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Assessing the Yield Spread for Corporate Bonds Issued by Private Firms

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This study assesses the determinants of yield spreads of bonds issued by private firms versus listed firms by applying measures of credit risk applicable to private firms and using real time transactions in estimating liquidity. Corporate bond yield spreads express the compensation that investors require for being exposed to risk related to corporate bonds versus government bonds and derive primarily from liquidity and credit risk. While data for estimating liquidity and credit risk inherent in bond specific characteristics and market conditions is equally available for private and listed firms, the main difference in assessing the yield spreads of their bonds stems from the quality and availability of firm-specific data. This study applies OLS regression analysis and finds that credit risk reflected in sector volatility and leverage is significant for explaining variation in yield spreads of bonds issued by private firms. The model provides a superior fit in terms of a lower SER compared to regressions applying financial ratios to control for credit risk and it is robust to controlling for rating and time fixed effects. Sector values have less explanatory power for bonds issued by listed firms, which suggest that yield spreads of bonds issued by private firms to a higher degree are affected by sector valuations. Publicly traded data is highly significant for the yield spreads of bonds issued by listed firms, explains up to over 30% of their variation and provides superior explanatory power over the data available for private firms. The application of credit risk measures founded on financial ratios provides different results for bonds issued by private and listed firms, which suggest that benchmarking private firms to listed firms in valuing their bonds can lead to erroneous results. While this study finds that there is a significant liquidity premium due to implicit bid-ask spreads, there are no clear indications in terms of the difference in the liquidity component for bonds issued by private and listed firms. Time fixed effects have more explanatory power for yield spreads of bonds issued by private firms than listed firms, which suggest that the valuation of their bonds to a larger degree might be affected by macro economic conditions.

This study only considers non-defaulted fixed coupon bullet bonds denominated in USD with maturity between a month and 30 years with transaction data available via Enhanced Trace and accounting data available via Bloomberg. The sample used includes 66,165 monthly observations and 12.3% is for bonds issued by private firms.

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1 Introduction

While there is a broad literature on assessing the determinants of corporate bond yield spreads, bonds issued by private firms are often left out. This is primarily due to limited data and the application of structural models of credit risk, which requires an estimate of firm value and volatility. The latter is difficult to estimate for private firms, but can be estimated from the market value of the firm's equity for listed firms. This study reports insights as to how the yield spreads of bonds issued by private firms can be assessed by using real time transactions in estimating liquidity, applying measures of credit risk applicable to private firms and using sector market data to proxy for inputs to a structural model of credit risk in applying it to private firms.

Bonds issued by private firms on average comprised 19% of the total number of bonds issued by US-domiciled non-utility non-financial firms in the US between 1993 and 2009, peaking in 2004 with 32% and bottoming in 1995 with 9%. The amount issued by private firms on average comprised 16% of the total amount issued in US dollars between 1993 and 2009, peaking in 1997 with 23% and bottoming in 2001 with 8% (Kovner & Wei, 2012). Hence, private firms' share of the corporate bond market measured both in number of bonds and amount issued is non-negligible. Assessing their value requires methods that are applicable to private firms, but so far bonds issued by private firms have had a negligible appearance in the literature on the pricing of corporate bonds. This study seeks to fill some of the gap by investigating the following question.

1.1 Research question

- *What determines the yield spreads of corporate bonds issued by private firms?*

To better assess this overall question, the study will investigate the following questions

  - What are the determinants of yield spreads?
  - Which credit risk measures are applicable to private firms and what is their significance for yield spreads?
  - What is the significance of publicly traded data in determining yield spreads?
  - Are bonds issued by private firms priced differently than bonds issued by listed firms?
  - What is the significance of liquidity and what is the size of the liquidity component?

1.2 Limitations, assumptions and model choice

In order to provide a focused answer to the research question it was found necessary to limit the scope of this study to a definite group of bonds and require that certain data was available for the individual

bonds and their issuers through the chosen databases. Furthermore, simple OLS regression analysis is applied in studying what determines yield spreads and it is a requirement that the approaches used are applicable or adaptable to bonds issued by private firms.

Firstly, the study only considers fixed coupon bullet bonds denominated in USD with a maturity of less than 30 years and more than a month and does not include observations for defaulted bonds. The first limitations were imposed as a variable coupon, option features and sinking fund provisions complicate the pricing of the bond beyond the general formula for valuating bonds and thus introduce noise to assessing the determinants of yield spreads focusing on bonds issued by private firms. As currency valuations affect the pricing of bonds issued in another currency, only USD issues are considered in this study. In terms of time to maturity, it is assumed that bonds with a very long time to maturity are more sensitive to interest rate risk and are priced more like perpetuity bonds, while the pricing of bonds with a very short maturity is affected by the price approaching face value. Thus, only bonds with maturities between one month and 30 years are included in this study. Lastly, defaulted bonds are excluded as they are usually priced more accordingly with their recovery rate, which leads to very high yields.

Secondly, the use of Enhanced TRACE to obtain data on transactions limits the study to bonds trading in the US between July 1 2002 and December 31 2012 and bonds not issued under Rule 144A. The study relies on transaction data from the database to calculate yield spreads and an implicit bid-ask spread. By including only observations where there are transactions in a given month to calculate both the yield spread and the implicit bid-ask spread this study focuses on the relatively more liquid bonds from the database.

Thirdly, the matching of the bond to its issuer and the establishment of the issuer's ownership status is done manually through Bloomberg, which is also used as the sole source for obtaining accounting data. While banks and rating agencies have better access to data, i.e. Moody's database on private firms includes more than 133,000 firms (Dwyer et al., 2012), the use of Bloomberg limits the scope of the dataset and the group of bonds classified as being issued by private firms. Furthermore, semiannual or annual statements are used, if quarterly financial statements are not available. As only 4.65% of the observations are not from quarterly statements, this should not cause a significant bias.

Finally, motivated by Moody's observation that the relation between financial ratios and credit risk differs from private to listed firms (Boral, Carty & Falkenstein, 2000), this study will assess the determinants of the yield spreads of their bonds separately for each measure of credit risk applied.

While the focus is on bonds issued by private firms, the analysis for bonds issued by listed firms provides important insights in terms of the extent to which the valuation of bonds issued by the two groups of firms differs. The analysis is further divided into bonds issued by non-financial and financial firms, as it is assumed that these firms are fundamentally different and that this will be reflected in the valuation of their bonds. This assumption is supported by the fact that Moody's has developed separate models to assess the credit risk of these firms (Dwyer et al., 2012), the frequent exclusion (Ericsson, Jacobs & Oviedo, 2009), use of dummy variables (Longstaff, Neis & Mithal, 2005; Campbell & Taksler, 2003) or separate treatment of financial firms in similar studies on bonds issued by listed firms (Elton, Gruber, Agrawal & Mann, 2001). This study applies a range of credit risk measures to private firms in assessing the yield spreads of their bonds and the extent to which these measures are developed for firms in a certain sector or listed firms might limit their applicability to private firms. However, in that case, the analysis will nevertheless shed light on whether the measures are significant in determining the yield spreads of bonds issued by private non-financial and financial firms. The use of OLS regression analysis will be discussed in Section 4.3.

To sum up, this study only considers fixed coupon bullet bonds denominated in USD with a maturity of less than 30 years and more than a month and does not include observations for defaulted bonds. The use of Enhanced TRACE to obtain data on transactions limits the study to bonds trading in the US between July 1 2002 and December 31 2012 and bonds not issued under Rule 144A. Furthermore, only monthly observations for which there were transactions enough to calculate the yield spreads and implicit bid-ask spreads and for which accounting data was available through Bloomberg will be included in this study. This limits the study to relatively more liquid bonds and issuers that are more transparent. Lastly, the focus will be on bonds issued by private non-financial and financial firms, but an analysis of bonds issued by listed firms will be conducted to shed light on the differences between the determinants of yield spreads for these groups.

1.3 Section overview

The study will proceed as follows. Section 2 examines literature relevant for assessing the yield spreads of bonds issued by private firms, while section 3 provides a definition of yield spread and its determinants together with credit risk measures applicable to private firms. Section 4 outlines the empirical methodology applied. It discusses how the credit risk measures are applied to private firms and summarizes the statistical method applied in studying their significance for yield spreads. Section 5 outlines the steps of the data collection process and motivates the associated choices and assumptions made, while section 6 presents the characteristics of the final dataset. Section 7 provides

and discusses the implications of the empirical results of the study. It focuses on the significance of credit risk reflected in financial ratios and publicly traded data for yield spreads of bonds issued by private and listed firms. Furthermore, it includes a discussion of the significance of the control variables applied and an assessment of the significance of liquidity for yields spreads and the liquidity component in basis points. Finally, section 8 concludes and discusses recommendations for further research.

2 Literature review

In the following, relevant literature for assessing the yield spreads of bonds issued by private firms will be reviewed. As the literature on the exact topic is scarce the focus will be on literature assessing the yield spreads of bonds issued by listed firms as it provides important insights in terms of methodology considerations and the results obtained provide inspiration as to which factors to consider even though they might not be directly applicable to bonds issued by private firms. Furthermore, even though few studies on bonds issued by private firms exist, there is a supporting literature on how to assess the credit risk of private firms, which is as an important element of assessing the yield spreads of corporate bonds.

2.1 Literature on assessing the determinants of yield spreads

The most well known theoretical model for pricing risky debt was developed by Merton (1974) applying the Black and Scholes (1973) option-pricing model to the value of the firm, where equity and debt are residual claims to the asset value of the firm. Since Merton (1974) developed his structural model for pricing risky debt, many studies have focused on credit risk when modeling the price of corporate bonds (See introduction of Ericsson & Renault, 2006). However, studies like Huang and Huang (2012) document that those models underestimate yield spreads, which imply that structural models either underestimate credit risk or that yield spreads contain other premia beyond that of credit risk. This peculiarity has been dubbed ‘the credit risk puzzle’ and covers the notion that structural models do not successfully manage to fit the default risk of the issuer, the recovery rate and the pricing of the bond. Following the conclusion that a structural model is not able to explain the yield spreads of corporate bonds fully, the literature on the significance of liquidity for yield spreads has grown and most studies assessing the determinants of corporate bond yield spreads either focus on credit risk or liquidity while controlling for the other or assess the significance of both.

2.1.1 Literature on the liquidity premium

Longstaff et al. (2005), Ericsson and Renault (2006), Chen, Lesmond and Wei (2007), Bao, Pan and Wang (2011) and Dick-Nielsen, Feldhütter and Lando (2012) all establish that there is a significant liquidity premium in corporate bond yield spreads after controlling for credit risk. The earlier studies rely on liquidity proxies and the later apply liquidity measures based on quotes or transaction data. Longstaff et al. (2005) control for credit risk by assuming that the credit default swap rate for a firm measures the credit risk premia in corporate yield spreads and by applying a reduced-form model and study whether the residual spread is related to liquidity proxies. Ericsson and Renault (2006) set up a structural model that includes liquidity and empirically test its significance. They find that a dummy variable for issues less than two months old is significant, together with a proxy for treasury market liquidity, which they measure as the difference between the yield of an older long-maturity bond and the most recently issued 30-year bond.

Chen et al. (2007) measure liquidity by the bid-ask spread calculated via quotes obtained from Bloomberg and by applying a percentage of zero returns and estimating a model in accordance with Lesmond, Ogden and Trzcinka (1999) based on daily quotes from Datastream. They find that the bid-ask spread and the modeled liquidity measure have significant and similar explanatory power for yield spreads of investment grade bonds, and that the latter have superior explanatory power for yield spreads of speculative bonds, whereas the percentage of zero returns is only significant for investment grade bonds. Bao et al. (2011) similarly apply a liquidity measure and compare its significance to the bid-ask spread. They estimate the Roll (1984) measure based on transaction data from TRACE and use bid-ask spreads estimated from quotes from Bloomberg. They find that the Roll measure has some explanatory power beyond the bid-ask spread. The weaker significance of the bid-ask spread found in the literature might be due to a reliance on daily quotes, which Dick-Nielsen (2009) similarly argues can bias the results of studies on the corporate bond market. Dick-Nielsen et al. (2012) develop a more extensive liquidity measure based on principal component analysis that outperforms the measures applied in Chen et al. (2007) and Bao et al. (2011) in terms of explaining variation in yield spreads. The measure is a factor loading evenly on the level and risk of the Amihud (2002) measure and the level and risk of imputed round trip costs. The higher quality of data on the US corporate bond market due to TRACE, thus, improves the measures of liquidity applied in the literature.

2.1.2 Literature on the credit risk premium

Elton et al. (2001) rely on historical ratings and defaults to estimate recovery rates and transition matrices to determine default risk and estimate the resulting risk premia. However, they conclude that

expected default account for a small portion of the observed spread, while taxes account for a more substantial portion and that this is especially the case for investment grade bonds, where the default risk is low. The low significance of expected default found in the study might be due to the reliance on historical data and the pace at which ratings are published. In assessing the remaining unexplainable part of the spread, they further conclude that the largest part of the spread is due to systematic risk premia that also explain the risk premium on common stocks. This could suggest that a model using firm specific data or market data might better reflect credit risk.

Ericsson et al. (2009) directly test the significance of the theoretical factors determining credit spreads in structural models for explaining the credit risk premium. Using the credit default swap rate as a measure of the credit risk premium, they find that leverage and equity volatility are highly significant in explaining its variation. Similarly, Campbell and Taksler (2003) show that idiosyncratic firm-level volatility can explain as much cross-sectional variation in yield spreads as can credit ratings by using panel data on bond transactions. Both volatility and ratings explain about 30% of the variation in yield spreads. Volatility remains significant even after ratings are included to control for credit risk. They further conclude that adding accounting measures to the regression does not significantly improve its explanatory power. Thus, while structural models motivate the use of equity volatility and leverage to account for credit risk, accounting measures primarily reflect credit risk reflected in ratings. In investigating rating agencies' standard for assigning ratings Blume, Lim and MacKinlay (1998) use equity volatility, pretax interest coverage dummy variables, the ratios of operating income to sales, long-term debt to assets and total debt to total capitalization as measures of credit risk. Campbell and Taksler (2003), Chen et al. (2007) and Dick-Nielsen et al. (2012) follow this literature in controlling for credit risk. By using equity volatility, bonds issued by private firms are automatically excluded from most of the studies and none of them comment on ownership of the issuer.

On that note, Kovner and Wei (2012) conclude that they are the first to study whether a private premium exists at the issuance of publicly offered bonds. After establishing the ownership of the issuer, they control for bond specific characteristics, financial measures, information characteristics, equity value and ownership and use a dummy variable for private ownership to conclude that bonds issued by private firms are issued with a premium over a similar bond issued by similar listed firms. However, as their focus is on assessing the private premium at issuance, they run their regressions on a dataset comprising bonds issued by both private and public companies and thus, do not directly conclude on the determinants of yield spreads for bonds issued by private firms.

2.2 Literature on assessing credit risk of private firms

Even though few studies on bonds issued by private firms exist, there is a supporting literature on how to assess credit risk of private firms. Broadly, two lines of literature exist on this topic; a line of empirically founded models using financial ratios and a line trying to fit structural models to private firms.

Through multiple discriminant analysis for bankrupt versus non-bankrupt firms, Altman (1968) develops a z-score consisting of specific loadings of financial ratios to predict bankruptcy of manufacturing firms. However, one of the ratios includes the market value of equity and thus Altman (2000) mentions that users of the z-score have frequently asked how to adopt the z-score to private firms. He suggests re-estimating the model with the use of book value of equity instead of market value of equity and does that for his sample of public firms. He further concludes that the new measure is still reliable in predicting bankruptcy for his sample, but slightly less so than the original z-score. In the same study he also re-estimates the model without the asset turnover to minimize industry effects, so that the model is also applicable to non-manufacturing firms. The final revised z-score (z"-score) is thus both applicable to private and non-manufacturing firms, but its loadings are determined based on a sample of public firms.

Altman (2000) refers to Moody's RiskCalc™, which includes a range of models developed specifically for private firms, which is based on an extensive dataset of private firm defaults. Boral et al. (2000) argue that the relation between financial ratios and default probability varies substantially for private and listed firms. They introduce the first RiskCalc™ model for private firms, which is based on having considered the explanatory power of a broad range of financial ratios for historical default probability. Both Altman, Fargher and Kalotay (2011) and later versions of the RiskCalc™ further highlight the power of including industry-level expectations of default likelihood and thus the latter add the average distance-to-default for the firm's sector in order to incorporate forward-looking market price dynamics that is not available on a firm level basis (Dwyer, Kocagil & Stein, 2004). The use of sector data is motivated by Moody's experience with the inferior power of their Private Firm Model (PFM™), which is based on a structural model with asset value and asset volatility of the private firms being estimated from econometric models based on market data on comparable listed companies. The RiskCalc™ was further developed for specific regions (Dwyer & Zhao, 2009).

Akhavein, Bohn, Kocagil and Stein (2003) find that the regional RiskCalc™ outperforms both the PFM™ and Altman's (2000) z"-score in predicting default in a sample of North American private firms. Blochwitz, Liebig and Nyberg (2000), however, conclude that the direct application of the

PFM™ and statistical discriminant analysis provides powerful approaches to credit risk analysis and yields similar results. Based on their test of the Deutsche Bundesbank's credit risk model, they also conclude that adding a qualitative scoring system to the quantitative models improves their power. Butera and Faff (2006) use a sample of client firms to the Bank of Rome and argue that an assessment of credit risk of private firms should include both a bottom-up technique relying on financial ratios and a top-down approach relying on forward-looking credit risk assessment based on economic outlooks.

As a last note, Oderda, Dacorogna and Jung (2003) test Moody's KMV Credit Monitor, which is their structural model for measuring credit risk of listed firms, and their RiskCalc™ model developed for listed firms, which combine the use of financial ratios and equity value and volatility. They find that both models contain information not inherent in the traditional rating of the firm and that they signal risk of default faster than ratings. This motivates the use of credit risk models in assessing the yield spreads of bonds in general.

