1st Factor	62.83	0.194	0.872	0.955	0.955	0.824	-0.050
	2nd Factor	76.01	0.676	0.114	0.005	0.002	0.192	0.793

*) the variance at the second factor is the cumulated explained variance

Prediction Model based on the Size of the Firm

The last section is about developing prediction models, which could be used to assess bankruptcies in advance. Based on the previous analyses it can be assumed that ln(total assets), ln(sales), ln(sales)² and ln(employees) will be the relevant predictors within the models. Discriminant analysis is used as potential and generally recognized methods for the development of bankruptcy prediction models. Multivariate linear discriminant analysis was introduced by Altman (1968) for prediction task and was also applied within numerous studies for this purpose (Edmister, 1972; Altman, Haldeman & Narayanan, 1977; Houghton & Woodliff, 1978; Dietrich et al, 2005; Mohamad, 2005; Vuran, 2009). With this method it is possible to compute a linear combination of relevant independent variables, which are able to

discriminate between bankrupt and non-bankrupt companies, whereas statistical type I and type II errors must be accepted. When the computed score is below a certain threshold, the respective company will be assigned as bankrupt.

As previously discussed all of the variables show mainly non-normality of data. Nevertheless multivariate discriminant analysis is applied here as earlier research denoted that a certain deviation from non-normality must not definitely affect the prediction accuracy of the discriminant model. For each year and for the whole observation period one discriminant function was computed based on step-wise method using Mahlanobis-distance. Within Table 8 the relevant statistical results, the functions and the classification accuracy for initial group are shown. It is remarkable that ln(total assets) is the predictor, which was sufficient for the single years and for the whole obseveration period in order to develop an explanatory model.

TABLE 8. RESULTS FOR DISCRIMINANT ANALYSIS

Year	Diff. in Means	Diff. In Var.	Box-Test	Sign. for Discrimination	Type I error	Type II error	Overall accuracy	Overall accuracy cross validated	Function
2000	**0.008**	**0.004**	**0.801**	**0.004**	33.333	35.401	64.6	64.6	$-10.924 + 0.636x_1$
2001	**0.002**	**0.000**	**0.179**	**0.000**	20.000	21.068	78.9	78.9	$-9.533 + 0.594x_1$
2002	**0.009**	**0.001**	**0.589**	**0.001**	50.000	29.689	70.2	70.2	$-9.149 + 0.575x_1$
2003	**0.001**	**0.000**	**0.489**	**0.000**	38.889	24.084	75.8	75.8	$-8.750 + 0.552x_1$
2004	**0.000**	**0.000**	**0.520**	**0.000**	37.037	24.233	75.7	75.7	$-8.974 + 0.564x_1$
2005	**0.000**	**0.000**	**0.539**	**0.000**	35.714	25.726	74.2	74.2	$-8.828 + 0.554x_1$
2006	**0.000**	**0.000**	**0.148**	**0.000**	28.571	22.911	77.1	77.1	$-8.804 + 0.551x_1$
2007	**0.000**	**0.000**	**0.781**	**0.000**	38.889	23.328	76.6	76.6	$-8.732 + 0.546x_1$
2008	**0.000**	**0.000**	**0.206**	**0.000**	34.694	32.064	67.9	67.9	$-8.829 + 0.550x_1$
2009	**0.001**	**0.000**	0.000	**0.000**	51.020	26.647	73.2	73.2	$-8.464 + 0.528x_1$
2010	**0.000**	**0.000**	**0.314**	**0.000**	46.667	24.976	74.9	74.9	$-8.787 + 0.544x_1$
2011	**0.000**	**0.000**	**0.503**	**0.000**	40.741	27.787	72.1	72.1	$-9.049 + 0.556x_1$
2000 - 2011	**0.000**	**0.000**	0.001	**0.000**	40.000	26.650	73.3	73.3	$-8.832 + 0.551x_1$

The Table 8 is arranged as follows:

- The second and the third columns show the significances of tests for differences in means and variances for ln(total assets); for all years and for the whole observation period the results were statistically significant at the 5% level and therefore the pre-conditions for a good model were given;
- The fourth column shows the results from Box-test, denoting whether the covariance-matrices of the groups are similar; except for 2009 and the whole observation period the null hypothesis was given (equality of covariance-

matrices), which indicates that the covariances matrices are similar; this is an important pre-condition for the application of multivariate linear discriminant analysis; if the null hypothesis must be rejected, then the application of the model and its results are generally questionable;

