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Bankruptcy probability and the cost of debt

An empirical investigation

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Summary

The relevance of bankruptcy probability is endorsed by the majority of scholars. The precise effect of bankruptcy probability on the cost of debt however, is still under debate. A reason for this ongoing discussion is the ongoing innovations with respect to bankruptcy probability models. Although there are some widely used models, such as the Altman Z-score, a definitive accurate prediction model is lacking. This paper contributes to both discussions by first reviewing the determinants of bankruptcy probability using a logit regression. The main focus of this paper however, lays on examining the relation between bankruptcy probability and cost of debt. Multiple possible characteristics of this relation will be investigated.

In order to estimate the effect of bankruptcy probability on cost of debt bankruptcy probability scores were first estimated using a logistic regression. A fixed effects and a random effects model were used to estimate the effect of bankruptcy probability on the cost of debt. The dataset that was constructed consists of 1044 firms with data ranging from 2010 up until 2017. Of these 1044 firms 449 had filed for bankruptcy in the mentioned time period. This comes down to an average bankruptcy rate of 4.49 percent.

The results of the logistic regression revealed that levels of assets and debt, financial ratios as well as performance indicators all had a significant effect on the bankruptcy probability of a firm, with the current ratio and the return on assets exhibiting especially strong effects. In addition, the industry and country in which a firm is active have a significant effect as well.

The results of the fixed and random effects models support the hypothesis that an increase in bankruptcy probability leads to an increase in the cost of debt. The estimated effect of a 10 percentage point increase in bankruptcy probability, using a random effects model including control variables, on the cost of debt is a 0.33 percentage point increase. This implies an 8.37 percent increase over the average cost of debt of 4.3 percent. In addition, evidence was found to support the statement that the effect of bankruptcy probability on cost of debt is exponential. No evidence was found to assume that there are differences between large and small firms.

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1 Introduction

1.1 Research problem

Capital structures have been studied extensively in financial research. Many theories have been constructed that describe the determinants of capital decision making within firms. A relatively unresolved issue within this field is the importance of bankruptcy costs. With some exceptions, most scholars seem to agree that cost associated with an incidence of business failure are significant. Consensus is missing however, on the impact and influence of these costs on the cost of capital and therefore capital decision making within firms. In addition, questions remain regarding specific characteristics of the relation between bankruptcy probability and cost of capital such as linearity and interaction effects.

To predict the probability of bankruptcy, many models have been constructed. Examples are the ZETA model (Altman, 2000) and the Ohlson model (Ohlson, 1980). Empirical research on the accuracy of these models produces mixed results (Begley, Ming, & Watts, 1996). The accuracy of the models seemed to be relatively high in the periods within which the models were constructed, relatively lower in more recent periods (Begley et al., 1996). This would imply a change in the underlying determinants of bankruptcy over time. Even more recently, improvements are made with respect to the prediction accuracy of bankruptcies (Du Jardin, 2010). Modern research on bankruptcy probability can unveil how determinants of bankruptcy probability have changed recently and how business failures can be best estimated.

1.2 Research goal

The goal of this research relates to the general interest in firm capital structures and more specifically debt financing. Focus is laid on the cost of debt, because debt financing is the main source of capital for most firms and bankruptcy probability is especially important for suppliers of debt financing. The main goal is to gain insights in the effects of bankruptcy probability on the cost of debt of firms. Furthermore, specific characteristics of this relation are hoped to be discovered. In addition, this study aims to strengthen knowledge on bankruptcy determinants by reviewing multiple methods to estimate bankruptcy probability. Overall, this study aims to amplify the existing literature on the relevance of bankruptcy probability and costs for firms, as this is an issue that is, due to multiple reasons, to a certain degree still unresolved. More interest in this particular subject is therefore hoped to be generated by conducting this research.

1.3 Research question

In order to address the research problem and pursue the goal elaborated above, the following research question has been constructed:

What are the determinants of bankruptcy probability and what is the effect of bankruptcy probability on the cost of debt acquired by firms?

This question addresses the central relation between bankruptcy probability and cost of debt, which are the main variables of interest. In addition, the first part of the question allows for the factors best capturing the bankruptcy probability of firms to be reviewed. This question will therefore enable the goals of the research to be achieved and support the structure of the remainder of the study.

1.4 Relevance

The significance of bankruptcy costs has been debated for a very long time (Altman, 1984; Brealey & Myers, 1984; Haugen & Senbet, 1988) Results from empirical research in recent years has not settled the debate as there has not yet been a definite conclusion on relative size of bankruptcy costs (Davydenko, Strebulaev, & Zhao, 2012; Glover, 2016). This paper will contribute to the existing theoretical framework on bankruptcy costs by examining the effects of bankruptcy probability on the cost of debt. It is therefore able to shed more light on the relative importance of bankruptcy costs through focusing on the influence of the probability of these costs being incurred by a specific firm on the costs of debt of these specific firms. In addition, this research will examine possible characteristics of this relationship. This study can further contribute by reviewing the determinants of the bankruptcy probability of a firm.

As the study examines a determinant of the cost of debt and therefore cost of capital of firms, it can help managers gain more insight in the determinants of their cost of capital and therefore help them make more informed capital decisions. In addition, the results of the study can also be relevant for suppliers of finance, as the study will elaborate on bankruptcy probability determinants. The study therefore holds practical relevance, in addition to scientific relevance.

1.5 Structure

This paper will advance in the following structure. First, the existing literature with respect to the main concepts of this study, bankruptcy probability and cost of debt, will be reviewed. In this section, the hypothesis that result from this theoretical study will be formulated. Consecutively, the research methods that are utilized in order to retrieve results will be discussed. Subsequently, the outcomes of the regression analysis will be presented. The scientific and practical relevance of these results will be discussed. Finally, a conclusion will be formulated regarding the main research question.

2 Literature review

This research focuses on the relation between bankruptcy probability and cost of debt. The majority of prior research has focused on the relation between bankruptcy probability and the cost of capital. As debt is a primary element of capital, the above mentioned research can be utilized to elaborate on the relation between bankruptcy probability and cost of debt. The literature discussed below is therefore predominantly concentrated on capital as a whole, rather than debt specifically.

2.1 Bankruptcy probability

Determinants of bankruptcy probability

Recent empirical research on the impact of both the number and types of bankruptcy causes has been conducted by Lukason and Hoffman (2014). They used a sample of 70 Estonian firms that had gone bankrupt to study the determinants of business failure and the effects of these failures. They found that firms suffering from multiple causes of business failure had a significantly higher pre-failure estimated bankruptcy probability than firms suffering from merely a single cause of business failure (Lukason & Hoffman, 2014, p. 85). They grouped the different causes of business failure into two categories, internal and external. Internal causes of failure are defined as *"as those that are within management's control"* (Lukason & Hoffman, 2014, p. 82). These include both operational and strategic management decisions in business units such as marketing, finance and human resources. External causes of business failure are defined as *"those that stem from outside of the firm and are not in management's control"* (Lukason & Hoffman, 2014, p. 82). Although these factors are outside management control, they might require an appropriate response from the firm. Examples of external causes are changes in the environment such as economic downturns, changes in the industry such as new entrants as well as unexpected events such as a natural catastrophe. They found that there is no significant difference between the scores of firms failing due to multiple types of causes and firms failing due to a single type of causes (Lukason & Hoffman, 2014, p. 85).

The taxonomy describing internal and external causes of business failure, used by Lukason and Hoffman, seems to be dominant in the literature. Early contributions were made by Robert Boyle and Harsha Desai (1991), who designed a conceptual framework to identify the determinants of business failure among small firms. 24 factors were identified that could be grouped into four categories: internal administrative, internal strategic, external administrative and external strategic (Boyle & Desai, 1991, p. 35). The distinction internal vs. external refers to whether a factor is internal to the firm or not. The distinction between administrative and strategic factors refers to the type of response that is necessary to combat the issue (Boyle & Desai, 1991, p. 36).

Arjen Witteloostuin (1998) found that human and social capital strongly predicted the dissolution of firms. The study emphasizes the importance of importance of firm-level social and human capital in creating a competitive advantage and the survival of the firm. This is especially true when the capital is held by its owners and is specific to the firm (Pennings et al., 1998, p. 438). The results show that human and social capital are important determinants of firm survival, especially for new/small firms, as the capital mentioned above is usually firm specific and held by the owners. Kamel Mellahi and Adrian Wilkinson (2004) stress that managers are the principal decision-makers in firms and, consequently, their actions and decisions are the primary causes of firm failure. They suggest an integrated framework that combines multiple factors that determine bankruptcy probabilities. They too distinguish between external and internal factors and emphasize the interactions between different factors. They further distinguish between four categories: environmental factors, ecological factors, organizational factors and psychological factors (Mellahi & Wilkinson, 2004, p. 32).

The probability of going bankrupt is significantly higher for small firms (especially for new firms) than for large firms exhibiting similar performance outcomes and other determinants of bankruptcy probability. A reason why the probability of a bankruptcy might be higher for small firms as opposed to larger more mature firms is the fact that smaller firms cannot rely on reputation to maintain trust by important stakeholders. A smaller firm will for example be more quickly pressured by suppliers to make early payments when it is experiencing financial distress as opposed to a larger firm that can rely on its reputation to negotiate more favourable payment terms.

The above reviewed literature describes the multiple causes of bankruptcy, but how to measure the probability that a firm will enter a bankruptcy. Multiple methods have been constructed to estimate the probability that a firm will go bankrupt. As stated by Altman (1984, p. 1084), the Zeta model is a somewhat dated model that can be utilized to measure the probability of bankruptcy at a particular point in time. Although the model is quite old, it is a good potential method to calculate bankruptcy probability as empirical testing has concluded that the ZETA model is accurate in 90% of the cases one year prior and 70% for a period up to 5 years (Altman, 2000, p. 32). The ZETA model calculates the probability of bankruptcy based on 7 variables: Return on assets, Stability of earnings, Debt service, Cumulative profitability, liquidity, Capitalization and Size (Altman, 2000, p. 37). Another model to estimate the cost of bankruptcy has been developed by Ohlson (Ohlson, 1980). He identified four basic factors that were statistically significant determinants of the probability of bankruptcy: firm size, financial structure, performance and current liquidity.

Bankruptcy costs

There are is no consensus about the relevance of bankruptcy costs for firms. There are many views on the relevance of bankruptcy costs that can be grouped in two ends of the spectrum (Altman, 1984, p. 1067). On the one hand, it is argued that bankruptcy costs are relevant and therefore at a specific point the tax benefits of increasing leverage is offset by the costs of increased bankruptcy probability. At this point, the theoretical optimal capital structure is reached. On the other hand, it is argued that bankruptcy costs are relatively unimportant and therefore have little or no effect on the capital decisions of firms and should therefore not be considered.

Bankruptcy costs are costs that are incurred as a result of a firm entering bankruptcy. “Dead weight” costs are costs that are incurred in the event of a bankruptcy that have a negative impact of the value of a firm (Altman, 1984, p. 1068). This includes payments to third parties such as trustee expenses, filling fees as well as legal and accounting fees. These costs are deducted from the net value of a firm when bankruptcy causes the firm to be liquidated. This can lead to a firm value that is lower than the market capitalization that is based on discounted expected future cash flows. As a result of this lower firm value, some financial obligations of the bankrupt firm cannot be met during the liquidation process. This implies that certain stakeholders, including debt financers, will not be able to recover their funds invested.

DeAngelo and Masulis were of the first to mention the importance of bankruptcy costs. They built on the optimal capital structure framework developed by Modigliani and Miller (1958). They state that *"market prices will capitalize personal and corporate taxes in such a way as to make bankruptcy costs a significant consideration in a tax benefit-leverage cost trade-off”* (DeAngelo & Masulis, 1980, p. 10) They stress that even bankruptcy costs of no more than 5 percent of total value can have a significant effect on the optimal capital structure of firms.

Empirical evidence on the importance of bankruptcy costs was first provided by Altman (1984). He concludes that bankruptcy costs are in fact significant and therefore relevant. After investigating 17 firms that went bankrupt, he found that bankruptcy costs amounted on average between 11 and 17 percent of total firm value up to three years prior to the bankruptcy (Altman, 1984, p. 1087). To measure the costs of bankruptcy, a distinction is made between direct and indirect costs (Altman, 1984, p. 1073). Direct costs refer to costs paid by the debtor during the liquidation process. Indirect costs relate to the loss of potential revenue and profit. The direct costs amounted up to 6 percent of firm value, while the indirect costs were significantly higher with on average 10 percent of value. The costs were found to be especially large for industrial firms (Altman, 1984, p. 1077). The significance of bankruptcy costs is further supported by Brealey and Myers (1984, p. 395) , who state that “We do not

know what the sum of direct and indirect costs of bankruptcy amounts to. We suspect it is a significant number particularly for large firms for which proceedings would be lengthy and complex."