2.3 Summary of literature review

To sum up, the literature on the pricing of corporate bonds issued by listed firms provides important insights for assessing the yield spreads of bonds issued by private firms. The literature documents that there is a significant liquidity premium in corporate bond yield spreads and uses either proxies for liquidity or liquidity measures estimated from quotes or transaction data to establish this. The higher quality of data on the US corporate bond market due to TRACE improves the measures of liquidity applied in the literature. The literature further documents that credit risk reflected in ratings and structural models is significant for the yield spreads of corporate bonds, while accounting measures do not add significantly to the explanatory power.

None of these studies consider bonds issued by private firms as they rely on the publicly traded equity value and volatility of the firms to control for credit risk. Another study investigates whether bonds issued by private firms demand a premium in their offering spreads for being private. The credit risk measures developed for private firms are based either on empirically founded models using financial ratios or on attempts to fit structural models to private firms. Industry-level expectations of default likelihood improve these measures. Furthermore, it is documented that qualitative considerations and economic outlooks are important for assessing the credit risk of private firms.

3 Analytical framework

This section provides the definition of corporate bond yield spread and an introductory assessment of its determinants for bonds issued by private and listed firms. Furthermore, measures of credit risk applicable to private firms are discussed.

3.1 Definition of yield spread and its determinants

The formula for pricing a fixed coupon bullet bond with no option features is given by

$$Bondvalue_{t=0} = \sum_{t=1}^{T} \frac{Coupon}{(1+r)^t} + \frac{Face\ value}{(1+r)^T}$$

where T is time to maturity and r is the discount rate. The yield to maturity is the discount rate that makes the present value of the coupon payments and the face value equal to the price of the bond. It has an inverse relation to the price of the bond in that an increase in risk decreases the value of the bond, while yield to maturity increases. Thus, yield to maturity can be considered a measure of the investors' compensation for taking on risk. The corporate bond yield spread is defined as the difference between the yield to maturity of a coupon paying corporate bond and the yield to maturity of a coupon paying government bond. It thus expresses the compensation that the investors require for being exposed to risk related to corporate bonds versus government bonds. In general, government bonds are thought to be free of credit risk and highly liquid and thus the main determinants of corporate bond yield spreads are expected to be liquidity and credit risk.

3.1.1 Liquidity premium

The liquidity of a bond is the ease and pace at which it can be traded in the market without causing changes to its price. Liquidity risk is thus related to whether the bond can be sold (bought) at the time the investor wants to sell (buy) at a price that is close to the price of bonds with a comparable level of risk. A liquid bond is characterized by high trading activity and can easily be converted into cash. While liquidity varies across bonds and across time, it is valuable for investors to hold liquid bonds as it enables them to react more quickly to changes in idiosyncratic and systemic risk. If investors want to invest the capital that they currently have invested in a bond elsewhere, they will immediately be able to sell the bond at a fair price if it is a liquid bond. Alternatively they will have to sell it at a lower price than the fair price or will be unable to sell it if the bond is illiquid. Thus, investors holding illiquid bonds carry the burden of either having their money tied up or having to sell at a lower price

than the fair price if they need to sell the bond with short notice. Thus, ceteris paribus, investors should require a premium as compensation for investing in illiquid bonds.

3.1.2 Credit risk premium

For corporate bonds, credit risk is the risk that investors are exposed to in terms of possible loss of principal or financial reward as a consequence of the issuer's failure to pay or live up to contractual obligations. Thus, any factor that affects the issuers' ability to pay or live up to its contractual obligations affects credit risk. Probability of default, loss given default and migration risk are important elements of credit risk (Bohn & Crosbie, 2003). Migration risk is the probability of changes in default risk and the effect that these changes have on the valuation of the bond. Thus, an assessment of migration risk depends on how default risk is evaluated, the investors' response to possible changes and the extent to which managers consider these effects when making important decisions. Loss given default is the size of the loss that investors expect if the issuer defaults and is thus embodied in the expected recovery rate of the bond. The probability of default is the probability that the firm defaults on its obligation to pay coupons or principal and is closely related to the probability of bankruptcy. Ceteris paribus, investors should require a premium as compensation for investing in bonds with higher credit risk.

3.1.3 Yield spreads of bonds issued by private firms versus listed firms

An assessment of the yield spreads of bonds issued by private firms should, like for bonds issued by listed firms, be focused on liquidity and credit risk. In terms of estimating liquidity, there is no difference in the quality and availability of data for bonds issued by private versus listed firms and thus, the significance of the liquidity measure can be equally assessed for the two groups. Similarly, the credit risk inherent in the bond specific characteristics and stemming from market conditions can be equally assessed. The issue is thus, how to assess credit risk based on firm specific measures.

While credit ratings are publicly available for both bonds issued by private and listed firms, using it to proxy for credit risk in assessing yield spreads would not elucidate any further the determinants of yield spreads than whether or not the rating agencies use relevant information effectively (Shortly discussed in Section II in Campbell & Taksler, 2003). The rating methodology of Moody's for example entails both a quantitative assessment of credit risk of the issuer based on sector specific credit risk models developed from a large historical database and a qualitative assessment based on comprehensive analysis ("Ratings Policy and Approach"). Thus, only the rating agencies know exactly what information is reflected in their final rating of an issue or an issuer.

Furthermore, ratings are intended to reflect long-term risk and will thus not be affected by short-term variation in credit risk of an issuer, which explain why credit ratings are updated rather infrequently.

With the objective element of rating methodologies relying partly on fundamental analysis of credit risk based on financial ratios derived from the firms' financial statements, this suggests another approach to assess credit risk reflected in yield spreads. To the extent that financial statements are available for both private and listed firms, this approach can be applied equally to the bonds issued by both groups. Furthermore, several measures founded on financial ratios have been developed to estimate credit risk of firms, such as Altman's (1968) z-score and the RiskCalc^{TM}. While these models usually focus on default risk, they can be applied to study the relationship between this element of credit risk and yield spreads. The weakness of relying on financial ratios as indicators of credit risk is that financial statements are published with a lag of three months and most frequently every quarter. If equity analysts cover the listed firms, consensus estimates of their financial entries are likely to be available through Thomson Reuters I/B/E/S and provide an additional source of information to assess their credit risk. Furthermore, to the extent that publicly traded data for listed firms reflect relevant information for assessing their credit risk, estimating credit risk of listed firms is further facilitated compared to that of private firms, as publicly traded data reflects new information faster.

The main difference in assessing the yield spreads of bonds issued by private versus listed firms thus, stems from the quality of firm-specific data available. To the extent that private firms are fundamentally different from listed firms it can further be expected that the valuation of their credit risk differ.

3.2 Measures of credit risk applicable to private firms

Measures of credit risk applicable to private firms are either based on empirically founded models using financial ratios, examples being Altman's z"-score and Moody's RiskCalc^{TM}, or based on attempts to fit structural models to private firms.

3.2.1 Altman's z"-score

Altman (1968) develops a z-score to predict bankruptcy of public manufacturing firms through multiple discriminant analysis. By considering the significance and the inter-correlation of a range of financial ratios together with the predictive accuracy of different combinations of them, he develops a linear function of five ratios, which best discriminates between bankrupt and non-bankrupt firms. His analysis is based on 33 bankrupt and 33 non-bankrupt firms in the period 1945 to 1965 and he considers 22 financial ratios covering liquidity, profitability, leverage, solvency and activity of the

firm. He further tests the performance of the z-score on a range of new samples. In Altman (2000) he re-estimates the model for the same sample to a four-factor model, which can be applied to private and non-manufacturing firms. He concludes that this z"-score is slightly less reliable than the original in predicting bankruptcy. The z"-score is

$$z''score = 6.56 * \frac{Working\ capital}{Total\ assets} + 3.26 * \frac{Retained\ Earnings}{Total\ assets} + 6.72 * \frac{EBIT}{Total\ assets} + 1.05 * \frac{Book\ value\ of\ equity}{Total\ liabilities}$$

Working capital to total assets measures the firm's net liquid assets relative to its total capitalization. Altman (1968) finds that bankrupt firms are characterized by lower liquidity than non-bankrupt firms, which intuitively is connected to the fact that firms experiencing operating losses will have shrinking current assets relative to their total assets. Retained earnings to total assets measure the cumulative profitability of the firm over time and thus express the profitability of the firm. However, the ratio also expresses the solvency of the firm, as a higher ratio implies that the firm has financed its assets by reinvesting profits rather than accumulating more debt and can implicitly express the age of the firm in that older firms have had more time to accumulate profits and vice versa. Bankrupt firms are found to be less profitable than non-bankrupt firms. EBIT to total assets measures the productivity of the firm in that it measures its assets' earning power without the effects of taxes and leverage. Bankrupt firms are found to be less productivity than non-bankrupt firms. Finally, the book value of equity to total liabilities expresses the solvency of the firm and is found to be lower for bankrupt firms. This variable replaced the market value of equity to book value of liabilities in the original model to make it applicable to private firms. Thus, part of the inferior reliability of the score is likely to stem from not considering the market's valuation of the firm. Originally, asset turnover was included in the model, but it was removed to make the model applicable to non-manufacturing firms, such as retail and service firms. As the ratio is likely to be higher for the latter firms, using the original score would underestimate the probability of bankruptcy of these firms due to their lower capital intensity (Hayes, Hodge & Hughes, 2010). As lower values of all the ratios are expected to characterize bankrupt firms, a low z"-score indicates higher probability of bankruptcy and thus, ceteris paribus, the z"-score should be negatively related to yield spreads with lower scores demanding a risk premium.

3.2.2 Moody's RiskCalc™

Moody's RiskCalc™ financial-statements-only (FSO) models are based on fitting financial statement variables to default data and estimate an expected default frequency (EDF) credit measure. The latest

US model, RiskCalc™ 4.0 US, is discussed in Dwyer et al. (2012). It is based on data from more than 133,000 private firms from 1994 to 2010 and includes over 9000 observations for defaults. The model excludes small firms (firms with net sales less than $100,000 in 2001 real dollars), financial institutions, real estate development companies, public sector and non-profit institutions and start-up companies together with observations with erroneous financial statements.

After collecting data, the next step in building the model is selecting which financial variables to include. A wide range of variables is categorized as expressing the activity, debt coverage, growth, leverage, liquidity, profitability or size of the firm. Every RiskCalc™ model includes at least one variable from each category. If the performance of the model is increased without deterioration in its robustness, several ratios from the same category are included. The inclusion of a variable in the final model is based on an assessment of its availability, whether the definitions of its inputs are ambiguous, its meaning being intuitive, its ability to predict default and its correlation with other variables in the model. Table 1 shows an overview of the ratios included in the RiskCalc™ 4.0 US model. After being selected, each financial variable is transformed into a preliminary EDF value based on the firm's percentile in relation to other firms and the variable's univariate non-linear relation to default probability. The transformed variables are checked for multicollinearity. The weighting of the transformed variables is then estimated using a probit model and finally the probit model score is converted into an actual EDF credit measure by a non-parametric transformation. The selection process and the weighting of the variables are updated only when there is an improvement in the model and a new RiskCalc™ model for the region is published.

Table 1. Financial Statement Variables in RiskCalc 4.0 US

RiskCalc 4.0 U.S. Ratios	Weight
Activity	15%
Inventories to Sales	
Change in Working Capital over Sales	
Current Liabilities to Sales	
Debt Coverage	13%
EBITDA over Interest Expense	
Growth	7%
Sales Growth: Sales(t)/Sales(t-1)-1	
Leverage	26%
Long-term Debt to (Long-term Debt plus Networth)	
Retained Earnings to Current Liabilites	
Liquidity	20%
Cash and Marketable Securities to Total Assets	
Profitability	13%
Return on Assets (Net income to total assets)	
Change in Return on Assets	
Size	6%
Total Assets	

Another feature of the RiskCalc™ 4.0 US is its adjustment for the credit cycle (CCA). The adjustment includes the average of the scaled standard deviations of the difference between the current average industry distance-to-default to the historical distance-to-default and the current unemployment rate relative to the historical rate.

Using a similar methodology, Moody's has developed RiskCalc™ for the sectors not included in the RiskCalc™ 4.0 US. Among others they have developed a RiskCalc™ model particularly for banks with the financial variables used being very specific to banks. The financial variables included in the model are net income to assets expressing profitability, the Texas ratio expressing asset quality, tangible equity capital to assets expressing the capital structure of the firm and loans to deposits and short-term liquidity expressing liquidity ("RiskCalc™ Plus US Banks 4.0").

The accuracy ratio of the RiskCalc™ US 4.0 FSO in-sample for the 1-year default probability is 51.6% and for the 5-year default probability, it is 37%. The CCA increases the performance of the model slightly with the accuracy ratio increasing to 56.2% for the 1-year default probability and to 34.3% for the 5-year probability (Dwyer et al., 2012). The relation between the ratios included in the model and yield spreads depend on the relation between the probability of default and yield spreads. As the functions used for transforming the variables to a preliminary EDF credit measure and the function used to transform the probit model score to an actual EDF credit measure are not publicly available it is not possible to perfectly replicate the methodology applied in RiskCalc™. Furthermore, another downside of the model is that it can only be applied when all the input financial variables are available for the company in question. However, the result that the non-linear relation between default probability and a range of financial ratios can be used to predict default and outperform Altman's z"-score (Akhavein et al., 2003) is important in that it suggests that the relation between the financial ratios and yield spreads might be non-linear and that the significance and functional form of this relation might vary across sectors.

3.2.3 Credit risk reflected in a structural model

Merton (1974) develops a structural model for pricing risky debt of public firms by applying Black and Scholes' (1973) option pricing model to the value of the firm in considering the equity and debt of a firm as contingent claims to the value of the firm. The model relies on a range of assumptions. Importantly, the value of the firm is assumed to follow a Geometric Brownian motion $dV = \mu V dt + \sigma_v V dW$, where V is the total value of the firm, μ is the expected continuously compounded return of the firm, σ_V is volatility of the firm and dW is a standard Wiener process (Bharath & Shumway, 2004). Furthermore, the Modigliani-Miller theorem that the value of the firm is invariant to its capital structure is imposed and it is assumed that the firm has issued only one discount bond maturing at the end of the forecast horizon and that the term structure is flat and known with certainty (Merton, 1974). Finally, the assumptions underlying the Black and Scholes (1973) option-pricing model of a frictionless and competitive market are made. These assumptions are that there are no transaction

costs, no indivisibility of assets and no taxes, that short-selling of assets is allowed, that borrowing and lending can be done at the same risk free rate r, that trading in assets takes place continuously in time, that agents are price takers and that trading in assets has no effect on prices.

Moody's KMV (Bohn & Crosbie, 2003) develops the model to estimate the default risk of a firm and this model is further explored by Bharath and Shumway (2004). If the value of equity, E, is considered as a call option on the value of the firm, V, with the strike price equal to the value of debt, F, this relation can be expressed as

$$E = VN(d1) - e^{-rT}FN(d2)$$

where

$$d1 = \frac{ln(V/F) + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma_V\sqrt{T}} \text{ and } d2 = d1 - \sigma_V\sqrt{T}$$

and $N(\cdot)$ is the cumulative standard normal distribution function. By employing Ito's lemma it follows that $\sigma_E = \left(\frac{V}{E}\right)\frac{dE}{dV}\sigma_V$ and as $\frac{dE}{dV} = N(d1)$ in the Merton model, the relation between the volatilities can be expressed as $\sigma_E = \left(\frac{V}{E}\right)N(d1)\sigma_V$. Thus, the value and volatility of the firm can be estimated from the relation between the value of the firm, equity and debt and the relation between the firm and equity value and volatilities through an iterative procedure (Bharath & Shumway, 2004). Using these estimated values, a z-score predicting the distance from the estimated value of the firm to the face value of debt can be derived by further taking into account asset drift, μ, and the horizon of the forecast, T. This distance-to-default (DD) is expressed as

$$DD = \frac{ln(V/F) + (\mu - 0.5\sigma_V^2)T}{\sigma_V\sqrt{T}}$$

Thus, the model assumes that the default point is when the value of the firm falls just below the face value of its debt and that the face value of debt is fixed over the forecast horizon. The input to the model is equity value, equity volatility, face value of debt, the risk free rate and an assumed asset drift and forecast horizon. It is expected that higher leverage and equity volatility, ceteris paribus, will require a risk premium, while the risk free rate through the asset drift will be related to a lower default probability and thus lower yield spreads.

As equity value and volatility are only available for firms with publicly traded equity, the structural model cannot be applied directly to private firms. Moody's has further developed a structural model for private firms (PFM^{TM}) in estimating the value and volatility of private firms by using econometric models based on publicly traded data on comparable listed firms and further

coupling it to operating cash flow, sales, book value of liabilities and its industry mix (Akhavein et al., 2003).

3.3 Summary of analytical framework

The yield spread of a corporate bond is defined as the difference between the yield to maturity of a coupon paying corporate bond and the yield to maturity of a coupon paying government bond. It expresses the compensation that the investors require for being exposed to risk related to corporate bonds versus government bonds. It is expected to derive from compensation for illiquidity and credit risk. The significance of liquidity and credit risk stemming from bond specific characteristics and market conditions can be assessed equally for bonds issued by private and listed firms, while the significance of credit risk reflected in firm-specific measures is more complicated to assess for bonds issued by private firms due to the quality and availability of data. Altman's z"-score, Moody's RiskCalc^{TM} and a structural model fitted to private firms are approaches that can be applied to control for credit risk of private firms.