- The fifth column shows the significance of Wilks-Lamdba for the derived functions; for values below 0.05% the results indicate that the obtained function can significantly discriminate between the goups on the 5% level and is therefore better than assignment of the firms into the two groups by chance;
- Columns six and seven show the type I (a bankrupt firms were a-posteriori assigned as non-bankrupt) and the type II (a non-bankrupt firms were a-posteriori assigned as bankrupt) errors for the shown discriminant functions;
- Columns eight and nine show the overall classification accuracy for the initital groups with and without cross validation (here the leave-one-out method was used); and
- The last column provides the classification functions based on linear discriminant analysis.

It is not suprising that ln(sales)² and ln(employees) did not appear as variables, because potential multicollinearity to ln(total assets) and their weaker ability to distinguish between the two types of companies based on differences in means and variances were considered at step-wise-method. Even if no other financial ratio is included, the computed models provided good results. Surely the overall accuracy is weak and type I errors are relatively high. This aspect can be explained by the missing normality of data and partially not given equality of covariance matrices. What must be emphasized in addition is that only one single measure appears in the functions (univariate approach). It is generally recognized that the classification accuracy of models is increasing, when a multivariate approach is used. This means that an extension of the derived models with other potential indicators like capital structure ratios, profitability ratios or liquidity ratios could improve the prediction quality substantially. Nevertheless, the variable ln(sales) itself is a potential explanatory variable for the occurrence of bankruptcy. Another important aspect is that the values for the constants and the weights of ln(total assests) are not fluctuating extremely for the different years and also compared to the whole observation period. This implies that this ratio is not heavily influenced by external factors, so that the variation in non-stationarity is relatively small.

SUMMARY OF RESULTS

The results of this study clearly show that the age of the company is not a relevant variable for the explanation of bankruptcies. This is in contrast to the findings of the theoretical framework, where a high age of the company is associated with lower

probability of bankruptcy. The ratio RETA did not show a high correlation to the age of the firm, but was loaded for all years of the observation period on the same factor like the age of the firm. Therefore it can be concluded that RETA is a proxy for the age of the firms, whose informational content about the "real" age of the firm is however limited to a certain degree. RETA itself only showed for some years significant differences in means between bankrupt and non-bankrupt firms, but was never a statistically significant discriminator for model building. This ratio is also not a relevant variable to explain the differences between both groups. This finding is in contrast to results from certain previous research (Altman, 1968; Frydman et al, 1985; Gilbert et al, 1990; Charitou et al, 2004; Chi & Tang, 2006; McKee, 2007; Altman et al, 2010; Hauser & Booth, 2011), but confirms results from studies with similar findings (Poston et al, 1994; Thornhill & Amit, 2003; Chancharat et al, 2010).

TABLE 9. MEAN LN(TOTAL ASSETS) OF BANKRUPT AND SOLVENT FIRMS, 2000-2011

Year	Mean ln(Total Assets) of Bankrupt Firms	Mean ln(Total Assets) of Solvent Firms
2000	15.01	16.21
2001	13.97	16.07
2002	14.60	15.92
2003	14.00	15.86
2004	14.13	15.93
2005	14.24	15.96
2006	14.02	15.98
2007	14.07	16.00
2008	14.91	16.06
2009	14.41	16.05
2010	14.43	16.16
2011	14.45	16.28

The variable ln(total assets) showed an impressive performance for the different years, but also for the whole observation period as well. It was the only ratio, whose means and variances were significantly different between bankrupt and non-bankrupt at the 5% level and confirms its importance for bankruptcy prediction task. The ratios ln(sales), ln(sales)^2 and ln(employees) are highly and at the 1% level significantly correlated with ln(total assets). Additionally these ratios are all together loaded on the same factor based on PCA. This indicates that they are measuring the same dimensions and are proxies for each other. Nevertheless, it is sufficient to only consider ln(total assets) for discrimination between different groups. Table 9 provides the means of ln(total assets) for bankrupt and non-bankrupt companies for different years.