An opposing view that bankruptcy costs are trivial and should therefore not be considered when analysing capital structures and cost of capital is given by Haugen and Senbet (1988). They state that the only costs incurred in a bankruptcy are liquidation costs and claim that these costs have no significant effect on the capital decision making. Even during liquidation, the value of the firm is maximized and bankruptcy probability as a consequence does not affect the capital structure of firms.

Recent empirical research supports the notion that bankruptcy costs are significant. Davydenko, Strebulaev and Zhao (2012) estimated the cost of default on average to be 21.7 percent of total market value. Even more recent empirical research has been conducted by Ben Glover (2016). He argues that studies that found low default costs suffer from a selection bias as these studies often focus on a sample of default incidences. Glover argues that firms that expect to incur high costs in case of default consciously choose a lower level of leverage, effectively lowering the probability of default. The firms that expect to incur low costs of default choose a higher level of leverage and therefore a higher probability of default. These firms would therefore be disproportionally represented in a sample of default firms. Due to the low costs of default that these firms incur, the average default costs that would be found would be low. This average is not generalizable to the true population due to the selection bias. The true average bankruptcy costs will be higher. This study shows that bankruptcy costs are more significant than has been assumed to date.

The above discussed research supports the notion that bankruptcy costs are indeed significant and therefore influence the cost of capital, including debt, of a firm. In line with these findings, the following hypothesis has been constructed:

Hypothesis 1: *Firms exhibiting a higher bankruptcy probability will experience higher costs of debt.*

(Non-) Linearity

The relation between bankruptcy probability and cost of debt can be described as a relation between a form of firm-specific risk and yields received by debt financers. The idea that the relation between risk and utility might be non-linear has already been introduced in 1959 by Archibald (Archibald, 1959).

Recent evidence that the relation between risk and yields are non-linear has been presented by Peter Feldhütter et al. (2018). Their empirical analysis revealed a non-linear relation between U.S. bond yields and variances. As bankruptcy probability affects the (credit) risk attributed to a specific firm, it is expected that the relation between bankruptcy probability and cost of debt is non-linear as

well. Furthermore, the relation is expected to exhibit increasing growth in cost of debt, relative to the growth in bankruptcy probability. This expectation is based on the rationale that banks and other suppliers of credit demand surpassing compensation when the risk increases due to increased probability of bankruptcy. This is due to the fact that suppliers of credit are to some extend risk averse and therefore want to be compensated disproportionally for the increased risk they bear.

Applying this rationale to the relation between bankruptcy probability and cost of debt, it can be stated that the relation between bankruptcy probability and cost of debt will be characterized by an exponentially increasing effect. The following hypothesis has therefore been formulated:

Hypothesis 2: *The effect of an increase in bankruptcy probability will increase as bankruptcy probability increases.*

Firm size and bankruptcy costs

Brealey and Myers (1984) assume that bankruptcy costs are more relevant for large firms due to lengthy and complex proceedings. The main argumentation for this assumption are the high direct costs due to high legal fees that are associated with a business failure of a large firm. The empirical evidence on this matter however is mixed. Several studies seem to support the rationale of Brealey and Myers (Baxter, 1967; Stanley & Girth, 1971; Van Horne, 1976).An early study by Jerold Warner (1977) found that the relative costs of a bankruptcy declined as the value of the firm increased. This would imply a negative relation between firm size and bankruptcy costs. A possible explanation for these different results is the different data samples that were used. Warner based his results on a sample that was limited to large railroad companies, whereas empirical studies by Baxter (1967), Stanley and Girth (1971) and Van Horne (1976) examined entities of much smaller size. This could imply a non-linear relation between firm size and bankruptcy probability. At smaller end of the spectrum, bankruptcy costs rise as the firm grows as a possible bankruptcy leads due to more lengthy and complex proceedings. As a certain firm size is reached, a further increase in firm size lowers the costs associated with a business failure as the complexity of the process has reached its maximum, while benefits of further growth are still achieved such as economies of scale.

Following the rationale of Brealey and Myers (1984), this study assumes that bankruptcy costs are indeed higher for large firms with respect to smaller firms as the process of a bankruptcy may be less complex and therefore less costly for new and small firms. The following hypothesis has therefore been constructed

Hypothesis 3: The effect of bankruptcy probability on cost of debt will be relatively higher for large firms with respect to smaller firms.

2.2 Cost of debt

Cost of capital

An overview of the theoretical framework related to cost of capital has been presented by Shannon Pratt and Roger Grabowski (2010). In their paper cost of capital is defined as "*the expected return market participants require in order to attract funds to a particular investment.*" (p. 1) Cost of capital are a form of compensation for the opportunity costs of investors, as investors give up their option to invest in a different project when they allocate their funds to a particular investment. Investors will therefore require a rate of return that is at least equal to the best alternative investment opportunity. Although the concept of cost of capital is forward looking, the actual calculation is often based on historical data. Cost of capital represent investor expectations of the firm/investment and consist of two elements: the risk free rate and a specific risk adjustment (Pratt & Grabowski, 2010, p. 3).

The foundation for an operational definition of the cost of capital has been laid by Franco Modigliani and Merton Miller (1958). They were the first to move beyond the belief that the cost of capital are equal to the interest payed on bonds. The cost of capital are influenced by the capital structure as they theorize that increasing financial leverage will lead to lower cost of capital.

Cost of capital consists of the cost of debt and the cost of equity. An often used calculation of the cost of capital is the weighted average cost of capital (WACC). The WACC corrects the costs of debt and equity for their portion of total capital to derive an average cost of capital for the firm. The cost of debt can be derived quite easily by identifying the interest payment that has to be made on the debt outstanding. Cost of equity are more complex. A widely used method to determine the cost of equity is the capital asset pricing model (CAPM) first introduced by Jack Traynor (French, 2003). This model estimates the cost of equity using a formula that includes a risk free rate, market risk and a beta coefficient that accounts for firm specific risk. Although more accurate approaches to estimating cost of equity have been constructed, the CAPM model is still widely used due to its simplicity. Nonetheless, this method for calculating the cost of capital is not uncriticised.

An interesting insight in this discussion has been presented by Chong, Jin and Phillips (2014). They argue that the approach of the CAPM towards risk is incorrect. The beta coefficient in the CAPM represents firm specific risk and is a measure of systematic risk. It does not differentiate between up- and downside risk. A hypothetical investment that yields exceptionally high positive returns in favourable market conditions and minor losses in unfavourable market conditions would, using the CAPM model, still have a high beta coefficient. This does not comply with how investors view risk. Investors are loss averse and therefore predominantly focus the probability of losses. Investors would therefore require a higher rate of return for investing in projects that are characterised by high levels

of downside risk in comparison with projects exhibiting high upside risk. This would imply that increased bankruptcy probability has a strong effect on the amount of compensation required by investors as an increased bankruptcy probability corresponds with an increased probability of losses occurring.

Christian Koziol (2014) has studied the implications of bankruptcy costs for the weighted average cost of capital (WACC). He found that including default risk leads to a significantly higher WACC discount rate. He states that the default risk and bankruptcy costs are disregarded in the 'traditional' WACC calculation as the model assumes there to be no possibility of the firm going bankrupt. In order to correct for bankruptcy costs, the model is adjusted in two ways. First, the model includes the tax benefits that can be generated if debt is used to finance the organisation. These benefits however are only enjoyed when the company survives. These benefits are therefore multiplied by the probability of survival (the reverse of the bankruptcy probability) to correct for this. Second, the costs of a bankruptcy are incorporated by multiplying the bankruptcy probability with the associated bankruptcy costs, which are proportionate to firm value. Although the traditional model can be applied to firms with a good investment rating, as bankruptcy is less probable in these cases, it certainly is not appropriate for firms which do not have a high investment ranking as they suffer from considerable bankruptcy costs (Koziol, 2014, p. 664). These costs, if included, can in certain cases increase the WACC with over 50%.

Britzelmaier et al. (2013) have investigated the implications of applying value based management concepts (VBM), one of them being the WACC, on small to medium-sized enterprises (SMEs). They state that VBM concepts were developed for large publically traded and recognize that the application of these concepts to small firms poses some problems (Britzelmaier et al., 2013, p. 7). The major problem resides with the calculation of the beta, a firm specific risk indicator that is used to calculate the cost of equity. As relevant capital market figures cannot be derived for small firms, this approach are not appropriate for small firms. Three alternative approaches are presented that solve the problem of lacking information (Britzelmaier et al., 2013, p. 9). The Analogy approach uses market data from reference companies that are publically traded in order to derive the beta of the firm. The analysis approach can be used in absence of capital market information. This method tries to connect accounting data from financial statements with a stock beta that is derived from market information. Last, the qualitative approach can be used in the absence of any objective data. In contrast to the above mentioned methods, the qualitative approach considers subjective appraisals to estimate firm specific risk. This study shows that there are considerable differences between small and large (publically traded) firms that should be taken into account when analysing these different types of firms.

Cost of debt

As elaborate above, a key element of cost of capital is cost of debt. Cost of debt is the effective rate of interest paid on funds borrowed from outside lenders. Cost of debt is composed of two parts: the risk free rate and a default premium. The risk-free rate determines the minimum amount of interest a lender will require. Additional interest will be required if the funding is exposed to credit risk. This refers to the chance that the lending party will be unable to return the borrowed amount plus interest. As opposed to cost of equity, cost of debt can be measured more easily by collecting interest payments made by firms. Since interest rates are contractually agreed, they are easy to verify and measure (Britzelmaier et al., 2013, p. 8). Restricting the study to focusing solely on cost of debt rather than cost of capital therefore adds to the practical viability of the study.

A specific benefit of debt financing is the deductibility of interest payments from profits. Interest payments, in contrast to dividend payments, are regarded as costs and can therefore be deducted from profits before taxes. This implies that the effective costs of debt financing are lower than the interest payments as tax costs are reduced. Initial ideas about the effective cost of debt and the provided tax benefits were already discussed by Franco Modigliani and Merton Miller (1958). The benefits that can be obtained depend on the appropriate tax rate, but John Graham discovered that the capitalized tax-reducing benefit of interest payments makes up about 10 percent of firm value (Graham, 2000, p. 1935).

Debt financing is an important source of funding for firms. A recent study by Huynh, Paligorova and Petrunia (2018) revealed that debt accounted for 44 percent of the total capital of public firms and 50 percent of total capital in private companies. This illustrates the importance of debt financing in the capital structure of both public and private firms. The higher relative amount of debt held by private firms could be explained by different levels of access to debt and equity financing between private and public firms.

The importance of debt is further illustrated by Darush Yazdanfar and Peter Öhman (2015). They examined the effect of debt on the performance of firms and found a significant negative relation between debt ratios and firm performance. This negative relation is a result of increased agency costs that arise when debt levels are high.

3 Research Method

3.1 Method

First, a logistic regression will be performed in order to review the determinants of bankruptcy probability and estimate a bankruptcy probability score for each firm. A logistic regression is chosen, because it was found to provide the best overall predictive accuracy among other estimation techniques (Muller, Steyn-Bruwer, & Hamman, 2009). In order to answer the research question: "*What is the effect of bankruptcy probability on the cost of debt of firms?"* a pooled regression analysis will first be performed. The results will be tested for potential bias using a chow test. If a bias is discovered, both a random effects and a fixed effects model will be performed to correct for this bias.

3.2 Operationalization

The main variables of interest in this research are bankruptcy probability and the cost of debt. In order to measure the effect of bankruptcy probability on cost of debt these variables have been operationalized.

Bankruptcy probability: Multiple methods are used in this study to assign a bankruptcy probability score to each firm. First a logistic regression is used to estimate a bankruptcy probability score as this estimation techniques has proven to provide the highest overall prediction accuracy (Muller et al., 2009). In addition, In order to allocate a bankruptcy probability to a firm, the firms in the sample are divided into multiple groups based on multiple categorizations. All firms within a particular group are assigned a bankruptcy probability that is equal to the average survival rate of the firms that are part of the group. The categorization process will be repeated with different variables including, among others, firm size, profit and revenue. The categorization process is repeated to examine which categorization provides the best overall fit.