4 Empirical methodology

As it is assumed that credit risk is more complicated to assess for bonds issued by private firms versus listed firms, the focus of this study will be to explore the significance of different measures of credit risk applicable to private firms in explaining variation in yield spreads. In this section, the empirical methodology applied is outlined and the regression underlying the analysis is presented. Both bonds issued by private and listed firms will be considered with the aim of highlighting any differences in how they are priced. Furthermore, the methodology used in applying the different measures will be discussed. This study will explore the significance of Altman's z"-score, simple proxies for the financial condition of the issuer used in the literature on corporate bonds, an approach inspired by Moody's RiskCalc^{TM} (FSO) and finally an approach inspired by the PFM^{TM} in applying a structural model to private firms. While it has been documented that a qualitative scoring model improves the performance of credit risk models founded on financial ratios for private firms (Blochwitz et al., 2000), applying this methodology is considered beyond the scope of this study due to its large sample size and limited resources. The section is concluded with an outline of the assumptions underlying OLS regression analysis, while measures of statistical significance and explanatory power applied is outlined in Appendix 1.

4.1 Regression

The significance of different credit risk measures for explaining variation in yield spreads of bonds issued by private firms is assessed through panel data OLS regression analysis controlling for premia related to illiquidity and credit risk stemming from bond specific characteristics and market conditions.

The dependent variable studied is the yield spread over the swap curve (for calculation details see Section 5.6.1). The variable used to control for liquidity is the implicit bid-ask spread (for calculation details see Section 5.6.2). Bond specific control variables used are time to maturity, bond age, issue size, coupon rate and level of subordination. Time to maturity is measured in years and as longer time to maturity implies that the bond is exposed to credit and interest rate risk for longer, it is expected to require a premium. Bond age is measured in years since the bond was issued and an older bond is expected to require a premium for illiquidity in accordance with the observation by Sarig and Warga (1989) that, as an issue gets older, a larger amount of it is included in investors' buy-and-hold portfolios and thus, it is traded less frequently and becomes less liquid. Issue size is also connected to liquidity as it expresses the general availability of the bond in the market and a larger issue size should, ceteris paribus, be connected with a lower premium. Issue size is measured as the log of the amount issued in millions of US dollars. The coupon rate in percentage is included to proxy for tax effects as a bond with a higher coupon is taxed more throughout the life of the bond and would thus require a tax premium (Campbell & Taksler, 2003). The control for these bond specific characteristics is in accordance with Longstaff et al. (2005) and Dick-Nielsen et al. (2012). Furthermore, a dummy variable for senior bonds is included to control for the higher protection of creditors that seniority offers and thus bonds with less protection are expected to require a premium. Market conditions affecting credit risk are controlled for by the 10-year swap rate and the slope of the swap curve calculated as the 10-year minus the 1-year swap rate as in accordance with Dick-Nielsen et al. (2012) and similar to Campbell and Taksler (2003) that use the 10- and 2-year US treasury rate. In a structural model of credit risk an increase in the risk free rate increases asset drift and is inversely related to default risk and thus it is expected that the slope of the swap curve and the 10-year swap rate are negatively related to yield spreads. The final regression studied is:

$$
\begin{aligned}
&Yield\ spread_{it} \\
&= \alpha + \beta_1 issuer\ specific\ credit\ risk_{it} + \beta_2 implicit\ bidask\ spread_{it} + \beta_3 time\ to\ maturity_{it} \\
&+ \beta_4 bond\ age_{it} + \beta_5 \log issuesize_{it} + \beta_6 coupon_{it} + \beta_7 senior_{it} + \beta_8 10Y\ swap\ rate_t \\
&+ \beta_9 (10Y - 1Y\ Swap\ rate)_t + \varepsilon_{it}
\end{aligned}
$$

Where i denotes the bond, t denotes the observation month and the issuer specific credit risk will vary with the different credit risk measures explored. The regression is run separately for bonds issued by private and listed firms in order to shed light on the explanatory power and significance of the variables used for both groups. In that way, it is also possible to gain insight as to whether the relations between the adopted credit risk measures and yield spreads differ for the two groups. To check whether the model has explanatory power beyond that of ratings, dummy variables for rating groups are added to check if the variables remain significant. The regressions are further run separately for groups of bonds issued by non-financial and financial firms. Furthermore, as the dataset is a pooled time-series and cross-section unbalanced panel, issuer and time-fixed effects and heteroskedasticity in the residuals are dealt with by calculating two-way clustered standard errors on issuer and month in accordance with Petersen (2009) and Thompson (2011). Lastly, the robustness of the models are checked by adding the financial ratios to the model with inputs to a structural credit risk measure, by considering the effect of adding 125 dummy variables for each, but one, month in the period and finally, by applying the inputs to a structural credit risk measure to each rating group.

4.2 Measures of credit risk applied

The following sections outline how the credit risk measures discussed in Section 3.2 and simple proxies for the financial condition of the issuer used in the literature on corporate bonds are applied in studying the determinants of yield spreads of bonds issued by private and listed firms. While the methodology of Elton et al. (2001) that rely on historical ratings and defaults to determine default risk and estimate the resulting credit risk premia could be applied directly to bonds issued by private firms, it would only elucidate the extent to which the credit risk reflected in ratings are reflected in yield spreads, but not any further what the determinants of yield spreads of bonds issued by private and listed firms are. The methodology is not applied in this study, but the significance and explanatory power of considering only ratings together with the control variables are explored and used as benchmark when assessing the other credit risk measures.

4.2.1 Altman's z"-score

While Altman's z"-score can be calculated directly for the firms with all the inputs available and applied directly as a proxy for credit risk, it is important to keep in mind that the score is developed to predict bankruptcy and thus will only proxy for this element of credit risk. Furthermore, its ability to predict bankruptcy out of sample will affect the extent to which it can proxy for this element of credit risk. Relying on a score that is developed from a sample of publicly traded manufacturing firms

to assess the credit risk of private firms from different sectors, one would have to make the assumptions that the same ratios are significant for predicting bankruptcy and that their relative importance has not changed since the sample period. While the significance of the z"-score for yield spreads is investigated for the firms for which all the data needed is available, the significance of the financial ratios will also be assessed by included them directly in the regression. This approach circumvents the strong assumptions specified above, explores each individual ratio's significance for yield spreads controlling for the other ratios, and thus, explores its significance beyond its role in predicting bankruptcy. However, even though one of the ratios is individually negatively correlated with yield spreads, the coefficient might be positive due to its interaction with the other variables. If this is the case, the approach will not capture the intuition behind the individual ratio's significance for yield spreads, but will highlight the effect of the correlation between the ratios for the yield spreads of bonds in the dataset. Furthermore, it should be noted that even though a measure of default risk has a strong performance in predicting default, its significance for yield spreads would further depend on the relation between probabilities of default and yield spreads. While the z"-score uses different cut-offs than the original score for when the firm is likely to go bankrupt and 3.25 is sometimes added to the score to adjust for negative values that with the original score implied bankruptcy (Altman et al., 2011), this study does not rely on a distinction between bankrupt and non-bankrupt as such, but rely on the score to effectively rank the firms in terms of their credit risk.

This study uses the trailing 12 months operating income instead of EBIT, which is discussed in Appendix 2.1.

4.2.2 Simple proxies from the literature

In order to assess whether the measures applied to assess credit risk of private firms have more explanatory power for yield spreads than financial ratios used to proxy for credit risk in the literature, the significance of the financial measures used in Kovner and Wei (2012) and Blume et al. (1998) are assessed.

4.2.2.1 Kovner and Wei's (2012) financial measures

Kovner and Wei (2012) use firm size, profitability, leverage and ratings to control for credit risk in investigating whether bonds issued by private firms demand a premium. Size is measured as the log of total assets in millions of dollars, profitability as the trailing 12 months EBITDA to total assets and leverage as total book value of debt to total book value of assets. As the study is conducted on both private and listed firms, the approach is directly applicable to the private firms in this study. Size and

profitability are expected have a negative relation with yield spreads, while leverage is expected to have a positive relation with yield spreads.

This study uses the trailing 12 months operating income instead of the trailing 12 months EBITDA, which is discussed in Appendix 2.2.

4.2.2.2 Blume et al.'s (1998) financial ratios

In investigating rating agencies' standard for assigning ratings, Blume et al. (1998) use three accounting ratios, which Campbell and Taksler (2003) further use to account for the objective credit risk inherent in ratings and which Dick-Nielsen et al. (2012) apply to control for credit risk in addition to variables derived from market traded data. The ratios are pretax interest coverage, operating income to sales and long-term debt to total assets. While higher values of the first two ratios imply stronger ability to pay through interest coverage and profitability, they are expected to have a negative relation to yield spreads. The last ratio measures leverage and is thus expected to have a positive relation to yield spreads as higher leverage, ceteris paribus, should demand a risk premium. To account for the skewed distribution of the pretax interest coverage ratio, which is measured as EBIT to interest expense, Blume et al. (1998) create four dummy variables[1], while negative interest coverage ratios are set to zero, as they imply that earnings are negative and that they therefore do not provide any coverage for paying interest. Note that operating income is again used instead of EBIT and that this to some extend could bias the results if the distribution of the interest coverage ratios differs significantly in terms of categorizing the dummy variables.

4.2.3 Approach inspired by Moody's RiskCalc™

As specified it is not possible to replicate the methodology applied in Moody's RiskCalc™ models as the functions used for transforming the variables to a preliminary EDF credit measure and the function used to transform the probit model score to an actual EDF credit measure are not publicly available. The result that the non-linear relation between a range of financial variables and default probability can be used to predict default, however, can be applied in assessing their significance for yield spreads. By investigating each financial variable's univariate, and possible non-linear, relation with and significance for yield spreads and its correlation with other financial variables, the financial variables most significant for yield spreads can be applied to control for credit risk. When selecting

[1] C1 is set equal to the interest coverage ratio (IRC) if IRC<5 and 5 if IRC>5. C2 is set equal to zero if IRC<5, equal to IRC-5 if 5<IRC<10 and equal to 5 if IRC>10. C3 is set equal to zero if IRC<10, equal to IRC-10 if 10<IRC<20, and equal to 10 if IRC>20. C4 is set to zero if IRC<20 and IRC-20 if IRC>20 and is truncated at 80.

the ratios, potential multicollinearity and the risk of over-fitting the models are considered. As working capital entries are not available for the whole sample of firms and as financial ratios expressing the activity of the firm always include these entries, this study will refrain from considering credit risk reflected in the activity of the firm. Thus, the significance of financial ratios expressing the debt coverage, growth, leverage, liquidity, profitability and size of the firm will be considered.

Another important implication of the RiskCalc^{TM} model is the notion that firms from the financial sector are fundamentally different from non-financial firms (Dwyer et al., 2012) and that these firms should therefore not be considered in the same model. Thus, the approach inspired by Moody's RiskCalc^{TM} will be applied separately to the subsamples of non-financial and financial firms. The broad categorization of the firms as non-financial and financial, however, implies that industry-specific variables significant for estimating credit risk in a certain industry will not be explored. Examples of such variables are those applied in RiskCalc^{TM} Plus US Banks 4.0 that only apply to banks and not insurance companies, which are also included in the sample of financial firms.

While each financials ratio's availability, whether the definitions of its inputs are ambiguous, its meaning being intuitive, its ability to predict default and its correlation with other variables in the model are considered in accordance with Moody's, it cannot be expected that the same ratios will be significant for yield spreads. This will depend on the relation between default probabilities and yield spreads. If the ratios in one category consistently have the opposite relation with yield spreads than expected through its effect on probability of default it might be due to the composition of the sample or that the relation between the financial ratio and default probability differs from that to its relation with yield spreads. As the analysis is conducted separately for non-financial and financial private and listed firms, it can be expected that it will shed light on the extent to which the relation between the financial variables and yield spreads for these groups differs.

4.2.4 Inputs to a structural model of credit risk

While the output of a structural model of credit risk amongst others is the distance-to-default, which effectively ranks the firms according to their default risk (Jessen & Lando, 2014), this study adopts a more simple approach instead of calculating the distance-to-default and relying on a range of assumptions in adopting it as a credit risk measure. Similar to Ericsson et al. (2009) it considers the significance and explanatory power of the available inputs, namely market value leverage, equity volatility and the risk free rate, for variation in yield spreads.

For private firms, this study uses a simple approach compared to that applied in Moody's PFM™ (Akhavein et al., 2003) in fitting a structural model to private firms. It uses the average sector equity volatility for a given month to proxy for volatility and a multiple of the average market value leverage to book value leverage for the sector in a given month to derive the market value leverage for the firms. Leverage is calculated as total debt divided by total capitalization. For the book value leverage, total capitalization is calculated as book value of equity plus total debt and for the market value leverage, total capitalization is calculated as market value of equity plus total debt. The simple approach was adopted instead of the approach of the PFM™ due to limited data and due to Moody's conclusion that PFM™'s inferior performance to RiskCalc™'s is not necessarily due to the structural model, but likely due to the difficulties in fitting it to private firms (Akhavein et al., 2003). Using this simple approach will yield insights as to whether publicly traded sector information offers explanatory power for variation in yield spreads of bonds issued by private firms. By applying it to bonds issued by listed firms and comparing its explanatory power to that of firm-specific values it will shed light on the significance of publicly traded data relative to sector data.

4.3 OLS model assumptions

While the choice of using OLS regression analysis is motivated by it being a simple approach to assess the linear relation between yield spreads and their determinants, it is important to consider the extent to which it provides a good estimate for this relation, when drawing conclusions based on an analysis applying the approach. In order for this to be the case, four assumptions must hold (Stock & Watson, (2011): 362-364).

Firstly, the error term of the regression should have a conditional mean of zero in order for the regression variables to be exogenous, which implies that the average of the residuals should be close to zero. Thus, by considering the distribution of the residuals it can be assessed whether this assumption holds for the regressions.

Secondly, the variables should be identically and independently distributed, which means that the variables for one bond should be distributed identically to, but independently from, the variables of the other bonds, which is a property obtained through random sampling from the studied population. While the population of this study is defined as fixed coupon bullet bonds denominated in USD with a maturity of less than 30 years and more than a month traded in the US between July 2002 and December 2012 and does not include bonds issued under Rule 144A and observations for defaulted bonds, some bonds that fulfill these requirements are not included in the dataset due to a lack of transaction or accounting data. To the extent that the relation between yield spreads and their

determinants for these bonds differs from the bonds in the dataset, it will affect the internal validity of the study. As mentioned the requirements for the liquidity measure result in less liquid bonds being excluded and thus, the results of this study are likely to be more valid for bonds that are more liquid. In terms of accounting data not being available for some issuers, it is not possible to assess their firm-specific credit risk and thus, whether or not the conclusions of this study are valid for the yield spreads of their bonds. Furthermore, some bonds might be connected to a listed issuer instead of a private issuer if the latter's accounting data is not available via Bloomberg and its listed parent company's is. This can cause significant bias in the validity of the results for both groups and can result in the groups of bonds not reflecting the true populations.

The third assumption is that large outliers are unlikely, which can be assessed by considering the kurtosis of the variables. The assumption implies that the variables have non-zero finite fourth moments, i.e. that the variables have finite kurtosis.

Finally, there should be no perfect multicollinearity between the variables as it increases the probability of getting inconsistent estimates. This assumption holds if the correlation between the variables included is not too large.

The use of OLS is widely adopted in the literature on the determinants of corporate bond yield spreads (Campbell & Taksler, 2003; Bao et al., 2011; Dick-Nielsen et al., 2012; Kovner & Wei, 2012), yield spread changes (Collin-Dufresne, Goldstein & Martin, 2001) and both (Ericsson el al, 2009).

4.4 Summary of empirical methodology

The significance of different measures of credit risk for yield spreads is studied through OLS regression analysis controlling for illiquidity and credit risk stemming from bond specific characteristics and market conditions for private and listed firms separately. The measures of credit risk applied are inspired by Altman's z"-score, simple proxies for the financial condition of the issuer used to proxy for credit risk in the literature on corporate bonds, Moody's RiskCalc^{TM} model and a structural model of credit risk. OLS regression analysis is a simple approach to assessing the relation between yield spreads and their determinants and the quality of the estimated relation will depend on the extent to which the assumptions underlying OLS regression analysis are fulfilled.

5 Data collection

In this section, the steps of the data collection process are outlined and motivated. The final dataset is constructed with data from Enhanced TRACE and Mergent FISD accessed via Wharton Research Data Services (WRDS) and Bloomberg and is affected by crucial decisions and assumptions made in collecting relevant data. Finally, the approaches applied in calculating yield spreads and implicit bid-ask spreads are specified.

5.1 Transaction data from Enhanced TRACE

The National Association of Securities Dealers (NASD) introduced Trade Reporting and Compliance Engine (TRACE) in July 2002 in an effort to increase price transparency in the US corporate bond market. After NASD merged with NYSE in 2007, they formed the Financial Industry Regulatory Authority (FINRA), which is a non-governmental regulator of the entire securities industry, which now manages TRACE. TRACE captures and disseminates consolidated information on secondary market transactions in the corporate debt market with brokers and dealers that are FINRA member firms being required to report their transactions in any TRACE-eligible security, which covers publicly traded investment grade, high yield and convertible corporate bonds. This means that individual investors and market professionals can access information on 100% of over-the-counter activity, which corresponds to 99% of the total US corporate bond market activity in these securities (FINRA, 2014b).

Through the history of the standard TRACE system dissemination has increased significantly and it now includes all transactions in investment grade, high yield, and convertible corporate bonds back to July 1 2002. However, the Enhanced TRACE data includes information that was not available when the transaction was published the first time, such as buy-sell information, and thus, this data is more detailed than the standard TRACE data (Dick-Nielsen, 2014). Due to the increased level of information, the Enhanced TRACE data is published with a lag of 18 months, whereas standard TRACE data is available with only a three months lag. Thus, there is a trade-off between the enhanced information and the length of the period that the data covers. This study prioritizes the enhanced information and thus, uses the Enhanced TRACE data, which at the time of writing is available from July 1 2002 to December 31 2012. This period sets the limit for the period considered in this study. The Enhanced TRACE data includes 114,213,116 trades.