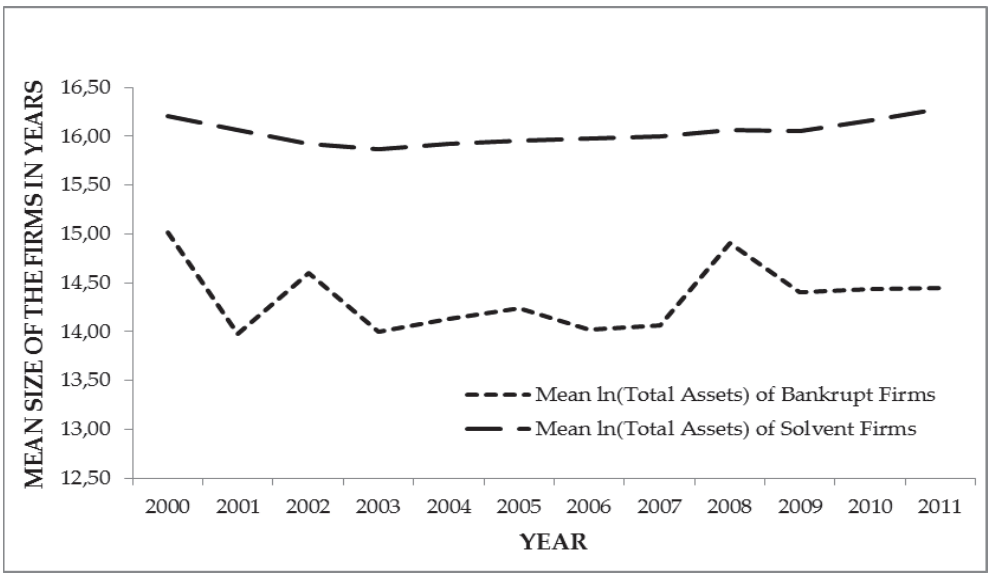

FIG. 4 MEAN LN(TOTAL ASSETS) FOR BANKRUPT AND NON-BANKRUPT FIRMS

In contrast to the illustrations about the age of the firm one can see in Figure 3 that the curves for both types of companies are differing and based on the analyses theses differences are also statistically significant. Generally, the results provide evidence that firms with greater size are less likely to fail. This aspect is also in congruence with results from prior research (Ohlson, 1980; Lennox, 1999a; Begley et al, 1996; Theodossiou et al, 1996; Dawley et al, Chava & Jarrow, 2004; Chi & Tang, 2006; Hol, 2007; Pervan & Visic, 2012).

IMPLICATION, RESTRICTIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The posted hypotheses can be now tested due to the obtained statistical results. H1 and H2 must be rejected. Based on the results from Table 5 there were several years, where the differences in means and variances for the age of the firms and for RETA were not statistically significant. Additionally neither variables were relevant as predictors within discriminant analysis. H3 and H4 can be accepted, when the size of the firm is proxied by ln(total assets). Within Table 5 this ratio showed statistically significant differences in means and variances between the two groups for all years and for the whole observation period.

To sum up the age of the firm, including its proxy RETA, are not relevant explanatory variables for the differences in bankrupt and non-bankrupt companies. The most suitable predictor is ln(total assets), which showed throught the different statistical tests and applications a good and stable ability to differentiate between the two groups of companies. Grounded on the obtained discriminant functions it is visible that the values for the constant and the weights for ln(total assets) were different for the individual years. However, their variablility was limited as the values ranged within a small interval. Such an implication is raising the question, to what extent and under which situation ln(total assets) could be a stationary variable

for bankruptcy prediction models.

This question can not be answered within this study, as this was not the purpose. But the results seem to give indication about this possibility, which would be a very helpful innovation for theoretical and practical purposes. The non-stationarity of ratios as predictors is one of the most important aspects in model building and a solution for this purpose will be a great step towards a potential theory for insolvency prediction. Therefore further research into this direction would be recommendable.