Cost of debt: Cost of debt will be operationalized as the interest rate as interest rates represent the effective rate a firm pays on its debt outstanding. It is therefore the best option for a proxy for the cost of debt incurred. The tax-reducing benefits of debt financing are disregarded, because the study controls for inter-country differences. As a consequence, the differences in effective tax rates and therefore benefits of interest payments are corrected for. Data on the exact interest rates that firms pay for individual loans and obligations are not available. Interest rates are therefore calculated by dividing the interest expenses by debt outstanding. This rate is equal to the weighted average interest rate of the firm. Interest expenses of individual firms are derived from Eikon which discloses the interest expense on debt of firms.

Besides the two main variables of interest multiple control variables have been incorporated into the functional model to account for the effects of these variables. The control variables have been chosen based on prior research (Robb & Robinson, 2014). Control variables that are included are: firm size, industry, leverage, liquidity, performance, growth and country of origin. A more detailed discussion of these variables can be found in appendix 1.

3.3 Regression function

Functional form

The basic regression function that will be used to verify whether bankruptcy probability has an effect on the cost of debt takes the following shape:

$$Cost\_of\_Debt = \beta 0 + \beta 1 * Bankruptcy\_Probability + Controls + \alpha + \upsilon$$

Non-linearity

To test the (non-) linearity of the relation between bankruptcy probability and cost of debt an additional variable will be added to the regression function. This variable will be the quadratic function of bankruptcy probability. This allows for the hypothesis two, which states that the relation is non-linear, to be verified. A significant positive estimate of the coefficient of the squared variable would indicate an exponential relation. This means that the effect of a change in bankruptcy probability on cost of debt is higher when the bankruptcy probability is high. If on the contrary, the effect of a change in bankruptcy probability is higher when bankruptcy probability is low, the relation is logarithmic. In this case, the estimated coefficient would be negative.

Interaction effect

To test whether an interaction effect between firm size and bankruptcy probability exists, a regression function will be tested that includes both an interaction term between assets and bankruptcy probability as well as the individual variables assets and bankruptcy probability. Hypothesis three is supported if the coefficient for the interaction term is found to be significant.

3.4 Data

Source

Data will be gathered using Thomas Reuters Eikon. This high-quality commercial database collects detailed company-specific financial information and therefore contains data on the variables of interest and control variables of this research. It can therefore provide this study with the necessary data. The database has been accessed using the licence of the Radboud University.

Sample

The sample time period ranges from 2010 until 2017. This time period has been chosen to limit the influence of the 2008 financial crisis on the results of the study. The crisis lead to disproportionally high incidences of business failures. Including this time period in the sample can therefore lead to biased results. 2017 is the last year for which complete data is available in Eikon and therefore forms a natural ending to the time period. The initial data collection process provides a dataset consisting of 1099 firms.

Data transformation

The cost of debt could not be directly extracted from the EIKON database. To obtain the cost of debt, interest paid on debt is divided by total debt outstanding as these variables could be obtained. After the data had been collected, outlier analysis was performed. Outliers that were identified and were found to be caused by an error in the data were removed from the sample. This led to a minor reduction in the size of the sample. In addition, the variables logassets and logdebt, which consist of the logarithmic functions of assets and debt, were generated to normalize the distribution of assets and debt. The distribution of assets and debt were skewed as a result of a negative limit of zero in combination with no positive limit. This leads to some extremely large firms pulling the average towards a higher amount. After all data transformations the final sample consists of 80.352 observations, divided over 10.044 firms, of which 449 firms have gone bankrupt.

3.5 Robustness tests

As there are multiple variables that affect both the bankruptcy probability and the cost of debt of a firm, the results of this study potential suffer from endogeneity.

A possible solution for the endogeneity issue is the use of an instrumental variable. the instrumental variable method has been used in prior research to correct the endogeneity issue (Cumming, 2008). This study will deploy a similar strategy to examine whether endogeneity leads to biased results. As mentioned in section 3.2, bankruptcy probability will be assigned to firms using a categorization process that divides the firms in multiple groups based on different variables. The group average bankruptcy rate will then serve as the bankruptcy probability of each member of that group. This process is therefore similar to the instrumental variable method as bankruptcy probability is assigned based on an instrumental variable in the categorization process. The results of regression analysis using this alternative method of bankruptcy probability estimation are compared to the results of the main regression analysis in order to examine whether large differences can be observed that might indicate a bias in the main results.

4 Results

Below, the results of the regression analyses will be presented. An overview of the summary statistics is given in appendix 2. The results show that the average cost of debt for bankrupt firms is significantly higher than the average cost of debt for firms that are still active.

In most of the tables presented below, multiple regressions have been performed with different sets of variables included in order to compare these different results and examine which model provides the best fit. The variables that are included can be observed in the table, with exceptions for the industry and country variables. These are included in the analysis, but are not included in the tables in order to limit the size.

4.1 Determinants of bankruptcy

The first part of the research focuses on the determinants of the probability of a firm entering bankruptcy. To estimate the determinants of bankruptcy probability a logit regression has been performed.

	(1) model 1 filed for ~y	(2) model 2 filed for ~y	(3) model 3 filed for ~y	(4) model 4 filed for ~y	(5) model 5 filed for ~y
assets					-2.16e-10*
					(-2.17)
debt					5.56e-10**
					(3.17)
logassets	-0.995***	0.267*	-0.947***		0.266*
	(-21.25)	(2.22)	(-11.99)		(2.21)
logdebt	0.542***	-0.792***	0.423***		-0.795***
	(12.08)	(-6.74)	(5.78)		(-6.74)
return on assets		-4.712***	-5.401***	-7.313***	-4.722***
		(-13.10)	(-15.34)	(-21.41)	(-13.10)
current ratio		-19.57***	-28.11***	-15.29***	-19.71***
		(-4.75)	(-6.86)	(-3.82)	(-4.78)
leverage		3.645***		1.901***	3.634***
		(12.27)		(10.88)	(12.22)
growth of assets		0.112	0.0765	0.151*	0.113
		(1.67)	(1.11)	(2.31)	(1.68)
Constant	3.637***	4.153***	7.723***	-1.158*	4.209***
	(20.07)	(5.86)	(12.34)	(-2.08)	(5.93)
Observations	64737	28352	28464	28352	28352
Pseudo R-squared	0.132	0.423	0.413	0.363	0.425
Log lik.	-5858.4	-2673.5	-2756.1	-2953.1	-2667.9

Table 1: Logistic regression results

The discussion below will be mainly focused on the fifth regression model. Although this regression does not involve all the observations, it encompasses all the variables and therefore reveals more insights in the effects of the different variables. In addition, the pseudo R-squared is significantly higher in the last regression with respect to the alternative regressions. A higher pseudo R-squared indicates a better fitted model with respect to a model with a lower pseudo R-squared (McFadden, 1973). According to Daniel McFadden, a pseudo R-squared of above 0.4 is fairly high. The last logistic regression therefore fits the data well, as the pseudo R-squared is 0.425 (see table 2). In addition, the log likelihood of the fifth regression is the highest of all the regression.

Table 3 shows mixed results regarding the effect of assets on the probability of bankruptcy. This negative relation however is not estimated in the complete model (see table 2, model 5). The inclusion of leverage in the analysis affects the coefficient estimate of assets, because the amount of assets influences the amount of leverage a firm has. To estimate the true coefficients for assets, a regression was performed in which leverage was not included. The results of this regression show that assets do indeed have a negative effect on the probability of bankruptcy (see table 2, model 3). This effect is substantive, as an increase in the logarithm of assets of one, keeping the other variables constant, decreases the logarithm odds of falling in the group of bankrupt firms with .947. This corresponds with a decreased bankruptcy probability of 61.21 percent (1 - e^-0.947). This result indicates that size, as expected, is an important determinant of bankruptcy probability. This is supported by the high level of significance of the estimated coefficient. The decrease of 61 percent appears to be somewhat out of proportion. This particularly large number however is based on an increase of one in the logarithmic function of assets, in contrast to an increase of one in the absolute amount of assets. An increase of one in the logarithmic function corresponds with a tenfold increase of the underlying variable. This means that a tenfold increase in assets, instead of a minor increase in assets, decreases the bankruptcy probability with 61 percent.

Similar to assets, the results on the effect of debt are mixed (see table 2, model 5). When excluding leverage in the third model, the true coefficient estimate for debt is retrieved. In contrast to assets, an increase of 1 in the logarithm of debt leads to an increase in the logarithm odds of going bankrupt of 0.422 (see table 2, model 3). This corresponds with an increased probability of 52.25 percent (e^.422 – 1). Similarly to assets, the estimated change in bankruptcy probability is based on the logarithmic function of debt rather than the amount of debt itself, meaning that an increase in bankruptcy probability of 52 percent is realized when debt increases tenfold.

As predicted by existing theory, an increase in performance leads to a lower probability of experiencing a bankruptcy. The results show that an increase in the return on assets of 1 leads to a

decrease in the bankruptcy probability of 99.11 percent (1 – e^-4.722) (see table 3, model 5). It should be noted that return on assets is depicted in the data in the form of a decimal[1]. An increase of one would therefore imply an increase of 100 percentage points. An increase of 1 percentage point would only lead to a decrease of 4.61 percent[2]. Although this relation complies with the theoretical consensus, the large effect is somewhat unexpected based on the descriptive statistics in table 1. A comparison between bankrupt and non-bankrupt firms revealed that the average pre-bankruptcy performance of bankrupt firms was only slightly worse than that of their surviving counterparts (0.592 vs. 0.624).

In addition, a strong liquid position has a positive effect on the probability of survival. An increase of 1 in the liquidity proxy, current ratio, leads to a decrease in the logarithmic odds of going bankrupt of 19.71 (see table 3). Although this number appears disproportionally large, it should be reminded that, as for return on assets, the current ratio is denominated in decimals and an increase of one corresponds with an increase of 100 percentage points. An increase of one percentage point decreases the logarithmic odds of going bankrupt with 0.1971 (19.71/100). This equals a decreased probability of 17.89 percent[3]. This result is still relatively high and this indicates that the short term solvability of a firm is an important factor for securing continuity.

The coefficient for leverage is positive. This implies that a worsening of the leverage position increases the probability of going bankrupt as an increase in the amount of leverage corresponds with a worsening of the financial position[4]. The unusual results that are found in model 5 are caused by the estimation process of the logistic regression. The coefficient describes the effect of an increase in a specific variable, holding all other variables constant. A change in assets or debt cannot occur without a change in the financial position of a company. An increase in assets, holding debt constant, means an improvement of the financial position of the company and thus a change in the amount of leverage. Similarly, an increase in debt, holding assets constant, corresponds with a worsened financial position. The model cannot estimate the true estimates for assets debt and leverage when all three are included simultaneously, since it estimates the effect of a change in one variable, keeping the other variables constant. The true estimate of leverage is estimated in model 4. In this regression, assets and debt are excluded from the model. The model estimates an increase in bankruptcy probability of 1.92 percent[5] if leverage increases with one percentage point.

[1] A return on assets of 8% would be stored in the data as 0.08

[2] 1 – e^-0.04722 = 0.0461 = 4.61%

[3] 1 – e^-0.1971 = 0.1789 = 17.89%

[4] Keep in mind that leverage is calculated as (Long Term Debt + Short Term Debt & Current Portion of Long Term Debt) / (Total Capital + Short Term Debt & Current Portion of Long Term Debt) * 100

[5] e^(1.901/100) – 1 = 0.0192 = 1.92%

The results show a limited effect of the growth of assets on bankruptcy probability. An increase of 1 percentage point in the growth of assets leads to an increased bankruptcy probability of 0.11 percent[6]. The estimated coefficient however is not significant. Conclusions about the true effect of growth on bankruptcy probability can therefore not be drawn.

	model 5 bankrupt
missing	0 (.)
industrial	0.548 (1.01)
utility	-0.534 (-0.91)
transporation	-0.229 (-0.40)
bank/savings	0 (.)
insurence	0 (.)
other financial	0 (.)

Table 2: Industry effects

Two variables that were included in the analysis, but are not visible in table 3 are industry and country dummies. The coefficients for the different industry dummies can be found in table 4. The results show that the industry a firm is active in significantly effects the bankruptcy probability of that firm. The category missing acts as the reference category, hence the value of 0. The industries banks/savings and insurance also have a coefficient of 0 as there are no firms included in the regression that are active in these industries. The coefficients for the industries utility and transportation are both negative. This implies that being active in one of these industries decreased the probability of bankruptcy. Being active in the industrial sector on the other hand seems to increase the probability of facing bankruptcy. However since no of the results are significant no hard conclusions can be drawn. Being located in some specific countries does have a significant effect on the bankruptcy probability of a firm. However since there are 85 countries included they will not be discussed in detail.