As estimating liquidity is an essential element of this study, bonds that appear in Enhanced Trace form the base of the dataset to ensure that actual transaction data is available. Thus, the

limitation of solely considering US traded bonds stems from the use of Enhanced TRACE as the source for trading data used in the liquidity measure. By adopting TRACE to improve price transparency in the secondary corporate bonds market, the US is the only country with a system that records all information on over-the-counter transactions and makes the data publicly available. By giving direct access to data on actual transactions, the Enhanced TRACE data significantly improves the quality of data on corporate bond transactions and makes it possible to estimate liquidity measures directly from actual transactions.

While transactions in bonds issued under Rule 144A have been publicly disseminated since July 1 2014 (FINRA, 2014a), they are not included in Enhanced Trace. Under Rule 144A, a firm is allowed to issue securities to qualified institutional investors that also may only be traded among qualified institutional investors in the secondary market. Furthermore, the issuer is not required to register with the SEC unless it has registration rights that require it to exchange the original Rule 144A issue for public bonds within a certain period, which results in them being registered with a new cusip id. Livingston and Zhou (2002) study the impact of Rule 144A debt offerings on bond yields and conclude that these issues have higher yields than public offerings after adjusting for risk and that the premia might be due to lower liquidity, information uncertainty and weaker legal protection of investors. Kovner and Wei (2012) use a dummy variable for bonds originally issued under Rule 144A to capture these effects, however, as the focus of this study is on pricing in the secondary market and as transactions on bonds issued under Rule 144A are not disseminated through Enhanced Trace, they will not be covered in this study.

As noted by Dick-Nielsen (2009) the TRACE data includes reporting errors, agency transactions and both sides of inter-dealer transactions, which, if not accounted for, can significantly bias liquidity measures derived from the data. Thus, the Enhanced Trace data is cleaned in accordance with Dick-Nielsen (2014), which includes deleting observations without a cusip id, cancellations, corrections, reports that are matched by reversals, agency transactions and one of the sides of the reported inter-dealer transactions. After cleaning the data 75,522,492 trades connected to 83,137 unique bond cusip ids remain and form the base for further collection of data.

5.2 Bond specific characteristics and ratings from FISD and Bloomberg

Mergent Fixed Income Securities Database (FISD) is a comprehensive database with issue and issuer information on corporate bonds publicly offered in the US. In accordance with other studies, such as Campbell and Taksler (2003), Bao et al. (2011) and Kovner and Wei (2012), FISD is used as the main data source for issue-specific characteristics. The database recognized 70,419 of the bond cusip ids

obtained from Enhanced TRACE. The issue specific information from FISD is supplemented with information on amount issued, sinking fund provisions, call options, default and industry classifications from Bloomberg.

Similar to Elton et al. (2001) and Dick-Nielsen et al. (2012) this study only considers fixed rate bullet bonds as embedded options significantly complicates the pricing of the bond. Thus, bonds that are callable, convertible, redeemable, fungible, or exchangeable or have put options or sinking fund provisions together with bonds that have a non-fixed coupon are removed from the dataset. Collin-Dufresne et al. (2001), Campbell and Taksler (2003) and Longstaff et al. (2005) similarly exclude callable and puttable bonds. Kovner and Wei (2012) on the other hand use a dummy variable to take account for these two option features in their study on the offering yield spread. The latter approach was not adopted in this study as the focus is on pricing in the secondary market and as argued these option features make the pricing of the bond more complex.

Furthermore, perpetuity bonds and bonds with a maturity longer than 30 years are removed as their price is more sensitive to changes in the interest rate due to their longer duration and exposure to interest rate risk. On the other hand, bonds with a maturity of less than a month are removed as it is assumed that the pricing in this period moves toward face value. Moreover, bonds issued in another currency are removed, as the pricing of these issues is additionally affected by currency valuations.

Bloomberg classifies the industry of a security through its Bloomberg Industry Classification System, which consists of three levels; sector, group and subgroup. Classification is based on the firms' business or economic function and characteristics. In order to have enough observations in each industry, the sector will be adopted as industry classification in this study. The subgroup and group are more narrowly defined and due to the sample size of this study, it is not applied. This study further groups the bonds by those issued by non-financial and financial firms. Finally, in accordance with the approach by Dwyer et al. (2012), bonds issued by public sector firms are removed, as it is assumed that the relations between their financial results and default risks are not comparable with that of other firms as the states or municipalities will be reluctant to let them fail.

FISD contains ratings from, among others, the three largest rating agencies; Moody's, S&P and Fitch. The ratings of the bonds used in this study will be the ones from Moody's. If they do not rate a bond, the rating from S&P will be used. If they do not rate the bond, the rating from Fitch will be used. If they do not rate the bond, the bond will be classified as not rated. As Enhanced Trace includes transactions of defaulted bonds and as it is assumed that these follow an unusual pricing pattern that will mostly be influenced by their recovery rate, observations where the bonds have a D-

rating are removed. Furthermore, observations for a bond are deleted if the trading date falls after the date for bankruptcy of the issuer or default of the bond.

The set limitations in relation to issue-specific characteristics result in a dataset with only bonds that are fixed coupon bullet bonds denominated in USD with a maturity of less than 30 years and more than a month and does not include observations for defaulted bonds.

5.3 Issuer information from Bloomberg

In order to obtain issuer-specific information, the bond cusip ids from FISD are matched to their issuer via Bloomberg. For each bond, the related equity ticker is found and, if the company belonging to that ticker published individual financial statements in the period where the bond was outstanding, that issuer is matched to the bond. If not, it is checked whether the financial statements of the issuer's parent company are available for that period. Thus, the final company matched to the bond is the first company, from a bottom-up perspective, in its corporate structure for which financial statements are available for the period covering the life of the bond. Thus, it is implicitly assumed that investors use the same approach, which affects their perceived risk of investing in the bond and thus the pricing of the bond. Another support for this method is the fact that the firms in the same corporate structure sometimes guarantee the debt of each other. If for example the parent guarantees the debt of its subsidiary, it can be expected that its performance will influence the pricing of the bond. However, if accounting data is available for the issuer through another data source, this approach will be inferior in terms of connecting the bond to the issuer, whose credit risk is reflected in the yield spread of the bond. This also implies the possibility of placing bonds in the wrong group in terms of them being issued by a private or listed firm. If there is no accounting information available for the firm via Bloomberg, the bond is removed from the dataset, as the information is needed to assess credit risk. As firms with public debt are required to register their financial statements publicly in the US (Kovner & Wei, 2012), this approach might bias the results, as investors will probably obtain access to the companies' financial statements through other sources. However, the fact that the financial statements are not readily available through a widely used data source such as Bloomberg decreases transparency and increases the cost for the investor due to the increased effort of gaining access to the statements.

Each issuer is then characterized in accordance with the status of their shares outstanding being listed or private. When the ownership of the issuer changes during the life of the bond in the period considered, this development is taken into account. Kovner and Wei (2012) go through the same process, but use CRSP and then search S&P's Capital IQ and a range of public data sources by hand to establish the issuer's equity status. This study takes the approach of manually searching all

issuers on Bloomberg, where information on merger and acquisition history and initial public offerings (IPOs) can be found. This is especially relevant in relation to mergers and acquisitions, if the resulting company publishes consolidated financial statements under a new equity ticker or if, as an acquired company, the issuer no longer publishes individual financial statements. Thus, if the issuer merged with another company (or was acquired) during the period considered, the accounting data matched to the bond after the merger (or acquisition) date will be that of the resulting company (or acquirer). If the issuer goes through an IPO during the period, it will naturally classify as private up until the IPO date and afterwards as listed. In the case of IPOs, not all companies enclosed their financial statements as private firms and thus only have data available after being traded publicly.

5.4 Accounting data from Bloomberg

For firms where it is available, accounting data is obtained via Bloomberg. Quarterly data has first priority. This study takes the simple approach of using the last available financial statements at each observation date and thus does not directly adjust for investor expectations for the information reflected in the financial statements of the firm (See Appendix 3). The items used from the income statement are the values of the trailing 12 months and are thus equally of better quality for the quarterly data than for the other data frequencies. Furthermore, a lag of three months in publishing the financial statements is assumed for all companies.

As a last note, the financial statements might be in a different currency than USD if the parent is located in another country. The country of domicile and the currency of the financial statements are obtained based on the final issuer matched to the bond. To make comparison easier, when for example considering the size of the companies, the financial statements are converted to USD. This is done by getting daily exchange rates for the currency in which the statements are published and then, based on the end date of the financial statement, converting them into USD.

5.5 Publicly traded data and swap rates from Bloomberg

In order to consider the significance of the inputs to structural measure of credit risk and sector data for private firms, publicly traded data for the listed firms in the dataset is obtained via Bloomberg. The relevant variables are share price, number of shares outstanding and annualized volatility based on the last 180 days, which is also used in other studies such as Campbell and Taksler (2003). If the shares are traded in another currency, their price is converted to USD based on the trading date and the matching exchange rate to enable comparisons and multiple analyses including market value of equity.

Daily USD vanilla interest swap rates for all available yearly maturities are also obtained through Bloomberg with the aim of calculating yield spreads for the bonds and controlling for market conditions reflected in the 10-year swap rate and the slope of the swap curve.

5.6 Input to yield spreads and implicit bid-ask spreads from Enhanced TRACE

Lastly, only transactions from the cleaned Enhanced Trace data connected to bonds and issuers fulfilling the requirements outlined above are considered. Furthermore, an outlier filter in accordance with Rossi (2014) is imposed on the transaction data. This implies excluding a transaction if it is preceded and followed by a price increase or drop of more than 50% and minimizing the impact of unusual observations[2]. Lastly, trades below USD 100,000 are deleted to focus on transactions of institutional investors in accordance with Dick-Nielsen et al. (2012). After imposing the above limitations, the final dataset from Enhanced Trace includes 1,831,610 transactions, which are used to calculate the yield spreads and implicit bid-ask spreads of the bonds.

5.6.1 Calculating yield spreads

The yield spreads are calculated from the yield obtained via Enhanced TRACE and linear interpolation of the matching swap rates from Bloomberg. Firstly, the yield for each bond is calculated as the average yield from all the transactions on a specific day weighted by the size of the transactions. The final yield observation used is the last observation in a month for the bond in question. After obtaining the yield, the time to maturity of the bond at each observation date is calculated. The two swap rates that have the closest maturities to the maturity of the bond are used. Then through linear interpolation of these two swap rates, an approximation of the risk free rate with the same maturity as the bond is derived and used to calculate the yield spread of the bond. This approach is adopted to enable comparison with other studies, which adopt the same approach, such as Campbell and Taksler (2003), Kovner and Wei (2012) and Dick-Nielsen et al. (2012).

5.6.2 Calculating implicit bid-ask spreads

With the dissemination of buy-sell information for transactions in Enhanced Trace, it is possible to calculate the implicit bid-ask spread from actual transactions. The bid-ask spread has been widely used to proxy for liquidity, as it is a direct cost of illiquidity of the bond. With TRACE data being available for all bonds traded in the US, there is no difference in the data availability for bonds issued

[2] "Only observations that pass the following screening are kept: $|p - med(p,k)| \leq 5 * MAD(p,k) + g$, where g is a granularity parameter which is set equal to \$1, and $med(p,k)$, and $MAD(p,k)$are respectively the centered rolling median, and median absolute deviations of the price p using k observations (k is set to 20)" - Rossi, 2014

by private and listed firms in taking into account liquidity as a determinant of yield spreads. The implicit bid-ask spread is calculated by deducting the average daily bid-price from the average daily ask-price and dividing this value by the average mid-price. Thus, the implicit bid-ask spread expresses the average cost, measured in percentage of the price, of selling a bond and immediately buying it back or vice versa and thus can be used as a proxy for illiquidity as its existence is a direct result of the illiquidity of the bond. The observation used is the median of the positive implicit bid-ask spreads over a month, which is matched to the yield spread observation for that month. The median is used to avoid outliers, while the specific calculation of implicit bid-ask spreads relying on prices over yields is also found in Feldhütter, Hotchkiss and Karakaş (2015). Only observations where both the yield spread and the implicit bid-ask spread are available for a specific month are kept and as a result 66,165 monthly observations from 5,913 bonds issued by 695 firms remain.

5.7 Summary of observations included in the dataset

The use of Enhanced Trace for obtaining transaction data limits this study to bonds traded in the US between July 1 2002 and December 31 2012 and bonds not issued under Rule 144A. Only monthly observations for which both the yield spread and a positive implicit bid-ask spread are available are included. Further restrictions imposed on the dataset are that the observations must be for fixed coupon bullet bonds with no option features, denominated in USD that have a maturity ranging from one month to 30 years and have not defaulted. Furthermore, it is required that accounting data for the issuer is available through Bloomberg, which is also used to establish the ownership status of the issuer's equity.

6 Characteristics of dataset

This section provides an overview of the characteristics of the dataset, which will be divided into bonds issued by private and listed firms and further into bonds issued by non-financial and financial firms.

6.1 Ownership status

Table 2 shows the distribution of observations across ownership status of the issuers. 12.3% of the observations are for bonds issued by private firms and 87.7% are for bonds issued by listed firms. The non-financial firms have the largest share of observations for bonds issued by private firms at 15.3% compared with 9.5% for the financial firms. The share of observations for private firms is similar to the distribution recorded by Kovner and Wei (2012) for their share of bond issuances per year by non-utility, non-financial firms (ranging from 9 to 32% from 1993 to 2009).

Table 2. Ownership Status

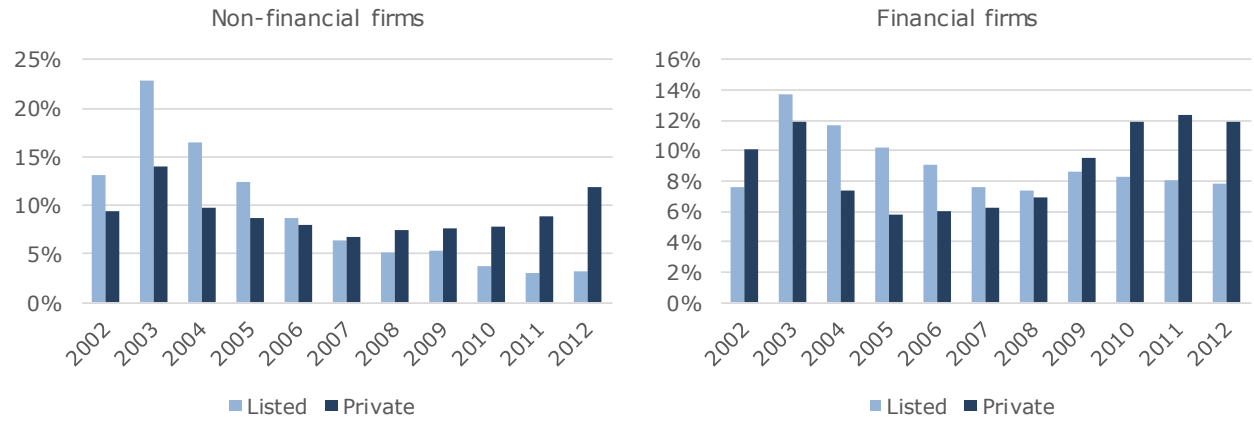
	Non-financial	Financial	Total
Observations			
Listed	84.7%	90.5%	87.7%
Private	15.3%	9.5%	12.3%
Total	31749	34416	66165
Observations per bond			
Listed	13	11	12
Private	8	9	8
Bonds per issuer			
Listed	5	16	8
Private	13	19	14

On average, there are 8 observations per bond for the period for bonds issued by private firms and 12 for bonds issued by listed firms. The low number of observations per bond can be due to the bonds only being active in part of the period studied or to the requirements for the liquidity measure applied. Considering bonds per issuer, the private firms on average have 14 bonds for the period, while the listed firms have 8 bonds.

6.2 Observations across time

Figure 1 shows the share of observations for non-financial and financial bonds across ownership status for each year in the period studied. While the whole period is covered by observations for all the subsamples, the fact that the shares vary each year across the groups might affect the analysis.

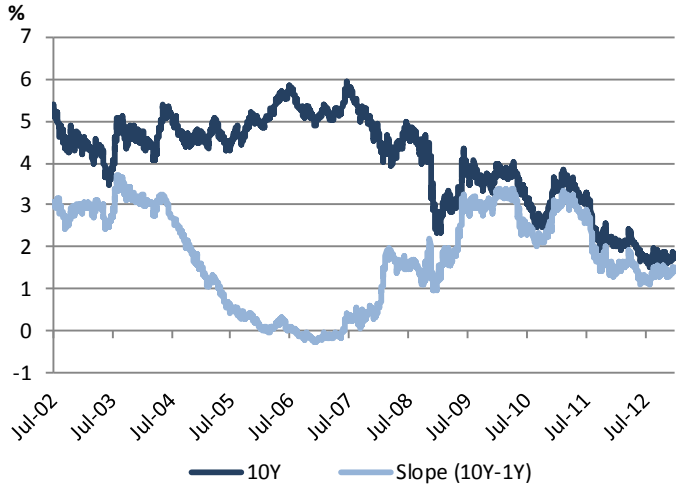
Figure 1. Observations across time



6.3 The 10-year swap rate and the swap curve

As Figure 2 shows, the period studied is characterized by a relatively higher 10-year swap rate early in the period, while it exhibits a downward trend from the onset of the global financial crisis in September 2008. Most of the period is characterized by a normal swap curve, i.e. with investors expecting a higher yield for longer maturity securities. However, as a result of the increasing 1-year swap rate, the slope of the swap curve decreased significantly from the middle of July 2004 to the onset of the US subprime mortgage crisis commencing in December 2007. Thus, some of the months in between are characterized by an inverse swap curve, implying an expectation of lower swap rates in the future. With a decreasing 1-year swap rate during the financial crisis, the slope of the curve turned positive again with expectations of higher rates in the future.