The age of the firm and the size were not highly correlated within this work. This is in constrast to the shown theoretical framework, but also to some results from previous research. The explanation for this can be found in the firm landscape of Austria, which is heavily based on small and medium-sized companies, which are in most cases family firms. Such families are passed on for generations and are having a certain age, which must not be correlated with size. The aims of family companies are different from those of companies managed by renumerated professionals. One of the main purposes of family companies is to guarantee the survival for the actual and the next generation and they are also showing altruistic tendencies like security for their employees, social and ethical responsibility. Profit is an important aspect for the survival of the family, but it is not the dominant strategic aspect. For the primarly goals it is therefore not necessary to grow in size, even if the company is having a high age.

By all means, the derived findings and results face some limitations. The first can be seen in the data base, which contains a small number of insolvent companies. Generally, it must be emphasized that the the phenomenon of bankruptcy is in practice an event, which does not occurr that often, so that insolvency rates (computed as number of insolvencies relative to the number of all companies) are relatively low. This is also true for the data base of this study shown in Table 1. Therefore the data to a certain degree well replicate the situation of the real world. Nevertheless, the different proportions between bankrupt and non-bankrupt companies can affect the reliability of the statistical results.

The second limitation can be seen in the regionality of data as the companies are all located in Austria. The results showed some divergence to prior literature, which could be reasoned on this special aspect. Austria shows structural differences to other countries. This puts in question the comparison of the findings from this work to results from other research based on firms from a totally different geographic region and economic structure. The comparison of ln(total assets) as potential predictor for bankruptcy prediction for different countries could therefore also be seen as an interesting task for further research.

REFERENCES

Abidali. A. F. & Harris, F. (1995). A methodology for predicting company failure in the construction industry, Construction Management and Economics, 13, 189-196.

Altman. E. I., Sabato. G. & Wilson. N. (2010). The value of non-financial information in small and medium-sized enterprise risk management, The Journal of Credit Risk, 6 (2), 1-33

Altman. E. I., Haldeman. R. G. & Narayanan, P. (1977). ZETA™ analysis: A new model to identify bankruptcy risk of corporations, Journal of Banking and Finance, 1, 29-54.

Altman. E. I. (1968). Financial ratios. discriminant analysis and the prediction of corporate bankruptcy, The Journal of Finance, 23 (4), 589-609.

Barniv. R., Agarwal. A. & Leach. R. (2002). Predicting bankruptcy resolution. Journal of Business Finance & Accounting, 29 (3 & 4), 497-520.

Bates, T. (1990) Entrepreneur humand capital inputs and small business longevity. The Review of Economics and Statistics, 72 (4), 551-559.

Begley, J., Ming, J., & Watts, S. (1996). Bankruptcy classification errors in the 1980s: An empirical analysis of Altman´s and Ohlson´s models, Review of Accounting Studies, 1, 267-284.

Ben-Zion, U. & Shalit, S. S. (1975). Size, leverage, and dividend record as determinants of equity risk, The Journal of Finance, 30 (4), 1015-1026.

Berg, D. (2007). Bankruptcy prediction by generalized additive models, Applied Stochastic Model in Business and Industry, 23, 129-143.

Bruse, H. (1978). Die Prognosefähigkeit von Kennzahlen bei verschiedenen Maßen für das Unternehmenswachstum, Zeitschrift für Betriebswirtschaft, 48, 138-152.

Castanias. R. (1983). Bankruptcy risk and optimal capital structure, The Journal of Finance, 38 (5), 1617-1635.

Chancharat, N., Tian. G., Davy, P., McCrae, M. & Lodh. S. (2010). Multiple states of financially distressed companies: Tests using a competing risk-model, Australasian Accounting Business and Finance Journal, 4 (4), 27-44.

Charitou, A., Neophytou, E. & Charalambous, C. (2004). Predicting corporate failure : Empirical evidence for the UK, European Accounting Review, 13 (3), 465-497.

Chava, S. & Jarrow, R. A. (2004). Bankruptcy prediction with industry effects. Review of Finance, 8, 537-569.

Chi. L.-C. & Tang. T.-C. (2006). Bankruptcy prediction: Application of logit analysis in export credit risks, Australian Journal of Management, 31 (1), 17-27.

Cressy. R. (2006). Why do most firms die young?, Small Business Economics, 26, 103 -116.