Comparing the effects of the different variables included in the analysis, it can be concluded that the financial resources of a firm are very important factors in securing viability. The ability to counter short-term setbacks with a strong liquid position is of additional importance. Furthermore, performance seems to have a significant influence on the bankruptcy probability of a firm. The growth of a firm appears to be of less influence.

[6] e^(0.133/100) – 1 = 0.0011 = 0.11%

4.2 Cost of debt analysis

In this part of the research, the main question: "*Which variable best estimates bankruptcy probability and what is the effect of bankruptcy probability on the cost of debt acquired by firms?"* will be answered. Multiple regressions will be performed in order to determine the answer to this question. First, the regression will be performed with the bankruptcy probability of the firms being estimated by the results of the logit regression performed above. Second, multiple regressions will be performed with bankruptcy probability being determined by the categorization process described in chapter 3. The variables that form the basis for the different categorizations are chosen based on the logit regression presented in section 4.2. In the end of this section, the possible non-linear character of the relation between bankruptcy probability and the cost of debt will be examined.

Regression based on logit estimation outputs

The logit regression performed in the previous part of this chapter forms the basis for the calculation of the bankruptcy probability for the first regression analysis. The estimation output of the logit regression describes the probability of a firm to fall in the group of bankrupt firm. This estimated probability is retrieved for each individual firm for each year. The estimates serve as the proxy for bankruptcy probability. The bankruptcy probability was assigned in multiple steps. First, bankruptcy probability was estimated using the fifth logit regression performed in section 4.2. As this logit regression utilizes all variables to estimate the probability of going bankrupt, only the firms that have data available for all variables could be assigned a probability score with this regression. Consecutive regressions were performed excluding more and more control variables. The results of each of these regressions were used to estimate probability scores for firms that were not assigned a probability score due to a missing value on any of the variables included in all the previous logit regression models. In this manner, the maximum amount of firms could be assigned a bankruptcy probability score, while simultaneously maintaining a maximum level of accuracy. Table 5 shows the means and standard deviations of the bankruptcy probability for bankrupt and non-bankrupt firms. On first sight, it is visible that the bankruptcy probabilities are significantly higher for bankrupt firms than for non-bankrupt firms. This indicates that the estimates of the logit regression are to a certain extend accurate and reliable, at least for this dataset, and can therefore serve as a proxy for the true bankruptcy probability.

bankruptcy probability	
not bankrupt	0.0255
	(0.0566)
bankrupt	0.359
	(0.343)
Total	0.0327
	(0.0896)

Table 3: Bankruptcy probabilities

Pooled regression

After the bankruptcy probabilities have been estimated for each specific firm, focus returns to the main question of this research: *"what is the influence of bankruptcy probability on the cost of debt?"* In order to answer this question, a pooled regression analysis is first performed. The results of the chow test (see appendix 4) indicate that a pooled regression analysis is not the most appropriate model to be used for this dataset. The results of the pooled regression analysis nonetheless deliver some interesting first insights, which will not be elaborated upon here, but an overview and a discussion of the results can be found in appendix 3.

Fixed effects and random effects models

The fixed effects model is widely used in panel data research, because it is able to capture the effects of the otherwise unaccounted for unique differences between different individuals within the data(Fitzmaurice, Laird, & Ware, 2012, p. 242). Since it captures these unique differences over time, it prevents the omitted variable bias for effects that are time-invariant. The regression function for the fixed effects model differs from the one used in the pooled regression as it includes a term that captures the fixed effect of the time-invariant characteristics of each firm. In addition, it includes an error term that assumes a within-subject random error, rather than an overall random error element (Fitzmaurice et al., 2012, p. 243). These two characteristics of the random effects model cause the fixed effects model to be preferred over the pooled regression when the existence of unique differences between individual subjects within the data have been proven to exist. Since the chow-test has shown that there are unique differences between the firms that are included in the dataset, a fixed effects model is performed. The results of the fixed effects model are presented in table 7.

In addition to a fixed effects model, a random effects model was performed. The difference between a random effects model and a fixed effects model lies in the nature of the firm-specific term that captures the unique differences between firms. Whereas this term is stable over time in the fixed effects model, the random effects assumes this term to be random. The results of the random effects model are presented in table 8.

Fixed effects model vs. random effects model

An advantage of the random effects model over the fixed effects model is the lower sample-to-sample variability as a result of the partially pooling of information across units. It would therefore be preferred above the fixed effects model. A drawback of the random effects model is the potential bias that can arise as a result of a correlation between the firm-specific term and the error term. This correlation can arise as a result of omitted variables that have a significant effect on the cost of debt.

To test whether the results of the random effects model are biased, a Hausman test is performed. This test compares the results of the fixed effects and the random effects model. The results are depicted in figure 2. The results show that there is in fact some bias in the estimation results of the random effects model. This does no however automatically mean that the results of the random effects model should be disregarded. *"in many cases, a biased (random-effects) estimator can be preferable to an unbiased (fixed-effects) estimator if the former provides sufficient variance reduction over the latter"* (Clark & Linzer, 2015, p. 403). The overall R-squared of the random effects model is substantially larger than the overall R-squared of the fixed effects model (0.291 vs. 0.0162). In addition, the rho, a measure of variance, is smaller for the random effects model with respect to the random effects model (0.542 vs. 0.740). This illustrates the advantage of the random effects model and supports the decision to not disregard the results of the random effects model. The results of both the random effects and the fixed effects model will therefore be considered in interpreting the true relation between the cost of debt and the explanatory variables. The fixed effects model can be used to examine the firm-specific mechanisms that influence the cost of debt, while the random effects model is more suited to explain different levels of cost of debt between firms. This can be observed when examining the different varieties of R-squared. The difference between the intra-firm explained variety, the within R-squared, is nearly non-existent, while the difference between the inter-firm explained variety, the between R-squared, is very large (see table 4 & 5).

Results

The results of both the random effects and the fixed effects regression show that bankruptcy probability of a firm has a significant effect on the cost of debt of that firm (see table 7 & 8). Hypothesis 1 stating that "*Firms exhibiting a higher bankruptcy probability will experience higher costs of debt*" is therefore supported. Consensus on the magnitude of this effect however is still lacking between the different regression models with a significant discrepancy between the estimates for the coefficient of the effect bankruptcy probability of 0.016 percent (0.017 vs 0.033). Since the Hausman test revealed that the random effects model is affected by bias to a certain degree, the true size of the effect will lie somewhere between these two estimates. An increase of 1 percentage point in bankruptcy probability therefore leads to a minimum increase in cost of debt 0.017 percent and a maximum increase of 0.033 percent. Whether bankruptcy probability is more effective in effective in explaining intra-firm or inter-firm differences is up for debate. On the one hand, based on the on calculated R-squared in table 4 and 5, it can be stated that bankruptcy probability is a better descriptor of the variance in the cost of debt between firms, rather than within the firm. The between R-squared is significantly higher than the within and overall R-squared. On the other hand, the fixed effects model, as described in the previous section, is more effective at estimating intra-frim effects of different variables. The random

effects model is better able to identify the determinants of inter-firm differences. The higher estimated coefficient of bankruptcy probability in the random effects model might therefore indicate that bankruptcy probability is a more dominant determinant of inter-firm differences, rather than intra-firm differences.

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt	(5) cost of debt	(6) cost of debt
bankruptcy probabi~y	0.0296***	0.0167***	0.0170***			
	(7.47)	(3.48)	(3.54)			
assets			-2.53e-13**	-2.44e-13*		
			(-2.58)	(-2.49)		
debt			7.80e-13**	7.66e-13**		
			(2.85)	(2.80)		
logassets		0.0310***	0.0311***	0.0314***	0.0151***	
		(32.78)	(32.82)	(33.37)	(23.66)	
logdebt		-0.0342***	-0.0343***	-0.0351***	-0.0196***	
		(-41.35)	(-41.43)	(-44.00)	(-46.04)	
leverage		0.0502***	0.0501***	0.0535***		-0.0340***
		(20.11)	(20.09)	(23.23)		(-26.76)
current ratio		-0.149***	-0.148***	-0.156***	-0.199***	-0.185***
		(-7.36)	(-7.34)	(-7.75)	(-9.75)	(-9.00)
return on assets		-0.00563*	-0.00553*	-0.00959***	-0.0202***	-0.0147***
		(-2.15)	(-2.11)	(-4.07)	(-8.48)	(-6.11)
growth of assets		-0.00550***	-0.00549***	-0.00547***	-0.00568***	-0.00620***
		(-21.74)	(-21.72)	(-21.61)	(-21.84)	(-24.23)
year		-0.000173**	-0.000172**	-0.000155*	-0.0000789	-0.000598***
		(-2.69)	(-2.67)	(-2.42)	(-1.20)	(-10.68)
Constant	0.0476***	0.403**	0.401**	0.372**	0.275*	1.286***
	(261.20)	(3.19)	(3.17)	(2.95)	(2.12)	(11.37)
Observations	61699	49111	49111	49111	49253	49111
rho	0.625	0.740	0.740	0.740	0.735	0.745
r2_o	0.0284	0.0162	0.0162	0.0160	0.0158	0.0000234
r2_b	0.0634	0.0194	0.0194	0.0177	0.0194	0.000497
r2_w	0.00106	0.0833	0.0835	0.0832	0.0739	0.0348

Table 4: Fixed effects model results

With respect to the control variables that are included in the analysis, the differences between the results of the fixed effects and the random effects models are limited. The coefficients are therefore likely to be close to their true values. In contrast to theoretical predictions, both models estimate a positive relation between logassets and the cost of debt. This means that an increase in the amount of assets leads to an increase in the cost of debt for a firm. Although the magnitude of the effect is reduced, the relation holds when leverage is excluded as a control variable. In addition, both models estimate a negative relation between logdebt and the cost of debt. This contradicts the theoretical notion that an increase in debt, holding all other variables constant, will result in an

increase in the cost of debt. Again, this relation holds when leverage is excluded from the regression. Possible explanations for these unexpected results are discussed in chapter 5.

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt	(5) cost of debt	(6) cost of debt
bankruptcy probabi~y	0.0620***	0.0323***	0.0327***			
	(22.16)	(9.19)	(9.26)			
assets			-2.23e-13**	-1.95e-13*		
			(-2.88)	(-2.51)		
debt			6.26e-13**	6.10e-13**		
			(2.73)	(2.66)		
logassets		0.0262***	0.0263***	0.0271***	0.0111***	
		(36.37)	(36.45)	(37.94)	(26.45)	
logdebt		-0.0297***	-0.0298***	-0.0313***	-0.0155***	
		(-42.43)	(-42.51)	(-45.85)	(-43.28)	
leverage		0.0491***	0.0491***	0.0554***		-0.0234***
		(23.52)	(23.50)	(28.06)		(-21.78)
current ratio		-0.115***	-0.115***	-0.130***	-0.199***	-0.148***
		(-6.55)	(-6.53)	(-7.44)	(-11.16)	(-8.29)
return on assets		-0.0125***	-0.0124***	-0.0213***	-0.0321***	-0.0316***
		(-5.33)	(-5.28)	(-9.91)	(-14.74)	(-14.45)
growth of assets		-0.00533***	-0.00533***	-0.00528***	-0.00551***	-0.00583***
		(-21.94)	(-21.93)	(-21.71)	(-22.03)	(-23.40)
year		-0.000304***	-0.000303***	-0.000300***	-0.000270***	-0.000772***
		(-5.45)	(-5.44)	(-5.38)	(-4.69)	(-14.00)
Constant	0.0477***	0.685***	0.683***	0.685***	0.664***	1.624***
	(111.22)	(5.89)	(5.87)	(5.88)	(5.52)	(13.99)
Observations	61699	49111	49111	49111	49253	49111
rho	0.587	0.542	0.542	0.543	0.560	0.547
r2_o	0.0284	0.291	0.291	0.287	0.264	0.243
r2_b	0.0634	0.342	0.342	0.335	0.303	0.280
r2_w	0.00106	0.0800	0.0802	0.0802	0.0714	0.0311

Table 5: Random effects model results

In tables 4 and 5, it can be observed that the financial position of a firm has a significant effect on the cost of debt incurred by the organisation. An increase of ten percentage points in leverage, indicating a worsening of the financial capacity of a firm, leads to an increase in the cost of debt of around 0,5 percentage points (see table 4 & 5). Since the average cost of debt in the sample is 4.3 percent (see table 2), this represents a significant amount. The estimated coefficient changes drastically in model 6, which excludes logassets and logdebt (see table 4 & 5, model 6). This model estimates a negative relation between leverage and the cost of debt. These mixed results will be further elaborated upon in chapter 5. In addition to the overall financial capacity of the firm (leverage), the liquidity position appears to influence the cost of debt of a firm. This effect appears to supersede

the effect of leverage. A ten percent increase in the current ratio of a company is estimated to lower to cost of debt of that firm by between 1,48 and 1,15 percentage points (see table 4 & 5, model 3).