Figure 2. 10-year Swap Rate and Slope of the Swap Curve



6.4 Sector

Table 3 shows the distribution of observations across sectors. For private firms 40.1% of the observations are for bonds issued by financial firms and 59.9% for bonds issued by non-financial firms, whereof the 37% are from industrial firms, the 15% are from the cyclical consumer goods sector and the 5.9% are from utility firms, while the other sectors have minor or no representation. For listed firms 53.7% of the observations are for bonds issued by financial firms and 46.3% for bonds issued by non-financial firms, whereof the remaining sectors are all represented by between the low of 1.3% for the technology sector and the high of 10.1% for the cyclical consumer goods sector. Thus, when comparing determinants of yield spreads for bonds issued by private and listed firms, it should be taken into account that the observations for private firms are primarily for financial and industrial firms, while for the listed

Table 3. Sectors

	Listed	Private
Basic Materials	3.9%	0.3%
Communications	9.6%	0.0%
Consumer, Cyclical	10.1%	15.0%
Consumer, Non-cyclical	7.7%	0.3%
Diversified	0.3%	0.0%
Energy	3.6%	1.3%
Industrial	6.4%	37.1%
Technology	1.3%	0.0%
Utilities	3.3%	5.9%
Total non-financial	46.3%	59.9%
Financial	53.7%	40.1%

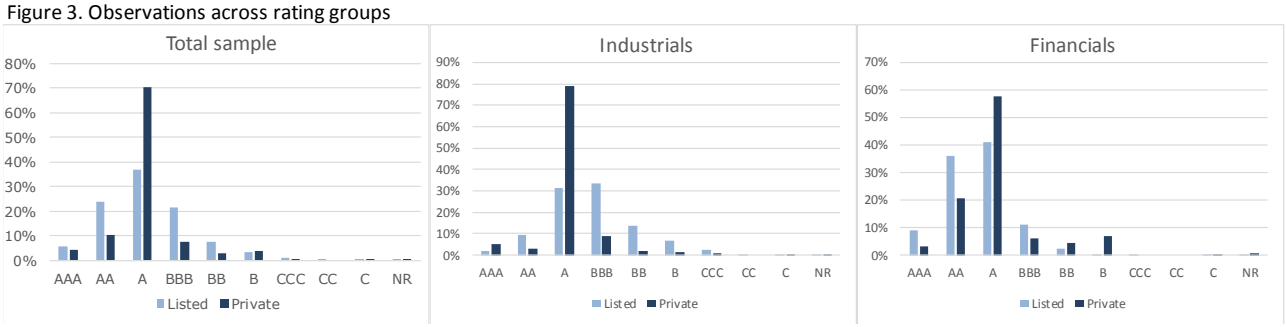
firms, there is an overweight of observations for financial firms with the remainder being more evenly spread across the sectors of non-financial firms.

6.5 Ratings

Figure 3 shows the distribution of observations across rating groups by ownership status. 92% of the observations for bonds issued by private firms are for investment grade bonds, while 70% of the observations are for bonds that have an A-rating. The remaining 7% are for speculative grade bonds and an insignificant share are for bonds not rated. For bonds issued by listed firms, the observations are more spread out across ratings and 87% of the observations are for investment grade bonds, 13% are for speculative grade bonds and an insignificant share are for bonds not rated.

The pattern is similar for non-financial firms, however, the private firms are on average higher rated and the listed firms lower rated than in the whole dataset. For financial firms, this pattern is reversed as a larger share of the observations for listed firms than that of private firms is for investment grade bonds.

Figure 3. Observations across rating groups



While Kovner and Wei (2012) also find that the majority of bonds issued by listed firms are investment grade, they find that the majority of the bonds in their sample issued by private firms are speculative grade. Their dataset is based only on bonds issued by non-financial and non-utility firms and includes callable bonds, bonds with a put option and bonds issued under Rule 144A. Thus, the extent to which these bonds are expected to have a lower rating can explain the difference. However, the difference can also be due to their access to S&P's Capital IQ, which among others provides an extensive database of financial statements. They define the database as their main source for obtaining accounting data from private firms and thus the extent to which it provides superior information on lower rated issuers over Bloomberg can explain the difference between the distributions of ratings for bonds issued by private firms found, as firms with accounting data not available through Bloomberg are excluded from this study.

6.6 Region of domicile

As Table 4 shows, 87.3% of the observations in the dataset are for bonds issued by a company with domicile in the US, with Europe is the region with the second largest representation of 8.4%. Companies from all the regions are represented in the dataset, however, not across both ownership groups and some only with small representations. The private firms in the dataset are only represented by domicile in Europe and North America. However, for non-financial private firms, only a negligent share of observations is for firms with domicile outside the US. For non-financial listed firms, the share is 11.4%, while for financial firms, the share of observations for issuers with domicile outside the US is similar for private and listed firms at 14.3% and 15.4%, respectively.

Table 4. Region of Domicile

	Total sample			Non-financial			Financial		
	Listed	Private	Total	Listed	Private	Total	Listed	Private	Total
North America	88.9%	94.2%	89.5%	90.4%	100.0%	91.9%	87.6%	85.7%	87.4%
US	86.4%	94.0%	87.3%	88.6%	99.6%	90.3%	84.6%	85.7%	84.7%
Canada	2.5%	0.2%	2.2%	1.8%	0.4%	1.6%	3.0%	0.0%	2.7%
Europe	8.7%	5.8%	8.4%	5.6%	0.0%	4.8%	11.4%	14.3%	11.7%
Asia	0.4%	-	0.3%	0.2%	-	0.1%	0.5%	-	0.5%
South Pacific	0.2%	-	0.1%	0.1%	-	0.1%	0.2%	-	0.2%
South America	1.9%	-	1.7%	3.7%	-	3.2%	0.3%	-	0.3%

6.7 Summary of data characteristics

12.3% of the observations in the dataset are for bonds issued by private firms. On average, there are more observations per bond issued by listed firms versus private firms, but the latter on average have more bonds per issuer during the period. The observations cover the whole period studied both for bonds issued by non-financial and financial private and listed firms. The observations for private firms are primarily from the financial and industrial sector, while for listed firms, over half of them are from the financial sector and the remaining observations are spread more evenly across the non-financial sectors. The dataset is dominated by investment grade bonds and bonds issued by firms with domicile in the US.

7 Empirical results

This section provides and discusses the empirical results of the study. It commences with a section covering the descriptive statistics of the dependent variable, the control variables applied and selected inputs to the measures of credit risk. To deal with outliers, the yield spreads and the implicit bid-ask spreads are winsorized, while when the distributions of other variables indicate that there are extreme outliers, these are removed (See Appendix 4). The section continues with the regression results. First,

the base regressions will be shortly discussed, as they will be used as benchmarks to evaluate the credit risk measures applied. Then results on the significance and explanatory power of the inputs to the credit risk measures applicable to private firms will be provided and discussed. Furthermore, the analysis will shed light on the significance of publicly traded data for yield spreads and the extent to which the relation between yield spreads and their determinants differs across the defined groups. The robustness of the results are assessed by considering the effect of adding the credit risk measures founded on financial ratios to the model applying the inputs to a structural measure of credit risk, the effect of controlling for months by adding 125 dummy variables for each, but one, month in the period and lastly, the effect of applying the model employing the inputs to a structural measure of credit risk separately to each rating group. Furthermore, the significance of the control variables will be discussed and finally, the significance of liquidity and the size of the liquidity component will be assessed.

7.1 Descriptive statistics

This section summarizes the descriptive statistics of the dependent variable, the control variables applied (Table 5) and selected inputs to the measures of credit risk (Table 6 p. 42, 7.a p.43 and 7.b p. 47). Descriptive statistics of the financial statement variables and their functional forms applied in the approach inspired by Moody's RiskCalc^{TM} will be provided in Section 7.3.9 as different variables are applied to the subsamples of bonds issued by non-financial and financial firms. The correlations between the variables for the different groups can be found in Appendix 5.

7.1.1 Yield spreads

The median yield spread of a bond issued by a private firm is 96bp, while it is lower for non-financial bonds and higher for financial bonds within the subsample. For bonds issued by listed firms, the median yield spread is 107bp, while it is higher for non-financial bonds and lower for financial bonds within the subsample. The relation between yield spreads of non-financial and financial firms is thus opposite for private and listed firms. In general, the distributions of yield spreads for the groups are right-skewed and has a high kurtosis compared to a normal distribution.

7.1.2 Bond-specific characteristics

The bonds issued by private firms have a median maturity of 2.5 years, are 2.6 years old, have a median coupon of 5.4% and a median issue size of $350m, while 91% of the observations are for senior bonds. On average the bonds issued by the private firms in the sample have characteristics that

Table 5. Descriptive Statistics of Dependent Variable and Bond Specific Control Variables

Bonds issued by private firms

	Firms	Obs	Mean	Standard deviation	Percentiles							Kurtosis	Skewness
					1st	5th	25th	50th	75th	95th	99th		
Yield Spread (bp)	Total	8130	189	313	-16	-2	27	96	234	633	1614	34.8	4.9
	Non-financial	4866	136	217	-17	-4	17	63	178	465	884	57.8	5.7
	Financial	3264	269	404	-12	5	65	145	300	1056	2083	20.6	4.0
Maturity (Years)	Total	8130	3.5	4.1	0.1	0.3	1.1	2.5	4.5	9.6	25.5	15.5	3.4
	Non-financial	4866	3.0	2.9	0.1	0.3	1.0	2.3	4.2	9.2	14.4	6.5	2.1
	Financial	3264	4.2	5.4	0.1	0.3	1.2	2.7	4.8	12.0	28.4	10.3	3.1
Bond age (Years)	Total	8130	3.7	3.5	0.0	0.2	1.2	2.6	4.8	10.5	16.8	3.5	1.7
	Non-financial	4866	4.0	3.8	0.0	0.2	1.2	2.8	5.6	11.3	17.3	2.5	1.5
	Financial	3264	3.3	3.1	0.0	0.2	1.2	2.4	4.3	9.3	15.6	5.9	2.1
Coupon (%)	Total	8130	5.2	1.7	1.1	1.9	4.3	5.4	6.4	7.8	9.2	-0.1	-0.3
	Non-financial	4866	5.1	1.9	1.1	1.6	3.9	5.4	6.6	7.8	9.2	-0.5	-0.3
	Financial	3264	5.4	1.5	1.8	2.4	4.6	5.5	6.2	7.9	9.3	0.6	-0.1
Issue size ($m)	Total	8130	580	623	2	8	200	350	750	2000	3000	6	2
	Non-financial	4866	421	465	2	9	200	300	500	1000	3000	22	4
	Financial	3264	818	741	2	8	219	700	1100	2250	3500	1	1
Ln(Issue size)	Total	8130	5.7	1.5	7.0	2.1	5.3	5.9	6.6	7.6	8.0	2.8	-1.4
	Non-financial	4866	5.5	1.4	0.8	2.2	5.3	5.7	6.2	6.9	8.0	2.9	-1.6
	Financial	3264	6.0	1.7	0.6	2.0	5.4	6.6	7.0	7.7	8.2	2.2	-1.5
Implicit bid-ask spread (bp)	Total	8130	51.2	69.5	0.0	0.2	9.9	26.7	64.9	176.9	341.9	15.4	3.3
	Non-financial	4866	47.0	64.2	0.0	0.6	8.7	23.8	59.7	167.5	300.4	14.8	3.2
	Financial	3264	57.6	76.5	0.0	0.0	12.5	32.2	71.5	187.5	393.0	14.7	3.3
Senior bonds:		Total: 91%			Non-financial: 96%			Financial: 82%					

Bonds issued by listed firms

	Firms	Obs	Mean	Standard deviation	Percentiles							Kurtosis	Skewness
					1st	5th	25th	50th	75th	95th	99th		
Yield Spread (bp)	Total	58035	215	373	-19	-2	35	107	255	696	2102	34.0	5.1
	Non-financial	26883	272	426	-15	4	57	148	326	851	2717	24.6	4.4
	Financial	31152	166	313	-23	-4	23	76	199	541	1452	51.4	6.2
Maturity (Years)	Total	58035	5.7	6.4	0.1	0.3	1.4	3.3	7.2	21.2	26.4	2.2	1.7
	Non-financial	26883	7.0	7.3	0.1	0.3	4.5	3.7	10.8	22.8	26.1	0.2	1.2
	Financial	31152	4.6	5.3	0.1	0.3	1.3	2.9	5.8	16.6	26.7	6.6	2.4
Bond age (Years)	Total	58035	6.6	4.5	0.1	0.5	2.9	6.2	9.3	15.1	19.1	0.1	0.7
	Non-financial	26883	8.5	4.4	0.4	1.7	5.5	8.2	11.0	17.0	19.6	0.0	0.5
	Financial	31152	4.9	3.8	0.0	0.3	1.8	4.1	7.5	11.7	16.4	0.8	1.0
Coupon (%)	Total	58035	6.4	1.7	1.9	3.2	5.4	6.7	7.5	9.0	10.0	0.6	-0.4
	Non-financial	26883	7.2	1.3	3.4	4.9	6.6	6.6	7.9	9.4	10.5	2.0	-0.2
	Financial	31152	5.7	1.6	1.6	2.5	4.8	5.8	6.9	7.9	9.3	0.1	-0.4
Issue size ($m)	Total	58035	513	601	5	28	200	300	600	1750	3000	16	3
	Non-financial	26883	327	279	7	50	150	250	400	994	1459	13	3
	Financial	31152	673	741	4	21	200	500	850	2100	3500	9	3
Ln(Issue size)	Total	58035	5.7	1.2	1.6	3.3	5.3	5.7	6.4	7.5	8.0	3.1	-1.2
	Non-financial	26883	5.5	0.9	2.0	3.9	5.0	5.5	6.0	6.9	7.3	480.0	-1.5
	Financial	31152	5.9	1.4	1.3	3.0	5.3	6.2	6.8	7.7	8.2	2.8	-1.3
Implicit bid-ask spread (bp)	Total	58035	58.4	85.6	0.0	0.0	9.5	27.4	69.5	228.7	449.8	11.9	3.1
	Non-financial	26883	62.9	91.2	0.0	0.0	10.6	30.3	73.9	246.1	483.6	10.7	3.0
	Financial	31152	54.5	80.2	0.0	0.0	8.7	25.3	65.2	212.1	405.2	12.8	3.1
Senior bonds:		Total: 83%			Non-financial: 96%			Financial: 72%					

are less risky than the bonds issued by listed firms. For bonds issued by private non-financial firms, the differences to the overall sample of bonds issued by private firms is small, but, on average, time to maturity and issue size are lower and a higher share of them is senior bonds. Bonds issued by

private financial firms are, on average, characterized by their significantly larger issue size, the longer time to maturity and a lower share of senior bonds compared to the other bonds issued by private firms. For listed firms, all the characteristics for bonds issued by non-financial firms, except seniority, imply that these have riskier characteristics than the other bonds in the dataset, while all the characteristics of bonds issued by financial firms, except for seniority, on average, imply that these bonds have less risky characteristics than the other bonds issued by listed firms in the dataset.

In general, the distributions of time to maturity and bond age are right-skewed, while the distributions of coupons are characterized by little skewness and low kurtosis. The distributions of log of issue sizes are left-skewed and have a kurtosis ranging close to 3.

7.1.3 Liquidity

The median implicit bid-ask spread for bonds issued by private firms is 26.7bp, while it is lower for non-financial bonds and higher for financial bonds within the subsample. Compared to bonds issued by private firms, bond issued by listed firms have a slightly higher median implicit bid-ask spread of 27.4bp, while it is higher for non-financial bonds and lower for financial bonds within the subsample. Thus, like for the relation between yield spreads of non-financial and financial firms, the relation between the implicit bid-ask spread of non-financial and financial firms is opposite for private and listed firms.

In general, the distributions of the implicit bid-ask spreads have a skewness of about 3 and a high kurtosis of at least 10.7.

7.1.4 Financial ratios

7.1.4.1 Subsample of bonds issued by firms with working capital entries available

For the group that has working capital entries available, it is clear that the distributions of yield spreads for private and listed firms are much closer than for the whole dataset. This subsample only includes bonds issued by non-financial private firms, which on average are characterized by being less liquid, more profitable, more productive and slightly less solvent than the listed firms, while they on the median are slightly more solvent by the ratios applied in Altman's z"-score. The average z"-score for private and listed firms is close, however, the range for listed firms is much wider than for private firms. Furthermore, the z"-score is negatively correlated with yield spreads, which is consistent with the expectation that a lower score implying a higher probability of going bankrupt demands a premium in terms of yield spreads.

For listed firms, the average yield spread is significantly lower for financial firms, which are characterized by being significantly less liquid, more profitable, less productive and less solvent than non-financial firms are by the ratios applied. Thus, only their profitability ratios imply that their bonds should demand lower yield spreads in terms of the expected relation between the ratios and yield spreads. Together with the z”-score on average being lower for financial firms and it having a low, but positive, correlation with yield spreads, this suggest that credit risk of financial firms is either differently measured or differently valued than for non-financial firms.