Dawley, D. D., Hoffman, J. J. & Brockman, E. N. (2003). Do size and diversification type matter? An examination of post-bankruptcy outcomes, Journal of Managerial Issues, 15 (4), 413-439.

Dietrich, J., Arcelus, F. J. & Srinivasan, G. (2005). Predicting financial failure: Some evidence from new Brunswick agricultural co-ops, Annals of Public and Cooperative Economics, 76 (2), 179-194.

Doukas, J. (1986). Bankers versus bankruptcy prediction models: An empirical investigation, 1979-82, Applied Economics, 18, 479-493.

Doumpos, M., & Zopounidis, C. (1998). A multicriteria discrimination method for the prediction of financial distress: The case of Greece, Multinational Finance Journal, 3(2), 71-101.

Dyrberg. A. (2004). Firms in financial distress: An exploratory analysis, Danmarks Nationalbank Working Papers, Nr. 17.

Edmister, R. O. (1972). An empirical test of financial ratio analysis for small business failure prediction, Journal of Financial and Quantiative Analysis, 7, 1477-1493.

Fitzpatrick. J. & Ogden. J. P. (2011). The detection and dynamics of financial distress, International Review of Finance, 11 (1), 87-121.

Frydman, H., Altman, E. I. & Kao, D.-L. (1985). Introducing recursive partitioning for financial classification: The case of financial distress, The Journal of Finance, 40 (1), 269-291.

Gepp, A., & Kumar, K. (2008). The role of survival analysis in financial distress prediction, International Research Journal of Finance and Economics, 16, 13-34.

Gilbert, L. R., Menon, K. & Schwartz, K. B. (1990). Predicting bankruptcy for firms in financial distress, Journal of Business Finance & Accounting, 17 (1), 161-171.

Gombola, M. J., Haskins, M. E., Ketz, E. J. & Williams, D. D. (1987). Cash flow in bankruptcy prediction, Financial Management, 16, 55-65.

Grice, J. S. & Dugan, M. T. (2001). The limitations of bankruptcy prediction models: Some cautions for the researcher, Review of Quantitative Finance and Accounting, 17, 151-166.

Grunert. J., Norden. L. & Weber, M. (2009). The role of non-financial factors in internal credit ratings, Journal of Banking & Finance, 29, 509-531.

Gudmundsson. S. V. (2002). Airline distress prediction using non-financial indicators, Journal of Air Transportation, 7 (2), 3-24.

Hauser, R. P. & Booth, D. (2011). Predicting bankruptcy with robust logistic regression, Journal of Data Science, 9, 565-584

Hol, S. (2007). The influence of the business cycle on bankruptcy probability, International Transactions in Operational Research, 14, 75-90.

Hopwood, W., McKeown, J. & Mutchler, J. (1988), The sensitivity of financial distress prediction models to departures from normality, Contemporary Accounting Research, 5 (1), 284-298.

Houghton, K. A. & Woodliff, D. R. (1987). Financial ratios: The prediction of corporate ´success´ and failure, Journal of Business Finance & Accounting, 14 (4), 537-554.

Iazzolino, G., Migliano, G. & Gregorace, E. (2013). Evaluating intellectual capital for supporting credit risk assessment: An empirical study, Investment Management and Financial Innovations, 10 (2), 44-54.

Jovanovic. B. (1982). Selection and the evolution of industry, Econometrica, 50 (3), 649-670.

Jovanovic, B. & MacDonald, G. M. (1994). The life cycle of a competitive industry, Journal of Political Economy, 102 (2), 322-347.

Klecka, W. R. (1980), Discriminant analysis, SAGE University Papers, Series: Quantitative Applications in the Social Sciences, Newbury Park, SAGE Publications, Inc.

Lau, A. H.-L. (1987). A five-state financial distress prediction model, Journal of Accounting Research, 25 (1), 127-138.

Lennox, C. (1999). Identifying failing companies: A re-evaluation of the logit, probit and DA approaches, Journal of Economics and Business, 51, 347-364.

Lennox, C. S. (1999). The accuracy and incremental information content of audit reports in predicting bankrupt, Journal of Business Finance & Accounting, 26 (5 & 6), 757-778.