Furthermore, performance indicators have a significant influence. In both regression models, an increase in the return on assets leads to a decrease in the cost of debt. The strength of this relation is uncertain, as the estimations of the fixed and random effects models show a large discrepancy. The true effect of return on assets on the cost of debt is therefore still open for debate and will be elaborated upon further in chapter 5. In addition, a high growth rate leads to a decrease in the costs of debt incurred by the firm. This effect however, is less strong than the effect of a high return on assets.

In order to test the robustness and consistency of the results for the control variables, an additional analysis was performed in which bankruptcy probability is excluded (see table 4 & 5, model 4). The results of this regression show that the estimated coefficients in model 3 are reasonably consistent. There are no differences in the direction of the estimated coefficients. In addition, differences in the sizes of the effects are very limited. These results can be used to support the accuracy of the results estimated in model 3.

4.3 Relation characteristics analysis

In this part, characteristics of the relation between bankruptcy probability and cost of debt will be examined. First it will be verified if the relation is non-linear, as is stated in hypothesis 2. Second, it will be determined if an interaction effect exists between firm size and bankruptcy probability. Last, it will be examined whether bankruptcy probability has a lagged effect on the cost of debt.

(Non) Linearity

In this section, support for the verification or falsification of the hypothesis: "*The effect of an increase in bankruptcy probability will increase as bankruptcy probability increases*" will be examined. In order to test for the linearity of bankruptcy probability, an additional term is included in the regression function that captures the nonlinear effect of bankruptcy probability. This term is made up of the squared function of the estimate of bankruptcy probability. If this variable is found to have a significant effect on the cost of debt, it can be concluded that the relation between bankruptcy probability and the cost of debt is nonlinear. As the pooled regression model has been proven to not be the most appropriate model for this data, only a fixed effects and a random effects analysis have been performed in order to test for linearity. The regression results can be found in appendix 6.

The results, although mixed, seem to indicate that the relation between bankruptcy probability and the cost of debt is in fact non-linear. Five out of the six regressions performed that include the squared

variable of bankruptcy probability exhibit a significant effect of this variable (see appendix 6). It can therefore be assumed with a fairly high level of confidence that the relation in in fact non-linear. As for the form of non-linearity that characterises the relation between bankruptcy probability and cost of debt, the sign of the coefficient estimate can be consulted. Again, five out of the six regressions exhibit a positive coefficient estimate between the squared variable of bankruptcy probability (see appendix 6). A positive coefficient estimate indicates an exponential relation. This implies that the effect of an increases in bankruptcy probability increases in magnitude when bankruptcy probability increases. These results therefore support hypothesis two, which states that the effect of an increase in bankruptcy probability increases as bankruptcy probability itself increases.

Interaction affect

In this section, evidence will be examined to verify or falsify the hypothesis: "*The effect of bankruptcy probability on cost of debt will be relatively higher for large firms with respect to smaller firms".* In order to examine whether there is an interaction effect between assets and bankruptcy probability, an interaction variable is generated by multiplying assets and bankruptcy probability. This interaction variable is included in the model after which a regression analysis has been performed. The results of this regression are presented in appendix 7.

The results of both models show that the interaction term has an insignificant effect on the cost of debt. Hypothesis 3: "*The effect of bankruptcy probability on cost of debt will be relatively higher for large firms with respect to smaller firms"* is therefore not supported. However, this does not mean that it can be stated with certainty that there is no interaction effect between firm size and the bankruptcy probability of a firm. It merely means that evidence in support of the existence of such an interaction effect has not been found at this point.

Lagged effect of bankruptcy probability

In this section, it is examined if the effect of bankruptcy probability on the cost of debt is lagged and to which degree the effect is lagged. In order to verify a possible lagged relation a regression is performed which includes, in addition to the current bankruptcy probability, the lagged estimates of bankruptcy probability up until three years prior. The results can be found in appendix 8.

The results for the mixed effects are mixed to a certain extend. A marginally declining lagged effect of bankruptcy probability on the cost of debt can be observed in table 14. Standing out is the negative effect of the two year lagged variable. Estimations for more lagged variables were not significant, indicating that bankruptcy probability has a significant effect on the cost of debt up to three years later. The results indicate that bankruptcy probability has a lagged effect on the cost of debt.

4.4 Robustness tests

In order to validate the robustness of the results presented above, multiple tests have been performed. First, a regression has been performed in which bankruptcy probability scores have been estimated using a different technique. In addition, a regression has been performed in which the variables have been centred. The process and results of these tests are discussed below.

Bankruptcy probability estimation based on categorization

In order to estimate a bankruptcy probability score for each firm in this process, not a logistic regression was used, but firms were assigned a bankruptcy probability based on the specific group to which they belong. Groups were constructed based on multiple categorizations. Consecutively, categorizations were made based on the variables assets, debt, leverage, current ratio and return on assets. These variables were chosen as the logistic regression in section 4.2 revealed that they all significantly affect the probability of a firm going bankrupt. In each categorization process, ten (practically) equally sized groups are constructed. After each firm is allocated to a certain group, the percentage of firms that have filed for bankruptcy present in each group is calculated. Consecutively, this group average is assigned as the bankruptcy probability for each firm belonging to that specific group. The results of these categorization processes can be found in appendix 1.

assets_category	N	sum	mean
1	6731	659	.0979052
2	6732	211	.0313428
3	6732	153	.0227273
4	6731	137	.0203536
5	6732	98	.0145573
6	6711	90	.0134108
7	6753	66	.0097734
8	6710	52	.0077496
9	6752	31	.0045912
10	6731	20	.0029713
Total	67315	1517	.0225358

Table 6: Firm categories

A comparison of the different categorization results revealed that assets was the best indicator of bankruptcy. As can be seen in table 13, the amount of bankrupt firms declines steadily from group 1 to 10. The percentage of bankrupt firm observations declines fast initially but flattens out as the amount of assets increases. This indicates a logarithmic relation between assets and bankruptcy probability.

The last column, mean, represents the percentage of firms in each group that has filed for bankruptcy. This score is assigned to all firms within that group as bankruptcy probability. After all firms have been assigned a bankruptcy score, a regression analysis was performed. The results are presented below.

	(1) cost of debt	(2) cost of debt	(3) cost of debt
bankruptcy_probabi~1	0.239***	0.136***	
	(15.00)	(8.64)	
leverage		-0.0334***	-0.0340***
		(-26.23)	(-26.76)
current ratio		-0.184***	-0.185***
		(-8.93)	(-9.00)
return on assets		-0.0141***	-0.0147***
		(-5.85)	(-6.11)
growth of assets		-0.00601***	-0.00620***
		(-23.42)	(-24.23)
year		-0.000497***	-0.000598***
		(-8.69)	(-10.68)
Constant	0.0435***	1.079***	1.286***
	(121.14)	(9.34)	(11.37)
Observations	61701	49111	49111
rho	0.622	0.738	0.745
r2_o	0.0314	0.000534	0.0000234
r2_b	0.0591	0.000429	0.000497
r2_w	0.00428	0.0365	0.0348

Table 7: Fixed effects model results

Three regressions were performed. First, only including bankruptcy probability and the cost of debt. Second, a complete regression, but without asset and debt variables. Thirdly a regression excluding bankruptcy probability. The results in table 7 show similar estimations to the estimations in table 4. This adds to the robustness of the results as it shows that the effect of bankruptcy probability is consistent when the estimated bankruptcy probability is calculated in a different manner.

This is also true for the results of the random effects model (see table 8). The estimated effect of bankruptcy probability is slightly higher than the estimated effect in the fixed effects model, as is the case in the regressions in table 4 and 5. As for the estimated coefficients for the control variables, they remain consistent. The only striking result is the low R-squared in table 7, which is substantially lower than the R-squared of the similar fixed effects model depicted in table 4.

	(1) cost of debt	(2) cost of debt	(3) cost of debt
bankruptcy_probabi~1	0.305***	0.222***	
	(26.95)	(19.41)	
leverage		-0.0220***	-0.0234***
		(-20.58)	(-21.78)
current ratio		-0.158***	-0.148***
		(-8.85)	(-8.29)
return on assets		-0.0274***	-0.0316***
		(-12.52)	(-14.45)
growth of assets		-0.00561***	-0.00583***
		(-22.57)	(-23.40)
year		-0.000603***	-0.000772***
		(-10.81)	(-14.00)
Constant	0.0432***	1.282***	1.624***
	(88.24)	(10.95)	(13.99)
Observations	61701	49111	49111
rho	0.590	0.539	0.547
r2_o	0.0314	0.258	0.243
r2_b	0.0591	0.311	0.280
r2_w	0.00428	0.0325	0.0311

Table 8: Random effects model results

By using the categorization process to retrieve bankruptcy probability scores a sort of instrumental variable technique is deployed. Assets is used as an instrument to assign a bankruptcy probability score to each firm. The minimal difference in results between these results and the main results contributes to the robustness of the overall results.

Centring

The process of centring consists of subtracting the mean of each variable from each observation. As a result, a variable value will become negative if the observed value is below the mean and positive if the observed value is above the mean. This does not change the slope of any of the predictor variables, but allows for the constant factor to be interpreted more accurately. In the previous regressions, the constant factor described the cost of debt, when all other variables are zero. As this is an extremely unlikely situation the value of the constant cannot be interpreted. By centring all variables, the constant term in the new regression describes the cost of debt when a firm exhibits average values for each variable. The same six regression models that were used in table 7 & 8 are used to estimate the coefficient of the constant term. The results are presented below.

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt	(5) cost of debt	(6) cost of debt
Constant	0.0476***	0.0617***	0.0617***	0.0620***	0.0613***	0.0625***
	(261.20)	(7.27)	(7.27)	(7.30)	(7.01)	(7.17)
Observations	61699	49111	49111	49111	49253	49111

Table 9: Fixed effects model results

The results in table 18 show significantly lower estimations of the constant term than the results in table 7. When looking at model 3, the complete model, an estimated constant term of 0.0617 can be observed. This means that a firm that scores average on all the variables included in the analysis, it will have an estimated cost of debt of approximately 6.17 percent. This is slightly above the overall average, but below the average for the group of firms that has gone bankrupt. These results remain similar when a random effects model is performed.

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt	(5) cost of debt	(6) cost of debt
Constant	0.0477***	0.0687*	0.0687*	0.0707*	0.0606	0.0525
	(111.22)	(2.12)	(2.12)	(2.17)	(1.76)	(1.56)
Observations	61699	49111	49111	49111	49253	49111

Table 10: Random effects model results

5 Discussion

5.1 Interpretation and relevance of results

Determinants of bankruptcy probability

Although the determinants of bankruptcy probability were not the primary subject of interest in this study, a logistic regression was performed in order to estimate a bankruptcy probability score for each firm. This regression revealed that the relative amounts of assets and debt, financial position and performance indicators were all important determinants of bankruptcy probability.

The results found confirm existing theory on the determinants of debt. Bankruptcy probability determinant models such as the Altman ZETA-model (Altman, 2000) and the somewhat older Ohlson model (Ohlson, 1980) describe performance indicators such as retained earnings percentage and relative sales revenue as well as financial ratios such as the working capital to assets ratio and the market value to equity ratio as important determinants of bankruptcy probability. These same variables were found to be important determinants of bankruptcy probability in this study. As data availability prevented detailed performance indicators to be used, a general performance indicator was used, return on assets. Although one single performance indicator was used, it aligns with the performance indicators used in the bankruptcy prediction model as both are relative to the amount of assets a firm holds. In addition to the performance indicators, the financial ratios were also found to be important determinants of bankruptcy probability. As overall financial position and the liquid capacity worsens the probability of bankruptcy was found to increase. This complies with the bankruptcy probability prediction models (Altman, 2000; Ohlson, 1980) as well as general bankruptcy theory(Lukason & Hoffman, 2014).