Table 6. Descriptive statistics of inputs to Altman's z''-score

Private firms with working capital entries

		Firms	Obs	Mean	Standard deviation	Percentiles							Kurtosis	Skewness
						1st	5th	25th	50th	75th	95th	99th		
	Yield spread	Non-financial	718	261	393	-6	6	42	124	329	912	1850	23	4
Altman's z''-score	Liquidity	Non-financial	718	1	9	-15	-9	-3	-1	1	17	29	6	2
	Profitability	Non-financial	718	10	20	-53	-37	5	16	20	33	44	5	-2
	Productivity	Non-financial	718	8.0	4.6	1.0	3.6	5.7	7.1	9.1	13.8	30.0	14.2	3.3
	Solvency	Non-financial	718	43.9	30.5	-32.7	-24.8	36.9	47.7	53.8	91.9	109.5	1.4	-0.6
	z''-score	Non-financial	718	1.36	0.73	-0.41	0.13	1.09	1.42	1.66	2.70	3.07	5.71	-0.22

Listed firms with working capital entries

		Firms	Obs	Mean	Standard deviation	Percentiles							Kurtosis	Skewness
						1st	5th	25th	50th	75th	95th	99th		
	Yield spread	All	30023	251.2	406.1	-17.0	0.6	51.0	134.1	297.3	794.6	2538.4	27.6	4.7
		Non-financial	26242	271.1	427.8	-15.2	3.4	56.7	146.1	323.5	850.5	2728.5	24.6	4.4
		Financial	3781	113.1	133.5	-26.7	-8.5	19.0	80.2	164.1	372.0	573.6	19.6	3.0
Altman's z''-score	Liquidity	All	30023	4.0	13.1	-24.8	-15.2	-3.6	1.6	10.6	27.8	40.1	2.3	0.5
		Non-financial	26242	5.4	12.8	-25.1	-10.1	-2.7	3.1	12.2	28.3	40.9	3.0	0.4
		Financial	3781	-5.5	11.4	-21.8	-19.1	-14.3	-4.3	-1.9	13.3	37.5	3.8	1.5
	Retaines earnings to Total Assets (Profitability)	All	30023	4.6	32.6	-161.7	-56.2	0.0	10.0	20.0	39.3	48.2	16.3	-3.3
		Non-financial	26242	3.6	34.7	-165.9	-63.7	-1.5	8.2	21.6	39.9	48.6	13.8	-3.0
		Financial	3781	11.7	4.6	5.3	8.0	10.0	11.2	12.6	19.7	32.0	21.6	3.4
	Operating Income to Total Assets (Productivity)	All	30023	6.7	6.5	-7.6	-1.8	2.9	6.1	9.5	18.6	26.1	4.9	0.3
		Non-financial	26242	7.3	-44.2	-5.2	-2.2	3.7	6.7	10.4	19.2	26.5	4.7	0.1
		Financial	3781	3.0	1.9	0.5	1.3	2.1	2.8	3.4	6.9	9.8	9.6	1.4
	Book Value of Equity to Toal Liabilities (Solvency)	All	30023	46.6	33.4	-29.0	2.0	20.7	44.6	66.6	107.7	134.0	0.1	0.4
		Non-financial	26242	49.9	34.1	-33.5	0.1	25.1	49.8	69.9	110.1	136.5	0.1	0.2
		Financial	3781	24.0	13.9	13.4	14.0	18.3	19.9	21.4	60.1	78.0	8.5	2.9
	z''-score	All	30023	1.35	1.80	-1.30	-1.45	0.42	1.27	2.48	4.20	5.40	2.38	-0.51
		Non-financial	26242	1.48	1.86	-4.40	-1.57	0.57	1.50	2.64	4.29	5.48	2.50	-0.70
		Financial	3781	0.48	0.90	0.68	-0.48	-0.33	0.38	0.66	2.42	3.72	3.44	1.67

7.1.4.2 Private firms

For private firms, the non-financial firms are on average smaller and more profitable than the financial firms in the sample are. Furthermore, they are on average more leveraged, but are also more solvent and have a slightly higher interest coverage ratio than the financial firms. The lower average yield spread of bonds issued by non-financial firms is thus in accordance with expectations, when

considering their higher profitability, higher interest coverage and higher solvency, but not when considering their higher leverage.

Table 7a. Descriptive statistics of selected inputs to the credit risk measures applied for private firms

Bonds issued by private firms

		Firms	Obs	Mean	Standard deviation	Percentiles							Kurtosis	Skewness
						1st	5th	25th	50th	75th	95th	99th		
Inputs to Altman's z''-score	Retaines earnings to Total Assets (%) (Profitability)	All	8116	7.1	7.6	-9.1	0.1	4.4	6.9	10.4	16.0	27.6	30.5	-2.7
		Non-financial	4860	7.7	8.4	-34.6	2.2	5.0	7.5	9.9	20.1	32.7	31.1	-3.1
		Financial	3256	6.2	5.9	-4.0	-0.3	1.4	5.6	11.5	14.0	15.7	12.3	-1.3
	Operating Income to Total Assets (%) (Productivity)	All	8116	2.3	2.9	-2.3	-0.1	1.2	1.8	2.5	7.4	13.8	31.3	4.5
		Non-financial	4860	2.8	3.0	0.0	0.8	1.4	2.1	2.6	8.7	13.7	30.7	4.4
		Financial	3256	1.5	2.6	-4.0	-1.1	0.7	1.4	2.1	3.5	19.5	40.4	5.3
	Book Value of Equity to Toal Liabilities (%) (Solvency)	All	8116	15.6	14.8	1.2	4.0	8.8	12.7	17.1	47.6	89.9	15.1	3.1
		Non-financial	4860	17.9	17.4	-23.5	7.6	11.2	13.0	15.6	51.4	91.9	9.1	2.5
		Financial	3256	12.1	8.9	1.6	2.5	7.6	9.6	18.4	22.9	25.4	62.0	5.7
Financial measures applied in Kovner and Wei (2012)	Log of Total Assets ($USm) (Size)	All	8130	10.7	1.2	7.9	8.9	10.0	10.3	11.5	12.6	13.9	0.5	0.5
		Non-financial	4866	10.1	1.0	7.6	8.4	9.8	10.1	10.3	12.0	12.1	1.1	0.1
		Financial	3264	11.4	1.1	8.6	9.9	10.1	11.2	10.5	12.2	13.8	-0.7	0.6
	Operating Income to Total Assets (%) (Profitability)	All	8130	2.3	2.9	-2.3	-0.1	1.2	1.8	2.5	7.4	13.8	31.3	4.5
		Non-financial	4866	2.8	3.0	0.0	0.8	1.4	2.1	2.6	8.6	13.7	30.7	4.4
		Financial	3264	1.5	2.6	-4.0	-1.1	0.7	1.4	2.1	3.5	19.5	22.9	40.5
	Total Debt to Total Assets (%) (Leverage)	All	8130	70.0	23.6	8.2	18.8	67.2	82.4	84.7	88.2	93.9	0.8	-1.3
		Non-financial	4866	75.9	19.1	19.8	31.3	79.7	83.5	84.8	87.0	88.5	3.2	-1.5
		Financial	3264	61.4	26.8	0.6	15.4	27.4	69.4	82.5	91.0	94.5	-0.8	-0.8
Financial measures applied in Blume et al. (1998)	Operating Income to Sales (%) (Profitability)	All	8026	19.7	12.7	-25.0	2.7	14.2	20.2	24.9	35.3	64.2	7.8	0.3
		Non-financial	4860	21.0	10.2	0.0	5.1	14.9	21.0	25.0	35.3	60.1	4.8	0.9
		Financial	3166	17.7	15.7	-31.2	-7.5	13.1	17.5	24.6	35.5	90.7	6.7	0.3
	Long-term Debt to Total Assets (%) (Leverage)	All	8026	45.4	18.6	0.0	6.7	38.7	49.1	56.3	70.4	84.0	0.4	-0.7
		Non-financial	4860	45.7	16.1	0.0	0.0	42.7	48.6	55.2	65.1	78.1	2.3	-1.2
		Financial	3166	44.8	21.8	3.6	8.9	20.4	51.6	59.3	80.1	85.0	-0.9	-0.4
	C1	All	8026	0.86	0.9	0	0.4	0.4	0.6	0.9	3.3	5.0	7.1	2.6
		Non-financial	4860	1.03	1.1	0	0.2	0.4	0.7	1.2	3.6	5.0	3.7	2.1
		Financial	3166	0.61	0.7	0	0.0	0.4	0.4	0.8	1.3	5.0	28.3	4.7
	C2	All	8026	0.04	0.5	0	0	0	0	0	0	2.3	102.9	10.1
		Non-financial	4860	0.03	0.4	0	0	0	0	0	0	0.6	142.0	11.7
		Financial	3166	0.07	0.6	0	0	0	0	0	0	5.0	69.2	8.4
	C3	All	8026	0.01	0.4	0	0	0	0	0	0	0	752.1	27.3
		Non-financial	4860	0.02	0.5	0	0	0	0	0	0	0	481.6	22.0
		Financial	3166	0.01	0.1	0	0	0	0	0	0	0	1412.5	35.1
	C4	All	8026	0.06	1.8	0	0	0	0	0	0	0	1026.8	31.8
		Non-financial	4860	0.10	2.3	0	0	0	0	0	0	0	620.1	24.7
		Financial	3166	-	-	-	-	-	-	-	-	-	-	-
Inputs to a structural credit risk measure	Sector volatility (%)	All	8077	37.7	20.6	15.9	17.7	25.6	32.7	44.8	67.7	127.2	8.8	2.7
		Non-financial	4825	34.7	12.1	16.6	20.7	25.7	31.1	42.6	58.5	66.8	-0.1	0.9
		Financial	3252	42.1	28.3	15.9	17.0	25.6	36.2	46.0	114.9	139.2	3.6	2.0
	Estimated Market Value Leverage (%)	All	8077	49.6	14.8	6.2	26.8	40.6	50.0	60.2	69.6	76.8	1.9	-0.3
		Non-financial	4825	46.8	16.2	4.8	18.0	36.3	44.9	59.1	70.0	74.8	1.8	0.1
		Financial	3252	53.7	11.3	11.3	37.8	46.8	54.0	61.4	71.1	80.6	2.3	-0.5
	10-year Swap Rate (%)	All	8077	3.9	1.1	1.7	1.7	3.2	4.3	4.7	5.3	5.7	-0.7	-0.6
		Non-financial	4825	4.0	1.1	1.7	1.8	3.3	4.4	4.8	5.4	5.7	-0.6	-0.7
		Financial	3252	3.8	1.1	1.7	1.7	3.1	4.1	4.7	5.3	5.7	-0.8	-0.5

Compared to listed firms, the private firms are on average smaller, less solvent and more leveraged, less profitable in terms of operating income to total assets, but more profitable in terms of operating income to sales and have a lower interest coverage. Thus, based on most of the relations, it is peculiar that that the average yield spread of their bonds is lower than that for bonds issued by listed firms.

7.1.4.3 Listed firms

For listed firms in the sample, the non-financial firms are on average smaller than the financial firms are. Furthermore, they are on average more profitable, when measured by the operating income to total assets, but less profitable, when measured by the operating income to total sales and retained earnings to total assets. Measured as total debt to assets, the non-financial firms are on average less leveraged than the financial firms and are accordingly more solvent measured by the book value of equity to total liabilities, while measured as long-term debt to total assets they are on average more leveraged. Furthermore, they have slightly higher interest coverage than the financial firms.

While the bonds issued by non-financial firms, on average, demand a higher yield spread than bonds issued by financial firms this is in accordance with expectations, when considering their smaller size, lower operating margin, lower retained earnings to total assets and their higher average long-term debt to total assets, but not when considering their higher interest coverage, higher operating income to assets, higher solvency and lower total debt to total assets.

7.1.4.4 Correlations

Correlation matrices for the variables for the different groups can be found in Appendix 5.

Most of the specified leverage ratios are as expected positively correlated with yield spreads for bonds issued by private firms, while operating income to sales has the expected negative correlation. Unexpectedly, both operating income to total assets and size are positively correlated with yield spreads, while the relations for the dummy variables of interest coverage are not intuitive and some of them have a very high inter-correlation, which can affect their estimated coefficients.

For the listed firms all the expected relations between yield spreads and the inputs used to assess credit risk are reflected in the correlation matrices. That is, profitability, size and interest coverage are negatively correlated with yield spreads and leverage has a positive correlation with yield spreads.

7.1.5 Publicly traded data

7.1.5.1 Private firms

For private firms, the average sector volatility is 37.66%, while it is lower for the non-financial firms and higher for the financial firms for which it also has a wider range. The estimated market value leverage for private firms is on average 49.55%, while it is lower for non-financial firms in the sample and higher for financial firms in the sample. The average risk free rate is 3.92%, which is a result of more observations early in the sample period.

The higher average yield spread of bonds issued by financial firms, is thus, in accordance with the expectation that higher leverage and volatility, ceteris paribus, demand a premium.

7.1.5.2 Listed firms

For listed firms, the average firm volatility is 37.68% and close to the average sector volatility of 37.76%. However, the distribution of the first has a wider range, which can be explained by the latter being derived from the average firm volatility in each sector. While the average market value leverage is 56.2%, the average estimated market value leverage is 38.04%, which indicate that basing the multiplier on the average across firms in a sector biases the estimated market value leverage downwards. The same conclusions are drawn from the subsamples of non-financial and financial firms, with the former on average having a lower volatility and a lower leverage than the latter. This is peculiar in relation to the yield spreads of non-financial bonds on average being higher than that of financial bonds, which indicate that credit risk inherent in the measures applied might be valued differently for the two groups.

7.1.5.3 Correlations

Correlation matrices for the variables for the different groups can be found in Appendix 5.

In accordance with expectations, sector volatility and estimated market value leverage are positively correlated with yield spreads for all the defined groups, while the 10-year swap rate is negatively correlated with yield spreads for most of the groups. Furthermore, as expected, firm volatility and market value leverage are positively correlated with yield spreads for bonds issued by listed firms, while the 10-year swap rate is negatively correlated with yield spreads. The higher correlation between sector volatility and firm volatility for the financial firms likely stems from the sector volatilities being derived from the group of financial firms, while sector volatilities for the non-financial firms are based on the seven sectors categorized as non-financial.

Table 7b. Descriptive statistics of selected inputs to the credit risk measures applied for listed firms

Bonds issued by listed firms

		Firms	Obs	Mean	Standard deviation	Percentiles							Kurtosis	Skewness
						1st	5th	25th	50th	75th	95th	99th		
Inputs to Altman's z''-score	Retaines earnings to Total Assets (%) (Profitability)	All	57385	4.1	23.8	-92.4	-22.4	1.5	5.0	11.2	33.5	44.9	32.3	-4.4
		Non-financial	26242	3.6	34.7	-165.9	-63.7	-1.5	8.2	21.6	39.9	48.6	13.8	-3.0
		Financial	31143	4.5	5.2	-11.4	-4.1	2.2	4.4	6.5	12.3	21.2	8.0	0.4
	Operating Income to Total Assets (%) (Productivity)	All	57385	4.2	5.5	-5.8	-0.8	1.0	2.2	6.4	15.0	22.4	6.8	1.1
		Non-financial	26242	7.3	-44.2	-5.2	-2.2	3.7	6.7	10.4	19.2	26.5	4.7	0.1
		Financial	31143	1.6	1.8	-2.8	-0.4	0.8	1.4	2.2	3.9	7.5	59.0	-2.3
	Book Value of Equity to Toal Liabilities (%) (Solvency)	All	57385	29.3	31.0	-17.2	3.4	8.3	14.8	48.3	94.3	125.7	1.3	1.3
		Non-financial	26242	49.9	34.1	-33.5	0.1	25.1	49.8	69.9	110.1	136.5	0.1	0.2
		Financial	31143	11.9	11.2	2.5	3.7	6.4	9.3	13.1	22.4	67.6	33.7	4.9
Financial measures applied in Kovner and Wei (2012)	Log of Total Assets ($USm) (Size)	All	58035	11.5	1.9	7.4	8.3	10.0	11.6	13.3	14.3	14.7	-0.9	-0.2
		Non-financial	26883	10.0	1.4	6.9	7.8	9.0	10.0	10.9	12.2	12.8	-0.5	0.0
		Financial	31152	12.7	1.4	8.6	10.3	11.8	13.1	13.8	14.6	14.7	0.6	-0.9
	Operating Income to Total Assets (%) (Profitability)	All	58035	4.2	5.7	-5.7	0.8	1.0	2.3	6.5	15.3	22.9	8.8	1.4
		Non-financial	26883	7.3	6.9	-7.9	-2.1	3.7	6.8	10.5	19.5	27.4	6.1	0.4
		Financial	31152	1.6	1.8	-2.8	-0.4	0.8	1.4	2.2	3.9	7.6	58.2	-2.2
	Total Debt to Total Assets (%) (Leverage)	All	58035	36.0	21.3	2.5	7.2	21.4	31.5	47.9	75.5	95.5	1.8	1.1
		Non-financial	26883	35.4	18.7	6.0	13.4	23.7	31.0	45.6	65.3	1114.7	7.2	1.9
		Financial	31152	36.5	23.3	1.5	5.4	18.4	32.3	52.3	81.0	94.4	-0.4	0.6
Financial measures applied in Blume et al. (1998)	Operating Income to Sales (%) (Profitability)	All	57740	14.4	12.0	-21.0	-3.3	7.2	14.2	22.0	32.7	44.7	2.4	-0.1
		Non-financial	26834	11.1	10.2	-14.3	-3.0	4.8	9.8	17.7	27.6	38.4	2.3	0.1
		Financial	30906	17.3	12.8	-22.8	-4.2	10.8	17.8	24.6	34.8	50.3	3.0	-0.5
	Long-term Debt to Total Assets (%) (Leverage)	All	57740	24.3	18.2	1.2	4.0	11.8	19.5	31.9	59.3	87.7	5.3	1.8
		Non-financial	26834	30.4	17.6	4.4	10.0	19.6	26.4	37.3	60.9	104.0	8.2	2.2
		Financial	30906	18.9	17.0	1.1	2.5	8.7	13.4	21.4	57.0	86.1	4.2	2.0
	C1	All	57740	2.38	1.9	0	0	0.7	1.8	5.0	5.0	5.0	-4.5	0.3
		Non-financial	26834	3.19	1.8	0	0	1.6	3.5	5.0	5.0	5.0	-1.3	-0.4
		Financial	30906	1.68	1.7	0	0	0.0	1.0	0.0	5.0	5.0	-0.4	1.1
	C2	All	57740	0.93	1.8	0	0	0	0	0.3	5.0	5.0	0.8	1.6
		Non-financial	26834	1.28	2.0	0	0	0	0	2.3	5.0	5.0	-0.5	1.1
		Financial	30906	0.63	1.6	0	0	0	0	0.0	5.0	5.0	3.2	2.2
	C3	All	57740	0.82	2.5	0	0	0	0	0	10.0	10.0	8.1	3.1
		Non-financial	26834	1.19	2.9	0	0	0	0	0	10.0	10.0	4.1	2.4
		Financial	30906	0.49	1.9	0	0	0	0	0	4.0	10.0	16.7	4.2
	C4	All	57740	0.70	4.6	0	0	0	0	0	0.0	26.0	91.4	9.0
		Non-financial	30906	1.29	6.4	0	0	0	0	0	6.4	34.8	44.9	6.4
		Financial	30906	0.18	2.0	0	0	0	0	0	0	4.2	523.1	20.5
Inputs to a structural credit risk measure	Sector volatility (%)	All	57147	37.8	23.2	15.9	17.0	22.7	31.3	44.9	96.6	138.0	6.3	2.4
		Non-financial	26028	36.5	14.5	17.7	19.8	26.2	31.7	44.9	65.5	77.8	3.1	1.4
		Financial	31119	38.8	28.5	15.9	16.4	19.2	31.2	44.8	114.3	138.2	3.9	2.1
	Estimated Market Value Leverage (%)	All	57147	38.0	20.0	2.4	4.7	23.0	40.3	51.9	67.3	83.2	0.2	0.1
		Non-financial	26028	28.0	21.8	1.9	3.2	10.2	24.8	38.2	69.6	100.3	2.2	1.3
		Financial	31119	46.5	13.6	10.0	17.6	39.7	47.5	55.1	6.4	74.3	0.6	-0.6
	Equity Volatility (%)	All	57147	37.7	29.6	11.8	13.9	20.4	29.5	43.5	92.3	167.2	15.1	3.3
		Non-financial	26028	36.3	22.1	12.8	15.1	22.0	30.7	43.3	76.3	125.2	11.5	2.6
		Financial	31119	38.8	34.6	11.2	13.3	19.1	28.7	43.9	113.2	184.3	12.5	3.1
	Market Value Leverage (%)	All	57147	56.2	26.7	2.1	9.5	35.1	59.0	79.0	93.0	98.2	-1.0	-0.3
		Non-financial	26028	43.8	24.1	0.6	8.3	23.0	40.8	61.9	89.6	94.8	-0.9	0.3
		Financial	31119	66.6	23.3	4.5	12.6	56.1	70.5	85.5	94.5	99.0	0.5	-1.0
	10-year Swap Rate (%)	All	57147	4.3	1.0	1.7	2.1	3.8	4.5	4.9	5.4	5.7	0.6	-1.1
		Non-financial	26028	4.4	0.8	1.7	2.6	4.3	4.6	5.0	5.4	5.7	2.5	-1.5
		Financial	31119	4.1	1.1	1.7	1.9	3.5	4.5	4.9	5.4	5.7	-0.2	-0.8