Liou, D.-K., & Smith, M. (2007). Macroeconomic variables and financial distress, Journal of Accounting – Business & Management, 14, 17-31.

Madrid-Guijarro, A., Garcia-Perez-de-Lema, D. & van Auken, H. (2011). An analysis of non-financial factors associated with financial distress, Entrepreneurship & Regional Development, 23 (3 - 4), 159-186.

McKee, T. E. (2007). Altman's 1968 bankruptcy prediction model revisited via genetic programming: New wine from an old bottle or a better fermentation process? Journal of Emerging Technologies in Accounting, 4, 87-101.

McKee, T., & Lensberg, T. (2002). Genetic programming and rough sets: A hybrid approach to bankruptcy prediction, European Journal of Operational Research, 138, 436-451.

Mensah, Y. M. (1984). An examination of the stationarity of multivariate bankruptcy prediction models: A methodological study, Journal of Accounting Research, 22 (1), 380-395.

Mohamad, I. (2005). Bankruptcy prediction model with ZETAc optimal cut-off score to correct type I errors, Gadjah Mada International Journal of Business, 7 (1), 41-68.

Moulton, W. N. & Thomas. H. (1993). Bankruptcy as a deliberate strategy: Theoretical considerations and empirical evidence, Strategic Management Journal, 14, 125-135.

Muller, G. H., Steyn-Bruwer, B. W. & Hamman. W. D. (2009). Predicting financial distress of companies listed on JSE – A comparison of techniques, South African Journal of Business & Management, 40 (1), 21-32.

Nam, C. W., Kim, T. S., Park, N. J. & Lee, H. K. (2008). Bankruptcy prediction using a discrete-time duration model incorporating temporal macroeconomic dependencies, Journal of Forecasting, 27, 493-506.

Nam, J.-H., Jinn, T. (2000). Bankruptcy prediction: Evidence from Korean listed companies during the IMF crisis, Journal of International Financial Management and Accounting, 11 (3), 178-197.

Ohlson, J. A. (1980). Financial ratios and the probabilitistic prediction of bankruptcy, Journal of Accounting Research, 18 (1), 109-131.

Pervan, I. & Kuvek, T. (2013). The relative importance of financial ratios and nonfinancial variables in predicting of insolvency, Croatian Operational Research Review, 4, 187-198.

Pervan, M. & Visic, J. (2012). Influence of firm size on its business success, Croatian Operational Research Review, 3, 213-223.

Platt, H. D., Platt, M. B. & Pedersen. J. G. (1994). Bankruptcy discrimination with real variables, Journal of Business Finance & Accounting, 21 (4), 491-510.

Pohar, M., Blas, M. & Turk, S. (2004), Comparison of logistic regression and linear discriminant analysis: A simulation study, Metodološki Zvezki, 1 (1), 143-161.

Poston, K. M., Harmon. K. W. & Gramlich, J. D. (1994). A test of financial ratios as predictors of turnaround versus failure among financially distressed firms, Journal of Applied Business Research, 10 (1), 41-56.

Sarlija, N., & Jeger, M. (2011). Comparing financial distress prediction models before and during recession, Croatian Operational Research Review, 2, 133-142.

Subhash, S. (1996). Applied multivariate techniques, New York, John Wiley & Sons, Inc.

Sung, T. K., Chang, N. & Lee, G. (1999). Dynamics of modeling in data mining: Interpretive approach to bankruptcy prediction, Journal of Management Information Systems, 16 (1), 63-85.

Theodossiou, P., Kahya, E., Saidi, R. & Philippatos, G. (1996). Financial distress and corporate acquisitions: Further empirical evidence, Journal of Business Finance & Accounting, 23 (5), 699-719.

Thornhill, S. & Amit, R. (2003). Learning about failure: Bankruptcy. firm age. and the resource based view, Organization Science, 14 (5), 497-509.

Ucbasaran, D., Westhead, P., Wright, M. & Flores, M. (2010). The nature of entrepreneurial experience. business failure and comparative optimism, Journal of Business Venturing, 25, 541-555.

Vuran, B. (2009). Prediction of business failure: A comparison of discriminant and logistic regression analysis, Istanbul University Journal of the School of Business Administration, 38 (1), 47-63.