A possible contribution to the knowledge on the determinants on the bankruptcy probability are growth rates. In this study, growth of assets has been included in the analysis. Although results of limited significance were found, the positive relation between growth and bankruptcy probability that was estimated in multiple logistic regressions is interesting. There are some rationales that can explain the increased bankruptcy probability for fast growing firms. These rationales are discussed by Donal Hambrick and Lynn Crozier (1985) First, high-growth firms need a lot of capital in order to support the high growth levels. If they are unable to acquire this capital, they might face financial trouble and eventually bankruptcy (p. 41). Another explanation could lay in the characteristics of the firms that exhibit high growth levels as these are often young, small innovative firms. These firms often operate in a less stable environment and are therefore more exposed to sudden changes in the business environment. As a result of their recent successes, they might have developed a sense of infallibility, which leads to them not adapting to these changes (p. 38). Third, rapid growth causes the firm to

increase in size tremendously. This sudden increase in size might lead to problems as the company is faced with new challenges that encompass this new size (p. 35). A different type of reasoning may focus on the age of these often young rapid growth firms. It could be argued that they might be less able to counter unexpected setbacks than more mature stable firms due to differences in experience and resources.

Bankruptcy probability and cost of debt

The results of nearly all the regressions performed seem to support the hypothesis that an increase in bankruptcy probability leads to an increase in the cost of debt. Although the effect of bankruptcy probability has been found to be statistically significant, the magnitude is limited. The maximum estimated effect of an increase of 10 percentage points in bankruptcy probability on the cost of debt in a random effects model is 0.6 percentage points (see table 5, model 1). In the complete model, the estimated effect of a 10 percentage point increase in bankruptcy probability was only 0.33 percent It should be noted that the overall average cost of debt was found to be 4,2 percent. A 0.6 percentage point increase would therefore correspond with an increase of 14 percent on the average cost of debt. As for the R-squared, when examining the results of table 7 & 8, it can be observed that the model that only included bankruptcy probability as a predictor variable was only able to explain around 3 percent of the total variance of the cost of debt.

Comparing this result with estimates of bankruptcy cost effects produced by recent studies it can be observed that the bankruptcy probability appears to have less of an impact than is estimated by these studies. Koziol (2014) for example estimated that the inclusion of bankruptcy costs can increase the cost of capital with over 50 percent in some cases. It should be noted that this 50 percent increase refers to a specific group of firms. In addition, the research by Koziol focused on the difference between including and excluding bankruptcy costs as a determinant of cost of capital, rather than the differences between the effects of different levels of bankruptcy probability. The significantly smaller effect of bankruptcy costs via bankruptcy probability on cost of debt found in this study however, do support the idea that the true effect of bankruptcy costs might be somewhat smaller than estimated by Koziol. Although this research focuses on cost of debt specifically, rather than the overall cost of capital, the results are able to contribute to the discussion on the relevance and impact of bankruptcy costs on the cost of capital of a firm. In this case, the results seem to support a more mitigated relation between bankruptcy costs and the cost of capital.

Non linearity

The results of the study revealed that the relation between bankruptcy probability and cost of debt has a non-linear characteristic. As bankruptcy probability increases, the effect of bankruptcy

probability on the cost of debt rises exponentially. This means that differences with regard to the cost of debt are smaller at the low end of the bankruptcy probability spectrum and larger at the high end of the spectrum.

This finding is a contribution to existing theory as such a characteristic of the relation between bankruptcy probability and the cost of debt has not been found as of yet. Although non-linearity has not yet been examined specifically with regard to bankruptcy probability, the relation between risk and yields has been found to be non-linear by Peter Feldhütter et al. (2018). The findings are nonetheless relevant, as it focuses on the costs of the borrower, as opposed to yields for risk takers. The non-linear relation between bankruptcy probability and cost of debt complies with the non-linear relation between risk and yields. Lenders require exponentially growing yields in the event of increasing risk. Increased bankruptcy probability leads to increased risks for lenders and therefore exponentially increased interest requirements, implying exponentially increased costs of debt for the firm in question.

Interaction effect

The study did not produce any evidence in support of the hypothesis that larger firms exhibit a smaller effect of increased bankruptcy probability on their cost of debt with respect to smaller firms. This means that at this point it cannot be stated that different mechanisms influence the cost of debt for firms at different ends of the size spectrum.

This contradicts theoretical assumptions that state that there is a discrepancy between the mechanisms that affect small and large firms. There are multiple theories that state that there are differences between firms of different sizes. The general notion that there are significant differences between small and large firms is proposed by Mark Casson (1982). In addition, Britzelmaier et al. (2013) found that there are significant differences between large and small firms and propose that different methods should be used in order to address small and large firms. More specifically, theories have been constructed that describe differences between small and large firms with respect to bankruptcy probability and cost of debt. For example Brealey and Myers (1984) state that large firms face higher costs in the incidence of a bankruptcy due to higher levels of complexity and higher legal fees. This would correspond with a stronger relation between bankruptcy probability and cost of debt for large firms with respect to smaller firms. In addition, Stiglitz and Weiss (1981)argue that credit rationalising causes debt to be more randomly allocated to small firms with similar characteristics. This would imply that bankruptcy probability is less of a determining factor for the cost of debt for small firms. The fact that no supporting evidence is found does not automatically imply that that this theory should be disregarded, but it does contribute to a further discussion on this topic.

Lagged effect

Evidence has been found for the lagged effect of bankruptcy probability on the cost of debt. Significant results were found for the three year lagged effect as well as the one year lagged effect. However, the two year lagged effect was found to be insignificant. These results therefore provide mixed evidence in support of the existence of a lagged effect.

A possible explanation for both the significant and the insignificant results is the rigidity of debt. As interest payments are often agreed upon for the entire lifetime of a debt investment, a sudden change in a firms (financial) performance may not have a direct impact on the cost of debt of that firm. The cost of debt will only change when new debt is acquired by the firm. While acquiring new debt, investors will reassess the firm and base the new interest requirements on the new state of the company. The new interest rate that will be agreed upon will alter the overall cost of debt of the firm. The concept of rigidity has been found to be of influence on multiple levels on market level, as well as on firm level (Buckle & Carlson, 2000; Hannan & Berger, 1997; Staw, Sandelands, & Dutton, 1981). This might explain why there might be a discrepancy in the evidence for a lagged effect between different time periods. No significant results were found for a lagged effect over a period of over 3 years. It can be interpreted that interest rate requirements are reassessed at least once over a three year period as a result of new debt acquirements.

Control variables

Most of the estimated effects of the control variables are in line with existing theory. Surprising results however, were found for the influence of the logarithm functions of both assets and debt on the cost of debt. Mixed results were found for the effect of leverage on the cost of debt.

Both the random and fixed effects models estimated a positive relation between the amount of assets and the cost of debt of a firm. This implies that the cost of debt will increase when the amount of assets in a firm increases. This result contradicts prior research, which assumes a negative relation between assets and the cost of debt. A possible explanation for discovered relation might be the small firm effect, which implies that small firms tend to outperform larger firms (De Moor & Sercu, 2013). The higher performance of small firms might cause them to be more favourable among financiers, effectively reducing interest rate requirements for these firms. It could also be argued that a large firm in financial trouble is more difficult to save, resulting in higher costs of debt.

In contrast to assets, a negative relation was estimated between debt and the cost of debt. This would imply a decrease in cost of debt as a result of an increase in debt. This contradicts the theoretical notion that an increase in debt, holding all other variables constant, increases the cost of debt. The concept of economies of scale might be used in order to explain this relation. When a firm

acquires debt more frequently or in higher quantities, it might acquire more experience and knowledge, effectively lowering the average cost of debt. In addition, firms with low cost of debt, might choose to acquire a large quantity of debt, causing the negative relation between debt and cost of debt found.

5.2 Limitations

A minor limitation regarding the results of the regression analysis regards the missing data within the dataset. Detailed high-quality data is difficult to gather with respect to debt related variables. For example, the dataset did not contain loan-specific information such as maturity, relation with debt provider and collateral used. These are factors that can influence the interest rate, and therefore the cost of debt, that is charged. A loan with a longer maturity for instance usually entails a higher level of risk for the investor and therefore a higher required interest rate. Lack of data on these debt-specific variables results has as consequence that these variables are not controlled for. This does not mean that the results of the study should be disregarded. Although the variables mentioned do in fact affect the cost of debt, it is assumed that data sample is sufficiently large to prevent influences from individual entities to cause a significant bias.

Another limitations refers to the amount of control variables that are included in the analysis. The desired detailed information was not available or achievable with the resources at hand. This is especially true for the group of bankrupt firms. Detailed historical data on these firms is difficult to gather. The inclusion of more detailed control variables would have contributed to the accuracy of the research. Lacking data that is of significant importance is debt-specific information such as time to maturity, collateral and type of debt. These characteristics all influence the interest rate that is paid. Their exclusion therefore limits the overall accuracy of the results. In addition, the relation between the lender and the borrower can influence characteristics of the debt agreement. These effects are also not controlled for, which further limits the overall accuracy of the results.

5.3 Further research

As mentioned above, data unavailability with regard to some variables causes certain limitations for research into the cost of debt. A new research could therefore contribute to this field by constructing an extremely detailed database that does contain debt-specific information such as maturity and the use of collateral. The construction of such a database can amplify the robustness of the results of this study and prior research. In addition, it could uncover the magnitude of the influence of these variables on the cost of debt and other debt related variables.

Further contributions could be made by investigating different types of firms. Despite the aim of this study to construct a diversified database, due to data availability issues, the firms that are

included in this study are still predominantly relatively large firms. Since it has been shown that smaller firms play a very important role within the global economy (Birch, 1987), more focus should be laid on this group. Future research could contribute to existing literature by focusing on a sample of small firms in multiple ways. First, it could uncover the dynamics of debt financing for small firms, which is a relatively unexplored subfield within finance. In addition, it could uncover important differences between different types of firms, something that has been stated by Du Jardin (2010). Third, as small firms are an important driver of economic growth, a future study into these firms can support policymakers stimulate more activity with respect to small firms.

6 Conclusion

From the results of the study, it can be concluded that bankruptcy probability has a positive exponential effect on the cost of debt of a firm. In addition, this relation includes a lagged effect. No results were found to support the rationale that there is an interaction effect between assets and bankruptcy probability. Although a strong significant link was discovered, bankruptcy probability only explains about 3 percent of the variance in cost of debt. Bankruptcy probability predominantly explains the variation between firms, rather than the cost of debt in a single firm over time. Most control variables had a significant effect on cost of debt. Unexpected outcomes were discovered for the effect of an increase in the logarithm of assets and debt on the cost of debt. Mixed results were gathered for the influence of financial leverage.

The logistic regression performed produced a fairly accurate estimate of the bankruptcy probability of a firm. The analysis revealed that assets and debt, the financial capacity as well as performance indicators are all significant determinants of bankruptcy probability. Less support was found to support the rationale that growth rates have a strong effect on bankruptcy probability. The results were consistent with theory.

The results contribute to the existing theoretical framework surrounding bankruptcy costs. First, the results that were found appear to support a more mitigated relation between bankruptcy costs and cost of debt than previously assumed. In addition, the effect of bankruptcy probability has been verified to be exponential. Furthermore, the revision of the determinants of bankruptcy probability has strengthened current consensus on this topic.

The most eminent point of improvement relates to the limits of the dataset used. More detailed data collection, especially for debt-specific variables such as time to maturity, can contribute to the robustness of the results. Future research should therefore aim to contribute to the discussion on the effect of bankruptcy probability by focusing on detailed data gathering. More empirical research can reveal more insights in the precise magnitude of the effect of bankruptcy probability and can examine more characteristics of the relation between bankruptcy probability and the cost of debt. Special attention could be given to examining differences between different types of firms. There are a lot rationales that assume these differences, but no evidence could be generated to support this in this paper.

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Appendix

1. Control variables operationalization

Firm size: Firm size is included in the regression as a control variable as it may affect the cost of debt in multiple ways and disregarding it can therefore lead to biased results. First, larger firms may have access to cheaper debt, as default risk, even in case of bankruptcy, is lower for these firms. They possess more assets that will be distributed in case of a bankruptcy. The probability that financial institutions will be able to retrieve their funding is therefore higher for larger firms, leading to less risk and lower interest rate requirements. Firm size will be measured by firm total assets.

Industry: Industry can have an effect on the cost of debt as investors will have different opinions about different industries and therefore will be more or less hesitant to invest in firms operating in a specific industry. This can lead to different costs of debt for firms operating in different industries. To allocate firms to certain industries, the general industry classification code of Eikon was used that distinguishes the following industries: industrial, utility, transportation, banks/saving, insurance and other financial.

Leverage: Financial leverage describes the capital structure of a firm. This is included as a control variable as it has been shown that leverage has a significant effect on financial outcomes. Leverage is therefore a widely used control variable in financial research. A simple measurement of leverage is used in this research as $\frac{Total\ debt}{Total\ Capital + short\ term\ debt}$. This calculation of financial leverage is used by Eikon and is similar to calculations used in the majority of prior research (Anderson, Mansi, & Reeb, 2003).