7.1.6 Summary of descriptive statistics

On average, the yield spreads of bonds issued by private firms are lower than that for listed firms, while bonds issued by private firms also have less risky characteristics and lower implicit bid-ask spreads. However, for bonds issued by financial firms these relations are reversed, which motivate a separate analysis of these firms. Most of the distributions of the variables differ across the defined groups and have descriptive statistics that do not resemble a normal distribution. Similar to Kovner and Wei (2012) this study finds that private firms are on average smaller and more leveraged than listed firms are, however, differently it also finds that bonds issued by private firms on average have a larger issue size and demand a lower yield spread than bonds issued by listed firms. From the descriptive statistics of the financial ratios of the firms in the sample, it is clear that there are some significant differences between the firms in terms of their financial conditions and how the variables are related to yield spreads of their bonds. On the other hand, the sector and firm-specific inputs to the structural credit risk measure have the expected relations with yield spreads for most of the groups.

7.2 Base regressions

This section briefly discusses the base regressions; one including the control variables and one including the control variables and dummy variables for rating groups, as they will be used as benchmark cases to evaluate the credit risk measures applied in the following sections. The results are shown in Table 8.

For bonds issued by private firms, the control variables for liquidity and credit risk reflected in bond specific characteristics and market conditions explain about 23.4% of the variation in their yield spreads. Adding dummy variables for the rating groups increases the adjusted-R^2 to 37.7% and improves the fit of the model in terms of the SER. The result is similar for non-financial bonds, but for financial bonds, the explanatory power of the control variables is higher at 29.8% and the control variables combined with dummy variables for ratings explain 54.6% of the variation in yield spreads.

For bonds issued by listed firms, variation in the control variables and ratings explains less of the variation in their yields spreads than it does for bonds issued by private firms. The adjusted-R^2 increases from 21% to 29.4% when adding dummy variables for rating groups. The results are similar for the subsamples of non-financial and financial bonds, however, with the explanatory power being slightly lower (higher) for the former (latter).

Table 8. Base regressions

	Bonds issued by private firms						Bonds issued by listed firms					
	All		Non-financial		Financial		All		Non-financial		Financial	
Intercept	-50.56	-40.89	-154,62**	-150,00**	15.11	-19.49	34.99	75.58	121.25	42.33	130.38	57.54
	(79,23)	(75,08)	(67,55)	(74,24)	(140,23)	(84,73)	(110,77)	(88,02)	(132,45)	(119,24)	(80,86)	(65,81)
Time to Maturity (Years)	-8,71*	-8,12*	-2.65	-6,79*	-9,22**	-4.38	-6,28***	-6,21***	-6,85***	-5,21***	-5.84	-7,93*
	(5,12)	(4,33)	(5,48)	(3,91)	(3,94)	(2,75)	(1,71)	(1,64)	(1,51)	(1,28)	(3,67)	(4,12)
Bond Age (Years)	2.54	0.96	14,41***	9,02**	1.17	6,61**	-5.32	-2.44	14,90***	-6,49*	1.78	0.98
	(5,98)	(4,81)	(5,49)	(4,52)	(6,84)	(2,97)	(3,49)	(2,71)	(4,62)	(3,85)	(3,77)	(3,75)
Coupon (%)	35,26***	12,87**	14.01	11,00**	39,48***	5.12	56,12***	19,69**	85,21***	41,2***	23,70***	7,92**
	(11,8)	(6,24)	(9,76)	(5,64)	(13,03)	(8,07)	(10,24)	(8,17)	(17,97)	(15,69)	(6,63)	(3,91)
Log(Issuesize)	15,93**	14,09**	7,99*	7,81**	16.28	6.46	-4.98	1.74	-10.69	-3.83	-1.22	2.78
	(7,67)	(7,03)	(4,25)	(3,74)	(16,57)	(8,25)	(8,05)	(6,63)	(8,54)	(7,44)	(8,34)	(6,29)
Senior	44.72	-0.65	65.39	67,13**	132,95**	29.26	75,67***	22,48**	41.21	34.58	42,11*	29,57**
	(38,59)	(34,45)	(41,11)	(33,13)	(65,13)	(29,72)	(17,95)	(10,76)	(35,24)	(37,31)	(21,99)	(12,89)
10Y Swap Rate (%)	-29.77	-12.57	5.43	4.32	-59,65**	-31,74*	50,38***	38,52***	79,24***	59,93***	40,32***	-23,32**
	(20,71)	(11,88)	(7,94)	(7,12)	(28,59)	(16,53)	(12,61)	(11,56)	(16,08)	(16,23)	(10,66)	(10,56)
10Y-1Y Swap Rate (%)	-18,87*	-11.61	-4.19	-2.66	-25.75	7.14	-14,30**	-7.96	-15,85*	-1.86	-15,60**	-13,72**
	(10,88)	(8,57)	(5,59)	(6,58)	(22,64)	(16,42)	(6,67)	(6,45)	(9,51)	(9,66)	(7,15)	(6,32)
Implicit Bid-ask Spread (bp)	1,93***	1,65***	1,03***	0,93***	2,61***	1,74***	1,71***	1,62***	1,76***	1,66***	1,68***	1,56***
	(0,53)	(0,38)	(0,17)	(0,14)	(0,6)	(0,49)	(0,27)	(0,25)	(0,24)	(0,23)	(0,51)	(0,43)
Rating dummy variables''	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Adjusted R^2	24.0	37.7	24.1	36.4	29.8	54.6	21.0	29.4	20.1	27.8	21.9	30.4
SER	274.0	247.1	188.8	172.8	338.7	272.6	331.8	313.4	380.9	362.0	276.3	260.8
# of observations	8130	8130	4866	4866	3264	3264	58035	58035	26883	26883	31152	31152
# of bonds	1012	1012	631	631	381	381	4943	4943	2172	2172	2771	2771

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

7.3 The significance of credit risk measured by financial ratios

In this section, the results on the significance and explanatory power of the inputs to the credit risk measures applicable to private firms founded on financial ratios will be provided and discussed.

7.3.1 Altman's z"-score

Table 9 shows the results from applying the z"-score to control for credit risk for the sample with working capital entries available.

For bonds issued by private firms, Altman's z"-score is statistically significant in explaining variation in yield spreads. Together with the control variables, the variation in the z"-score explains 29.9% of the variation in yield spreads. When controlling for ratings the coefficients change slightly, the adjusted-R^2 increases to 46.8% and the SER decreases implying a better fit of the model. The z"-score remains significant, which implies that it has explanatory power for yield spreads beyond the credit risk reflected in ratings. A decrease in the score of one, ceteris paribus, is related to a 160.6bp higher yield spread. The magnitude of the z"-score's coefficient should be considered in light of the average yield spread for the group being 261bp and the standard deviation 393bp, while the average z"-score is 1.36 and the standard deviation is 0.73.

Considering bonds issued by listed firms, Altman's z"-score is statistically significant for variation in yield spreads at a 1% significance level. With an adjusted-R^2 of 31.5%, the model for

Table 9. The significance of Altman's z''-score and its inputs for yield spreads

	Bonds issued by private firms				**Bonds issued by listed firms**											
	Non-financial firms				All listed firms				Non-financial firms				Financial firms			
Intercept	-205.44	112.47	76.43	40.71	34.39	47.53	102.34	101.93	361,76***	294,7***	498,56***	505,56***	107,65*	146,9***	151,64***	158,10***
	(251,5)	(203,8)	(181,9)	(204,1)	(200,3)	(134,3)	(215,2)	(223,1)	(118,7)	(100,3)	(126,6)	(127,2)	(55,8)	(37,8)	(58,4)	(52,7)
Time to Maturity (Years)	-3.89	-7.36	-5.38	-6.24	-6,01***	-4,77***	-6,54***	-6,35***	-6,29***	-5,1***	-6,67***	-6,59***	2,03*	-0.16	1.33	1.03
	(4,5)	(4,5)	(5,3)	(4,6)	(1,5)	(1,3)	(1,4)	(1,5)	(1,5)	(1,3)	(1,5)	(1,5)	(1,2)	(1,1)	(1)	(0,9)
Bond Age (Years)	14.26	2.66	17,18***	16,7***	-8.77	-3.66	-6.72	-6.72	-14,90***	-8**	-12,86***	-12,93***	7,25**	2.98	3,88*	4,17**
	(9,9)	(7,8)	(4,4)	(4,6)	(5,4)	(4,1)	(4,9)	(5)	(4,5)	(3,9)	(4,1)	(4)	(3,5)	(1,9)	(2,2)	(1,8)
Coupon (%)	11.08	22.92	0.97	5.30	77,3***	35,50***	72,62***	73,58***	72,24***	39,5***	63,91***	63,82***	10.16	8,3***	11,75**	10,64**
	(22,3)	(16,4)	(16,7)	(16,2)	(14,8)	(13,5)	(14,6)	(14,4)	(15,4)	(14,5)	(14,2)	(14,3)	(7)	(2,2)	(5,3)	(5,1)
Log(Issuesize)	42,76*	3.22	-2.36	0.52	-12.60	-4.10	-6.44	-8.44	-22,79**	-15,3*	-10.91	-11.74	2,89**	2.17	1.91	3,32**
	(25,8)	(15)	(14,1)	(15,5)	(9,3)	(8,6)	(6,6)	(6,8)	(9,3)	(8)	(7,5)	(7,8)	(1,4)	(1,4)	(1,4)	(1,5)
Senior	183,16*	104,61**	118,41*	138,4***	73,5**	54.28	71,03**	75,43**	80,39**	70*	73,05**	75,04**	-9.50	-30.04	-32.15	-24.59
	(102,2)	(57,5)	(61,8)	(53)	(35,4)	(34,7)	(33,6)	(33,3)	(37,9)	(37,3)	(35,4)	(34,6)	(53,5)	(30,3)	(42,9)	(38,7)
10Y Swap Rate (%)	12.08	-28.00	-21.21	-20.47	-49,41**	-42,91**	-42,01*	-43,17*	-83,36***	-66,9***	-83,76***	-84,49***	-28,46***	-26,3***	-23,28***	-20,17***
	(20)	(23,4)	(26,5)	(27,4)	(22,4)	(18,3)	(25,5)	(25,1)	(16,4)	(16,6)	(17,8)	(17,5)	(6,2)	(8,2)	(5,7)	(6,4)
10Y-1Y Swap Rate (%)	32.68	15.61	29.66	27.44	-7.09	0.50	-12.25	-11.19	-17,42*	-6.02	-23,49**	-23,44**	-2.38	-5.04	-5.27	-10,54**
	(25,2)	(22,9)	(24,9)	(25,3)	(10)	(9)	(9,8)	(10,4)	(9,5)	(9,8)	(10)	(10,1)	(4,2)	(5,1)	(3,3)	(4,5)
Implicit Bid-ask Spread (bp)	1,41***	0,98***	0,96***	0,98***	1,42***	1,39***	1,28***	1,27***	1,56***	1,5***	1,36***	1,35***	0,43***	1,5***	0,42***	0,46***
	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,1)	(0,1)	(0,1)	(0,1)
Working Capital to Total Assets (%)			3.57				1.44				0.57				-1,72**	
(Liquidity)			(4,3)				(1)				(1,1)				(0,7)	
Retained Earnings to Total Assets (%)			-10,62***	-11,42***			-1,10**	-1,11**			-0,75*	-0,75*			-6,07**	-6,45**
(Profitability)			(4,3)	(3,4)			(0,5)	(0,6)			(0,4)	(0,4)			(2,9)	(2,8)
Operating Income to Total Assets (%)			8.60	8.17			-14,30***	-14,07***			-16,42***	-16,37***			-15.77	-12.65
(Productivity)			(6)	(5,6)			(2,7)	(2,8)			(2,7)	(2,8)			(9,7)	(10,4)
Book Value of Equity to Total Liabilities (%)			-0.22	-0.31			-1,5***	-1,3***			-1,84***	-1,80***			3,29***	2,61***
(Solvency)			(1,1)	(1,2)			(0,5)	(0,6)			(0,5)	(0,5)			(1,3)	(0,9)
Altman's z''-score	-206,66**	-160,59*			-53,01***	-43,75***			-59,49***	-47,9***			-18,49***	-28,6***		
	(101,3)	(86,9)			(13,3)	(12,6)			(13,7)	(13,5)			(5,2)	(6,6)		
Rating dummy variables''	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No
Adjusted R^2	29.9	46.8	52.5	52.3	24.7	31.5	29.4	29.2	26.4	31.5	31.7	31.7	25.4	32.9	29.0	27.7
SER	329.3	287.0	271.2	271.8	352.3	336.2	341.3	341.7	367.1	354.0	353.5	353.6	115.3	109.3	112.5	113.5
# of observations	718	718	718	718	30023	30023	30023	30023	26242	26242	26242	26242	3781	3781	3781	3781
# of bonds	98	98	98	98	2629	2629	2629	2629	2152	2152	2152	2152	447	447	447	447

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

bonds issued by listed firms controlling for ratings explains less variation in yield spreads than the model for bonds issued by private firms. The model implies that a decrease of one in the z”-score is, ceteris paribus, associated with a 43.8bp higher yield spread. While the magnitude is much smaller than for the coefficient found in the model for private firms, the range of the score is much wider for the listed firms, while the distribution of yield spreads for the groups are similar.

For listed non-financial firms, it is clear that they dominate the sample of listed bonds as the conclusions carry over to this group with only a slightly more negative coefficient on the z”-score and a slightly improved fit of the model in terms of the adjusted-R^2, but not in terms of the SER. For financial listed firms the coefficient of the z”-score is much lower in magnitude than for the whole sample of listed firms, which should be considered in relation to the lower average yield spread of the group, the lower range of the z”-score and its small, but positive correlation with yield spreads.

To sum up, the z”-score is statistically significant for explaining variation in yield spreads and still remains significant after controlling for ratings. The model for bonds issued by private firms has a better fit than the model for bonds issued by listed firms.

7.3.2 Inputs to Altman’s z”-score

Table 9 also shows the results of including the ratios instead of the z”-score in the model. For private firms, only profitability is statistically significant for explaining variation in yield spreads and together with the coefficient on solvency, its coefficient have the expected negative sign unlike the coefficients on liquidity and productivity. This estimation likely stems from a degree of multicollinearity between profitability and solvency as they are 79% correlated, which makes sense as the ratio for profitability to some extent also can expresses solvency of the firm if retained earnings make up a significant share of the book value of equity. Furthermore, there is an unexpected positive correlation between the two latter ratios and yield spreads. Including the ratios improves the fit of the model over using the z”-score with an adjusted-R^2 of 52.5% and a SER of 271.2.