Liquidity: The liquid capacity of a firm is important as it determines whether the firm is able to counter short-term setbacks. In addition, a strong liquid position provides the firm with more resources to respond quickly to changes in the environment. The current ratio is used as a proxy for liquidity and is measured as $\frac{total\ current\ assets}{total\ current\ liabilities}$.

Performance: profitability has been included by both Altman (2000) and Ohlson (1980) in their models as determinants of bankruptcy probability. Performance simultaneously determines the cost of debt acquired by firms. Performance is therefore a mediating variable, which exclusion could lead to biased results. Performance has therefore been added to the regression model as a control variable. Performance will be measured as return on assets, as is common in financial research. ROA is calculated by Eikon as: (Net Income – Bottom Line + ((Interest Expense on Debt-Interest Capitalized) * (1-Tax Rate))) /Average of Last Year's and Current Year's Total Assets * 100

Growth: This study includes a measure of growth: growth of assets. This measures has been added as growth can have an effect on both the probability that a firm will face a bankruptcy and on the cost of debt. High levels of growth may indicate that a firm has a high potential. Increased opportunism within capital providers will then lead to lower cost of debt. In addition, a sharp decline in assets (meaning a large negative growth) may indicate that a firm faces financial troubles, sparking negativism. Capital providers will require higher risk premiums, leading to higher costs of debt for the firms. Simultaneously, high growth can lead to multiple internal problems for firms, making them more prone to face a bankruptcy in the future (Hambrick & Crozier, 1985)

Country: The country in which a firm is located can have an influence on the cost of debt for that firm as the firm is exposed to the characteristics of the local environment. Firms can for example benefit from a national stimulating policy. Country should therefore be included in the analysis.

2. Summary statistics

The total sample consists of 10.044 firms, of which 449 have gone bankrupt in the period from 2010 up until 2017. This means an average bankruptcy rate (or probability) of 4,47%, which is slightly higher than the 1 year bankruptcy rate in the united states according to statistics disclosed by the American Bankruptcy Association (ABI). When correcting the average real bankruptcy rate for a period of 8 years, the average bankruptcy rate in the sample is actually below average. A possible explanation for this is that the statistics provided by the ABI include all U.S. firms, while the sample investigated is limited to public companies. Publically listed firms are more mature and are therefore on average less likely to file for bankruptcy. Tanking this into consideration, the sample is fairly representative. For each variable the average and the (standard deviation) are presented below.

summary statistics

	not bankrupt	bankrupt	Total
cost of debt	0.0428	0.0626	0.0430
	(0.0317)	(0.0633)	(0.0323)
debt	265168037.6	8270995.3	262543877.1
	(2.17350e+09)	(33368364.2)	(2.16253e+09)
interest expense o~t	11407982.5	432210.7	11295866.8
	(102560798.0)	(1980994.1)	(102041781.6)
assets	871130379.8	28262453.7	862520624.3
	(7.02276e+09)	(136137844.0)	(6.98733e+09)
return on assets	0.0624	0.0592	0.0624
	(0.0421)	(0.0432)	(0.0421)
leverage	0.416	0.455	0.417
	(0.185)	(0.199)	(0.185)
current ratio	0.0164	0.0155	0.0163
	(0.0104)	(0.00832)	(0.0104)
growth of net income	0.391	0.442	0.392
	(1.352)	(1.683)	(1.356)
growth of assets	0.166	0.266	0.167
	(0.488)	(0.600)	(0.490)

e+x refers to the amount of zeros to be added, for example e+04 means
* p<0.05, ** p<0.01, *** p<0.001

Table 11: descriptive statistics

A few things become apparent after a first glance at these statistics. The average cost of debt for the group of firms that have filed for bankruptcy is substantially higher than the average for non-bankrupt firms. This could indicate that there is indeed a relation between bankruptcy probability and the cost of debt. Drawing such a conclusion at this stage however would be precipitated as multiple differences can be found between the bankrupt and non-bankrupt firms in the sample. First, the average size of non-bankrupt firms is significantly larger than bankrupt-firms. Both the amounts of assets and debt are substantially larger for the still active firms. Second, strikingly the average return on assets are higher for bankrupt. This would imply that the performance for the later bankrupt firms in the period before bankruptcy was on average better than the performance of surviving firms in the same period. This does not comply with existing theory, which states that low performance increases the probability of a bankruptcy in the future. Third, the growth rates of both assets and net income are higher for bankrupt firms. This could indicate that firms with a relatively high probability of going bankrupt are very volatile firms that maintain a risky strategy. This rationale could explain why the firms that eventually went bankrupt experienced high-growth and performance rates in the pre-bankruptcy period. As for the financial position of both groups of firms, the amount of leverage is equal. The current ratio on the other hand is much lower for the group of bankrupt firms, indicating a weaker liquid capacity.

Something that stands out is the high standard deviations. Further analysis reveals that these high standard deviations are the result of a few very large firms that exhibit such high amounts of for example assets and debt that lie so far away from the average that they cause the standard deviation to rise exponentially. These very high standard deviations result in a distribution that has very long tails. In addition, the distributions of the mentioned variables are skewed. This is caused by the extremely large observations. Extreme outliers are solely positive outliers, since values for assets and debt cannot fall below zero. The distribution minimum is therefore limited, while the maximum is unlimited. This means the distribution of these variables are skewed. In order to normalize the variables assets and debt, new variables logassets and logdebt were constructed that consist of the logarithmic functions of assets and debt respectively. This transformation normalizes the distribution of these variables.

3. Pooled regression results

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt	(5) cost of debt	(6) cost of debt
bankruptcy probabi~y	0.0856***	0.0359***	0.0367***			
	(42.49)	(14.21)	(14.46)			
assets			-1.33e-13*	-9.93e-14		
			(-2.38)	(-1.78)		
debt			1.28e-13	1.29e-13		
			(0.75)	(0.75)		
logassets		0.0186***	0.0187***	0.0195***	0.00413***	
		(33.41)	(33.53)	(34.98)	(13.70)	
logdebt		-0.0214***	-0.0215***	-0.0228***	-0.00743***	
		(-38.62)	(-38.61)	(-41.40)	(-26.29)	
leverage		0.0479***	0.0479***	0.0536***		-0.00441***
		(29.35)	(29.30)	(33.78)		(-5.26)
current ratio		-0.0412**	-0.0403**	-0.0564***	-0.172***	-0.0659***
		(-2.71)	(-2.65)	(-3.71)	(-11.31)	(-4.27)
return on assets		-0.0433***	-0.0431***	-0.0547***	-0.0669***	-0.0733***
		(-19.23)	(-19.14)	(-25.96)	(-31.19)	(-34.40)
growth of assets		-0.00498***	-0.00498***	-0.00490***	-0.00484***	-0.00490***
		(-17.17)	(-17.18)	(-16.87)	(-16.16)	(-16.39)
year		-0.000706***	-0.000707***	-0.000749***	-0.000768***	-0.00113***
		(-10.37)	(-10.37)	(-10.99)	(-10.89)	(-16.12)
Constant	0.0458***	1.490***	1.489***	1.583***	1.655***	2.327***
	(236.67)	(10.75)	(10.74)	(11.40)	(11.53)	(16.37)
Observations	61699	49111	49111	49111	49253	49111
r2	0.0284	0.307	0.307	0.304	0.282	0.261

Multiple pooled regressions have been performed with different sets of variables included in the models. The first model merely examines the relation between the bankruptcy probability and the cost of debt. The second model includes all control variables, including dummy variables controlling for industry and country effects. An additional dummy is included to account for the missing value adjustment for the return on assets. In the third model, in addition to logassets and logdebt, the absolute values of assets and debt are included. Models four five and six exclude bankruptcy probability in order to examine the effects of the control variables on the cost of debt. The fourth model encompasses all control variables, but excludes the bankruptcy probability estimate. The fifth model excludes leverage in order to derive the true coefficient estimates for assets and debt. The last model excludes asset and debt variables in order to derive the true coefficient estimate for leverage.

To test whether a pooled regression analysis best suits the data a chow test is performed. This test focuses on entity specific differences. If significant differences with regard to the intercept and the effect of the independent variable are observed, a pooled regression model is not the appropriate to estimate the variable coefficients. In order to test whether this is the case for this specific set of data, the firms are split into two equally sized groups. The hypothesis is tested that there are no significant

differences between the two groups. This test resulted in an F score of 91.76, as can be seen in figure 1. This means that the hypothesis that there are no significant differences between firms can be refuted. This means that a pooled regression model is not the regression model that is best suited for this specific set of data. Nevertheless, the results of the pooled regression can provide some interesting first insights.

Firstly, there appears to be a significant positive relation between bankruptcy probability and the cost of debt. Although the magnitude of the effect decreases when more control variables are added to the model, it retains a high level of significance. The results seem to support the statement that an increase in bankruptcy probability leads to an increase in the cost of debt of a firm.

Secondly, surprisingly, the coefficient results for the logarithm of assets and debt are contradictory to predictions based on literature. An increase in the logarithm of assets, holding all other variables constant, increases the cost of debt with approximately 1.9 percentage points (table 6, model 2 & 3). As the independent variable in this case is a transformed variable, the true relation between assets and cost of debt can be interpreted as: A 10% increase in assets leads to an increase in cost of debt of 0.08%[7]. Although this effect is very small, it implies that, in contrary to predictions, an increase in assets does not lower the cost of debt of a firm. This effect is even smaller when leverage is excluded from the analysis (see table 6, model 5). Because of these unexpected result, an additional regression was performed that includes the absolute values of assets (see table 6, model 3 & 4). In contrast to the relation between logassets and cost of debt, an increase in the absolute value of assets leads to a decrease in the cost of debt. This complies with the notion that larger firms have more access to debt at a lower cost. The magnitude of the effect however, is very small. When logassets is excluded from the analysis the effect of assets gains in statistical significance, but the magnitude remains nearly unchanged.

thirdly, similar to the result for the logarithm of assets, the estimated effect of the logarithm of debt on the cost of debt contradicts theoretical predictions as it estimates that an increase in debt, holding all other variables constant, decreases the cost of debt of a company. An increase of one in the logarithm of debt lowers the cost of debt with approximately two percentage points. An increase of 10% leads to an estimated decrease in the cost of debt of 0.09%[8]. Parallel to assets, this relation, although limited in magnitude, does not abide by the predicted direction. The third regression in table 6 shows a positive relation between the absolute value of debt and the cost of debt. This complies with

[7] The expected change in a dependent variable based on a percentage change (p) in a log transformed variable can be calculated as follows: β * log([100+p]/100). (Benoit, 2011) 0.0187 * log((100+10]/100)=0.08%

[8] -0.0215 * log([100+10]/100) = -0.09%

theoretical predictions. Similar to the absolute value of assets, the coefficient estimate is extremely small, but significant when logdebt is excluded from the analysis.

Lastly, the dramatic shift in the effect of leverage on the cost of debt is noteworthy. At first glance an increase in leverage, meaning a worsening of the financial position, leads to an increase in the amount of leverage (see table 6, model 2). This result complies with the theoretical notion that a stronger financial position leads to a lower level of risk and therefor lower costs of debt. When assets and debt are excluded from the equation however, this result shifts to a negative relation.

4. Chow test results

```
 ( 1)  bankruptcy_probability_0 - bankruptcy_probability_1 = 0

       F(  1, 68220) =  183.12
            Prob > F =    0.0000

. test _b[d0]=_b[d1], accum

 ( 1)  bankruptcy_probability_0 - bankruptcy_probability_1 = 0
 ( 2)  d0 - d1 = 0

       F(  2, 68220) =   91.76
            Prob > F =    0.0000
```

5. Hausman test results

	Coefficients (b) est1	(B) est2	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
bankruptcy~y	.0169768	.03265	-.0156732	.0032569
assets	-2.53e-13	-2.23e-13	-2.97e-14	6.02e-14
debt	7.80e-13	6.26e-13	1.54e-13	1.50e-13
logassets	.0310504	.0262622	.0047883	.0006132
logdebt	-.0343353	-.0297805	-.0045548	.0004429
leverage	.0501238	.0490649	.0010589	.001366
liquidity	-.1481746	-.1146892	-.0334854	.0099298
ROA	-.005526	-.0123961	.0068702	.0011608
growth_ass~s	-.0054945	-.0053257	-.0001688	.0000708
growth_ass~g	-.0467948	-.0037528	-.0430419	.0271158
year	-.0001721	-.0003035	.0001314	.0000322

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 736.71
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

6. (Non) – Linearity

Fixed effects model

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt
bankruptcy probabi~y	0.00870	-0.0218*	-0.0212*	
	(0.99)	(-2.14)	(-2.09)	
bankrupt_probabili~d	0.0297**	0.0473***	0.0470***	
	(2.67)	(4.29)	(4.26)	
assets			-2.44e-13*	-2.44e-13*
			(-2.48)	(-2.49)
debt			7.71e-13**	7.66e-13**
			(2.82)	(2.80)
logassets		0.0309***	0.0310***	0.0314***
		(32.71)	(32.75)	(33.37)
logdebt		-0.0346***	-0.0347***	-0.0351***
		(-41.58)	(-41.66)	(-44.00)
leverage		0.0523***	0.0523***	0.0535***
		(20.56)	(20.54)	(23.23)
current ratio		-0.160***	-0.159***	-0.156***
		(-7.85)	(-7.83)	(-7.75)
return on assets		-0.00882**	-0.00869**	-0.00959***
		(-3.24)	(-3.19)	(-4.07)
growth of assets		-0.00549***	-0.00548***	-0.00547***
		(-21.68)	(-21.66)	(-21.61)
year		-0.000168**	-0.000167**	-0.000155*
		(-2.61)	(-2.59)	(-2.42)
Constant	0.0480***	0.399**	0.397**	0.372**
	(200.96)	(3.15)	(3.14)	(2.95)
Observations	61699	49111	49111	49111
rho	0.626	0.741	0.741	0.740
r2_o	0.0189	0.0165	0.0165	0.0160
r2_b	0.0457	0.0200	0.0201	0.0177
r2_w	0.00120	0.0837	0.0839	0.0832

Random effects model

```
> gassets logdebt leverage liquidity ROA ROA_missing growth_assets year)
```

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt
bankruptcy probabi~y	0.0904***	0.0181*	0.0188*	
	(13.15)	(2.27)	(2.36)	
bankrupt_probabili~d	-0.0395***	0.0169*	0.0163	
	(-4.48)	(2.00)	(1.94)	
assets			-2.18e-13**	-1.95e-13*
			(-2.82)	(-2.51)
debt			6.24e-13**	6.10e-13**
			(2.72)	(2.66)
logassets		0.0262***	0.0263***	0.0271***
		(36.41)	(36.49)	(37.94)
logdebt		-0.0299***	-0.0299***	-0.0313***
		(-42.38)	(-42.46)	(-45.85)
leverage		0.0500***	0.0499***	0.0554***
		(23.43)	(23.40)	(28.06)
current ratio		-0.119***	-0.118***	-0.130***
		(-6.73)	(-6.70)	(-7.44)
return on assets		-0.0138***	-0.0136***	-0.0213***
		(-5.67)	(-5.61)	(-9.91)
growth of assets		-0.00533***	-0.00532***	-0.00528***
		(-21.93)	(-21.92)	(-21.71)
year		-0.000306***	-0.000305***	-0.000300***
		(-5.49)	(-5.47)	(-5.38)
Constant	0.0471***	0.691***	0.689***	0.685***
	(105.66)	(5.94)	(5.92)	(5.88)
Observations	61699	49111	49111	49111
rho	0.583	0.542	0.542	0.543
r2_o	0.0327	0.290	0.291	0.287
r2_b	0.0718	0.341	0.341	0.335
r2_w	0.000856	0.0803	0.0805	0.0802

7. Interaction effect

Fixed effects model

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt
bankruptcy probabi~y	0.0297***	0.0167***	0.0171***	
	(7.47)	(3.48)	(3.55)	
assets_bankruptcy_~y	-8.22e-13	-6.74e-14	-1.29e-12	
	(-0.29)	(-0.03)	(-0.54)	
assets			-2.59e-13**	-2.44e-13*
			(-2.62)	(-2.49)
debt			8.08e-13**	7.66e-13**
			(2.90)	(2.80)
logassets		0.0310***	0.0311***	0.0314***
		(32.78)	(32.82)	(33.37)
logdebt		-0.0342***	-0.0343***	-0.0351***
		(-41.35)	(-41.43)	(-44.00)
leverage		0.0502***	0.0501***	0.0535***
		(20.11)	(20.09)	(23.23)
current ratio		-0.149***	-0.148***	-0.156***
		(-7.36)	(-7.34)	(-7.75)
return on assets		-0.00563*	-0.00551*	-0.00959***
		(-2.15)	(-2.10)	(-4.07)
growth of assets		-0.00550***	-0.00549***	-0.00547***
		(-21.74)	(-21.72)	(-21.61)
year		-0.000173**	-0.000172**	-0.000155*
		(-2.69)	(-2.67)	(-2.42)
Constant	0.0476***	0.403**	0.401**	0.372**
	(261.19)	(3.19)	(3.17)	(2.95)
Observations	61699	49111	49111	49111
rho	0.625	0.740	0.740	0.740
r2_o	0.0285	0.0162	0.0162	0.0160
r2_b	0.0634	0.0194	0.0194	0.0177
r2_w	0.00107	0.0833	0.0835	0.0832

Random effects model

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt
bankruptcy probabi~y	0.0620***	0.0324***	0.0327***	
	(22.16)	(9.19)	(9.28)	
assets_bankruptcy_~y	-1.63e-12	-2.87e-13	-1.37e-12	
	(-0.60)	(-0.13)	(-0.61)	
assets			-2.29e-13**	-1.95e-13*
			(-2.93)	(-2.51)
debt			6.55e-13**	6.10e-13**
			(2.80)	(2.66)
logassets		0.0262***	0.0263***	0.0271***
		(36.37)	(36.45)	(37.94)
logdebt		-0.0297***	-0.0298***	-0.0313***
		(-42.43)	(-42.52)	(-45.85)
leverage		0.0491***	0.0491***	0.0554***
		(23.52)	(23.50)	(28.06)
current ratio		-0.115***	-0.115***	-0.130***
		(-6.55)	(-6.52)	(-7.44)
return on assets		-0.0125***	-0.0124***	-0.0213***
		(-5.33)	(-5.27)	(-9.91)
growth of assets		-0.00533***	-0.00533***	-0.00528***
		(-21.94)	(-21.93)	(-21.71)
year		-0.000304***	-0.000304***	-0.000300***
		(-5.45)	(-5.44)	(-5.38)
Constant	0.0477***	0.685***	0.683***	0.685***
	(111.22)	(5.89)	(5.87)	(5.88)
Observations	61699	49111	49111	49111
rho	0.587	0.542	0.542	0.543
r2_o	0.0285	0.291	0.291	0.287
r2_b	0.0634	0.342	0.342	0.335
r2_w	0.00107	0.0800	0.0802	0.0802

8. Lagged effect

Fixed effects model

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt
bankruptcy probabi~y	0.0188***	0.0205***	0.0208***	
	(3.63)	(3.40)	(3.45)	
lag_bankruptcy_pro~1	0.0462***	0.0328***	0.0328***	
	(9.23)	(7.02)	(7.02)	
lag_bankruptcy_pro~2	0.0000717	-0.00477	-0.00478	
	(0.01)	(-1.05)	(-1.05)	
lag_bankruptcy_pro~3	0.0155***	0.00952*	0.00952*	
	(3.61)	(2.38)	(2.38)	
assets			-2.87e-13	-2.44e-13*
			(-1.77)	(-2.49)
debt			9.99e-13**	7.66e-13**
			(2.70)	(2.80)
logassets		0.0339***	0.0339***	0.0314***
		(26.01)	(25.98)	(33.37)
logdebt		-0.0373***	-0.0374***	-0.0351***
		(-33.34)	(-33.38)	(-44.00)
leverage		0.0449***	0.0447***	0.0535***
		(13.64)	(13.56)	(23.23)
current ratio		-0.172***	-0.172***	-0.156***
		(-6.78)	(-6.79)	(-7.75)
return on assets		0.00298	0.00309	-0.00959***
		(0.91)	(0.95)	(-4.07)
growth of assets		-0.0113***	-0.0113***	-0.00547***
		(-25.36)	(-25.35)	(-21.61)
year		-0.000289**	-0.000285**	-0.000155*
		(-2.74)	(-2.71)	(-2.42)
Constant	0.0443***	0.622**	0.616**	0.372**
	(142.02)	(2.99)	(2.96)	(2.95)
Observations	38273	30679	30679	49111
rho	0.673	0.748	0.748	0.740
r2_o	0.0326	0.0401	0.0405	0.0160
r2_b	0.0550	0.0378	0.0381	0.0177
r2_w	0.00363	0.118	0.119	0.0832

Random effects model

	(1) cost of debt	(2) cost of debt	(3) cost of debt	(4) cost of debt
bankruptcy probabi~y	0.0328***	0.0128**	0.0132**	
	(8.16)	(2.80)	(2.89)	
lag_bankruptcy_pro~1	0.0520***	0.0409***	0.0410***	
	(11.84)	(9.98)	(10.00)	
lag_bankruptcy_pro~2	0.00143	-0.000271	-0.000231	
	(0.32)	(-0.07)	(-0.06)	
lag_bankruptcy_pro~3	0.0127***	0.00936**	0.00939**	
	(3.39)	(2.66)	(2.67)	
assets			-2.02e-13*	-1.95e-13*
			(-2.52)	(-2.51)
debt			4.95e-13*	6.10e-13**
			(2.05)	(2.66)
logassets		0.0261***	0.0262***	0.0271***
		(30.18)	(30.27)	(37.94)
logdebt		-0.0294***	-0.0295***	-0.0313***
		(-34.66)	(-34.72)	(-45.85)
leverage		0.0473***	0.0472***	0.0554***
		(19.09)	(19.05)	(28.06)
current ratio		-0.106***	-0.106***	-0.130***
		(-5.07)	(-5.06)	(-7.44)
return on assets		-0.0112***	-0.0111***	-0.0213***
		(-3.94)	(-3.89)	(-9.91)
growth of assets		-0.0112***	-0.0112***	-0.00528***
		(-27.45)	(-27.46)	(-21.71)
year		-0.000443***	-0.000442***	-0.000300***
		(-4.75)	(-4.73)	(-5.38)
Constant	0.0445***	0.989***	0.986***	0.685***
	(104.28)	(5.21)	(5.19)	(5.88)
Observations	38273	30679	30679	49111
rho	0.639	0.580	0.580	0.543
r2_o	0.0332	0.336	0.336	0.287
r2_b	0.0564	0.378	0.378	0.335
r2_w	0.00349	0.110	0.110	0.0802

9. Categorization process results

Below, the results for the categorization processes are depicted. The figures list consecutively the amount of observations in each group (N), the amount of observations of bankrupt firms (sum) and the percentage of bankrupt firm observations within each group (mean).

Assets

assets_category	N	sum	mean
1	6731	659	.0979052
2	6732	211	.0313428
3	6732	153	.0227273
4	6731	137	.0203536
5	6732	98	.0145573
6	6711	90	.0134108
7	6753	66	.0097734
8	6710	52	.0077496
9	6752	31	.0045912
10	6731	20	.0029713
Total	67315	1517	.0225358

Debt

debt_category	N	sum	mean
1	6731	554	.0823057
2	6732	271	.0402555
3	6732	129	.0191622
4	6731	129	.0191651
5	6732	105	.0155971
6	6728	94	.0139715
7	6723	91	.0135356
8	6735	78	.0115813
9	6742	45	.0066746
10	6726	21	.0031222
Total	67312	1517	.0225368

Leverage

leverage_category	N	sum	mean
1	6102	93	.0152409
2	6104	94	.0153997
3	6103	95	.0155661
4	6114	95	.0155381
5	6107	114	.0186671
6	6110	120	.0196399
7	6109	105	.0171878
8	5783	101	.017465
9	6426	165	.0256769
10	6112	382	.0625
Total	61070	1364	.022335

Current ratio

liquidity_category	N	sum	mean
1	5247	305	.0581285
2	5142	158	.0307273
3	5414	149	.0275212
4	5266	143	.0271553
5	5131	97	.0189047
6	5425	107	.0197235
7	5207	101	.019397
8	5359	117	.0218324
9	5276	86	.0163002
10	5309	142	.026747
Total	52776	1405	.0266219

Return on assets

ROA_category	N	sum	mean
1	6111	641	.1048928
2	6075	161	.0265021
3	6131	78	.0127222
4	6110	107	.0175123
5	6124	93	.0151862
6	6110	90	.01473
7	6126	65	.0106105
8	6157	66	.0107195
9	6118	61	.0099706
10	6122	82	.0133943
Total	61184	1444	.0236009