For listed firms, all the ratios except the liquidity ratio are statistically significant for yield spreads with a negative coefficient. The negative correlation between all the ratios and yield spreads together with the largest inter-correlation being 35.5%, support why this estimation is more in line with expectations. However, the fit of the model is only slightly improved over using the z”-score with an adjusted-R^2 of 29.4% and a SER of 341.3. These results carry over to the sub-sample of non-financial firms, while for financial firms it is productivity that is not statistically significant and the coefficient on solvency that has an unexpected positive sign, which can be explained by its small, but positive correlation to yield spreads.

With the model requiring working capital as input, over half of the sample is excluded from the analysis due to missing data. The small improvement in the of fit of the model applied to the overall samples of private and listed firms and the small changes in the coefficients after including the liquidity ratio motivate the application of the other three ratios to the full sample.

7.3.3 Available inputs to Altman's z"-score for the whole sample

Table 10 shows the results of including the ratios instead of the z"-score in the model for the whole sample.

Table 10. The significance of inputs to Altman's z''-score for yield spreads of whole sample

	Bonds issued by private firms			Bonds issued by listed firms		
	All	Non-financial	Financial	All	Non-financial	Financial
Intercept	-29.44	-83.67	26.67	64.78	505,56***	180,68**
	(78,2)	(58,4)	(122,8)	(111,1)	(127,2)	(75,3)
Time to Maturity (Years)	-9,32**	-5,08*	-8,08**	-5,65***	-6,59***	-4.66
	(4,8)	(2,9)	(3,6)	(1,7)	(1,5)	(3)
Bond Age (Years)	1.24	13,16***	4.63	-2.78	-12,93***	1.76
	(4,9)	(2,1)	(10,1)	(3,1)	(4)	(3,1)
Coupon (%)	38,34***	14,74**	28.26	56,67***	63,82***	24,05***
	(11,6)	(6,7)	(20,7)	(10,2)	(14,3)	(7,3)
Log(Issuesize)	13.89	3.80	16.25	-12.39	-11.74	-6.37
	(9,1)	(5,9)	(16,5)	(8,9)	(7,8)	(8,7)
Senior	69,32*	104,22**	65.48	114,29***	75,04**	43,05**
	(36,7)	(45,4)	(46,1)	(25,2)	(34,6)	(19)
10Y Swap Rate (%)	-32.42	-1.66	-62,68**	-43,25***	-84,49***	-27,66***
	(20,3)	(8,9)	(31,2)	(12,7)	(17,5)	(9,9)
10Y-1Y Swap Rate (%)	-18.22	-0.33	-23.10	-14,44**	-23,44**	-21,40***
	(11,3)	(6,6)	(25,8)	(6,7)	(10,1)	(6,1)
Implicit Bid-ask Spread (bp)	1,90***	0,89***	2,56***	1,52***	1,35***	1,48***
	(0,6)	(0,1)	(0,6)	(0,2)	(0,2)	(0,4)
Retained Earnings to Total Assets (%)	-6.01	-11,30***	9.83	-1,78**	-0,75*	-11,40***
(Profitability)	(4,1)	(3,3)	(6,7)	(0,8)	(0,4)	(4,3)
Operating Income to Total Assets (%)	7.85	9,94***	-6.29	-12,46***	-16,37***	-38,80***
(Productivity)	(5,3)	(3,5)	(12,6)	(2,4)	(2,8)	(10,2)
Book Value of Equity to Total Liabilities (%)	-0.36	0.54	3,74***	-0.12	-1,80***	4,52***
(Solvency)	(0,8)	(1,2)	(1,4)	(0,5)	(0,5)	(1,4)
Adjusted R^2	25.8	42.2	32.0	26.5	31.7	29.5
SER	269.8	164.9	333.7	320.2	353.6	262.5
# of observations	8116	4860	3256	57385	26242	31143
# of bonds	1010	630	380	4922	2152	2770

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

For the private firms, none of the ratios are significant for yield spreads and the fit of the model is with an adjusted-R^2 of 25.8 and a SER of 269.8 clearly inferior to the fit of the model for the subsample of firms with working capital entries available, while the signs of the coefficients and correlations remain the same. The model for the subsample of private non-financial firms, however, has a better fit with an adjusted-R^2 of 42.2 and a lower SER, while both profitability and productivity are statistically significant for yield spreads. However, both higher productivity and solvency require

a premium, which is counterintuitive. For the subsample of private financial firms, the model has a better fit compared to the overall model in terms of a higher adjusted-R^2, but the higher SER implies an inferior fit. Again, the estimation is not intuitive with solvency being statistically significant for yield spreads and demanding a premium. Considering the correlation of the ratios to yield spreads, it is clear that for this group the expected relations are not evident as they are all positive.

For listed firms, including the rest of the financial firms in the sample slightly decreases the fit of the model, while solvency is not statistically significant and has a smaller negative coefficient. Considering the larger subsample of financial firms increases the fit of the model slightly in terms of the adjusted-R^2, but not the SER, compared to the smaller sample of listed financial firms. The three ratios are all significant for yield spreads, but the magnitudes of the coefficients are larger than those found in the model for listed non-financial firms are and higher solvency is associated with higher yield spreads.

7.3.4 Conclusion and perspectives for Altman's z"-score

To sum up, the z"-score is statistically significant for explaining variation in yield spreads, and still remains significant after controlling for ratings, for bonds issued by non-financial private and listed firms. Applying the ratios instead of the z"-score shows that the expected relation between the ratios and yield spreads is not found for private and financial firms. Thus, while the fit of the model is improved, this is intuitive only to the extent that the true relations between the ratios and yield spreads are different for the bonds issued by these groups of firms. While some of the ratios are unexpectedly statistically significant for yield spreads demanding a premium, this does not necessarily imply causation, which is further supported by their significance and the magnitude of their coefficients being sensitive to controlling for ratings. While the expected relation between the ratios and yield spreads is evident for listed non-financial firms, the mediocre fit of the model implies that it can be improved.

Akhavein et al. (2003) test the ability of a range of credit risk models applicable to private firms on a sample of North American private firms with sales over $50 million USD (326,316 financial statements from 1986-2001 covering 43,950 firms and 3,123 defaults) and conclude that the accuracy ratio of the z"-score in discriminating between defaulting and non-defaulting firms is about 40%. If this accuracy ratio applies to the sample, it can be a factor explaining room for improvement in the fit of the model, which can further be explained for all bonds by the score only measuring one element of credit risk, it being developed for a sample of listed manufacturing firms in the period

1945 to 1965 and the extent to which the firms included in this study are fundamentally different from those firms.

Altman et al. (2011) map fundamentals to the equity-implied default likelihood calculated by use of a structural model in accordance to Moody's KMV (Crosbie & Bohn, 2003) for a sample of 1,072,577 monthly observations from April 1978 to December 2007 and, amongst others, show that adding size and age of the firm to the z"-score inputs, the ratios can explain only 32% of the variation in equity-implied default likelihood. Thus, if yield spreads are more likely to reflect credit risk inherent in equity-implied default likelihood, the fit of the model relating the ratios to yield spreads in this study can be expected. Furthermore, Altman et al. (2011) estimate their model for all sectors, but the utility sector, and find that the significance and relation between the ratios and the equity-implied default likelihood differ across sectors. If this conclusion can be carried over to the ratios' significance for and relation to yield spreads, this suggests that the model can be improved by estimating it on a sector level. However, this would require a larger sample better representing the different sectors.

As a last note, the validity of the results depends on the extent to which the sample represents the population. If it does so well, these results suggest that the financial ratios used as inputs to Altman's z"-score have different implications for yield spreads through credit risk than expected for private and financial firms, while they apply to listed non-financial firms with room for improvement in the model.

7.3.5 Kovner and Wei's (2012) financial measures

The results discussed in this section are shown in Table 11. For private firms, only size is statistically significant for yield spreads out of the three measures applied in Kovner and Wei (2012), while it unexpectedly demands a premium and its significance and coefficient increases when ratings are controlled for. Leverage measured as total debt to total assets and profitability measured as operating income to total assets are not significant and the signs and magnitude of their coefficients are sensitive to controlling for ratings. Together with the small difference in the adjusted-R^2 and the SER to the base regressions, this imply that the measures do not have much explanatory power for yield spreads of bonds issued by private firms. Considering only non-financial private firms, there is an improvement in the fit of the model with a higher adjusted-R^2 and a smaller SER. Furthermore, leverage is statistically significant and demands a premium as expected. While size is not significant it has a negative coefficient as in accordance with expectations and profitability still, unexpectedly,

requires a premium. For private financial firms, none of the measures are significant for yield spreads and the signs and magnitudes of the coefficients are sensitive to controlling for ratings.

For listed firms, all the measures are statistically significant with the expected sign on their coefficients and have explanatory power for yield spreads similar to and beyond ratings. For the subsamples of listed non-financial and financial firms, the conclusions from the overall model for listed firms apply with small differences in the fit of the model and different magnitudes of the coefficients. Amongst others, a one percentage point higher profitability or a one percent larger size is, ceteris paribus, associated with a larger discount for bonds issued by financial firms relative to non-financial firms, while a one percentage point higher leverage ratio is, ceteris paribus, associated with a smaller premium in yield spreads for bonds issued by financial firms relative to non-financial firms.

Table 11. The significance of financial measures applied in Kovner and Wei (2012) for yield spreads

	Bonds issued by private firms						**Bonds issued by listed firms**					
	All		Non-financial		Financial		All		Non-financial		Financial	
Intercept	-270,14*	383,44**	-161.88	-252.73	55.89	78.13	749,25***	375,72***	586,26***	423,43**	874,14***	480,28***
	(140,5)	(159,1)	(195,7)	(161)	(268,4)	(147,8)	(110)	(106,8)	(156,4)	(174,7)	(223,9)	(152,5)
Time to Maturity (Years)	-8.22	-6,78*	-4.51	-5,85*	-9,40**	-4.53	-5,96***	-5,64***	-6,29***	-5,50***	-5,13*	-6,51*
	(5,4)	(3,9)	(4,3)	(3,4)	(4,1)	(2,9)	(1,5)	(1,5)	(1,5)	(1,3)	(3,1)	(3,4)
Bond Age (Years)	1.49	1.47	19,30***	12,14**	0.81	6,75*	-0.70	0.36	-7,73*	-5.45	3.08	0.77
	(6)	(4,8)	(6,5)	(5,3)	(6,4)	(3,6)	(2,7)	(2,4)	(4)	(3,7)	(2,8)	(3,4)
Coupon (%)	33,81***	11,71**	16,49*	14,12**	39,83***	5.53	36,56***	21,07***	51,95***	37,41***	19,00***	12,86**
	(11,4)	(5,9)	(9,6)	(6,6)	(12,2)	(7,8)	(8,3)	(7,8)	(15)	(14,2)	(6,3)	(5,3)
Log(Issuesize)	12.80	7.43	9.51	5.20	16.88	6.99	2.63	0.06	9.56	2.35	-5.92	-5.94
	(9,4)	(6,1)	(6,7)	(4,5)	(17,4)	(8,5)	(7,9)	(7,7)	(7,4)	(7,3)	(9,3)	(8,8)
Senior	68.71	-15.42	54.22	5.06	140.98	31.32	51,77***	34,59**	76,07**	64,61*	30,91**	15.77
	(65,4)	(28,3)	(42,6)	(31,8)	(100,1)	(47,8)	(16,1)	(14,5)	(32,8)	(36)	(12,4)	(14)
10Y Swap Rate (%)	-29.65	-12.29	2.22	3.02	-57,65**	-31,52*	-58,55***	-44,04***	-76,41***	-66,58***	-45,84***	-27,75***
	(20,4)	(12,6)	(8)	(7,7)	(29,2)	(17,1)	(13,6)	(12,9)	(16,8)	(17,1)	(14,4)	(10,9)
10Y-1Y Swap Rate (%)	-18.23	-11.79	0.13	-2.00	-24.93	7.14	-19,75***	-11,94*	-21,36**	-12.48	-24,73***	-21,39***
	(11,2)	(8,7)	(6,2)	(6,6)	(24)	(16,4)	(6,8)	(6,9)	(10,3)	(10,9)	(6,3)	(5,9)
Implicit Bid-ask Spread (bp)	1,89***	1,55***	0,99***	0,87***	2,62***	1,74***	1,54***	1,48***	1,49***	1,44***	1,46***	1,38***
	(0,6)	(0,4)	(0,2)	(0,2)	(0,6)	(0,5)	(0,2)	(0,2)	(0,2)	(0,2)	(0,4)	(0,4)
Log(Total Assets ($USm))	20,41*	32,08**	-32.36	-3.62	-3.77	-8.45	-50,81***	-22,62***	-38,49***	-17,5*	-49,28***	-23,45***
(Size)	(11,5)	(13,6)	(30,9)	(21,2)	(22,2)	(14)	(6,6)	(6)	(8,6)	(9,5)	(12,9)	(7,5)
Operating Income to Total Assets	7.51	-0.85	15,42**	3.05	4.25	-1.70	-17,85***	-13,86***	-17,01***	-14,45***	-46,34***	-41,62***
Profitability	(5,9)	(4,9)	(6,7)	(3,5)	(9,9)	(9,2)	(3,3)	(3,1)	(3,6)	(3,8)	(12,9)	(11,9)
Total Debt to Total Assets (%)	-0.13	0.86	3,61**	2,50*	-0.40	-0.17	1,92***	1,57***	2,61**	1.95	1,65*	1.53
(Leverage)	(1,2)	(0,6)	(1,8)	(1,4)	(1,5)	(0,7)	(0,6)	(0,7)	(1,1)	(1,2)	(1)	(1)
Rating dummy variables''	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Adjusted R^2	24.0	39.1	30.2	38.7	29.9	54.6	30.1	33.6	30.3	32.9	30.7	35.6
SER	272.9	244.3	181.0	169.6	338.6	272.6	311.9	304.0	355.6	348.9	260.2	250.7
# of observations	8130	8130	4866	4866	3264	3264	58035	58035	26883	26883	31152	31152
# of bonds	1012	1012	631	631	381	381	4943	4943	2172	2172	2771	2771

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

7.3.6 Conclusion and perspectives for Kovner and Wei's (2012) financial measures

To sum up, the measures applied in Kovner and Wei (2012) to control for the financial condition of the issuer do not add significantly to the explanatory power of the control variables and ratings for variation in yield spreads of bonds issued by private firms. However, for private non-financial firms they improve the fit of the model, while the poor fit of the overall model likely stems from the

measures not being significant for yield spreads of bonds issued by private financial firms. On the other hand, the measures are statistically significant for explaining variation in yield spreads of bonds issued by listed firms.

In the majority of their specifications, Kovner and Wei (2012) find that the estimated coefficients on the financial measures have the expected sign, but that their magnitudes are sensitive to which other variables they control for. However, as they analyze private and listed firms in one model, it is unclear whether the financial measures are significant for the yield spreads of bonds issued by private firms in their sample.

7.3.7 Financial ratios applied in Blume et al. (1998)

The results discussed in this section are shown in Table 12. For bonds issued by private firms, profitability measured as operating income to sales and leverage measured as long-term debt to total assets are statistically significant for explaining variation in yield spreads and remain so after ratings are controlling for. Higher leverage, ceteris paribus, demands a premium and higher profitability, ceteris paribus, results in a discount in yield spreads as expected. However, the ratios only improve the fit of the model slightly over that of the base regressions. For the subsample of non-financial private firms, only profitability is significant for yield spreads, while the fit of the model is improved compared to the overall model. For financial private firms, the significance of the variables is sensitive to controlling for ratings. While profitability is statistically significant, leverage only becomes so after controlling for ratings, but their coefficients have the expected signs in both specifications. The estimated coefficients on the dummy variables for the interest coverage ratios are not intuitive, as some of the variables for higher interest coverage demand a premium, while some of the variables for lower interest coverage demand a discount.

For bonds issued by listed firms, leverage and profitability are statistically significant for explaining variation in yield spreads at a 1% significance level with the magnitudes of their coefficients changing after controlling for ratings and with their explanatory power for variation in yield spreads being similar to and beyond ratings'. The fit of the model is slightly improved after separating non-financial and financial bonds. For financial bonds, the conclusions from the overall model for listed firms apply, however, ceteris paribus, with profitability being associated with a larger discount and leverage with a larger premium. For the non-financial bonds only profitability and some of the interest coverage dummy variables are statistically significant for yield spreads. The estimated coefficients on the dummy variables for interest coverage are not intuitive in that the dummy variables

for the lowest interest coverage have a negative coefficient and the dummy variables for higher interest coverage demand a premium.

That lower interest coverage is connected to discounts might be explained by the generally low interest coverage found in the sample. As negative interest coverage ratios are set to zero and serves as a benchmark, any positive interest coverage ratio might be attractive and be associated with the issuers' bonds demanding lower yield spreads. However, if this is the case, the coefficients on all the dummy variables for interest coverage are expected to have negative signs.

Table 12. The significance of financial measures applied in Blume et al. (1998) for yield spreads

	Bonds issued by private firms						Bonds issued by listed firms					
	All		Non-financial		Financial		All		Non-financial		Financial	
Intercept	3.34	42.98	-154.55	-38.78	59.14	-62.73	246,63***	221,83***	549,3***	454,59***	269,65***	174,57**
	(116,08)	(86,03)	(135,77)	(80,6)	(167,32)	(87,53)	(95,11)	(80,26)	(138,82)	(132,01)	(70,97)	(63,65)
Time to Maturity (Years)	-7.57	-7,15*	-1.55	-5,30*	-10,68**	-5,44*	-5,08***	-5,07***	-6,81***	-5,88***	-4.32	-5,9*
	(4,91)	(3,86)	(4,48)	(2,93)	(4,45)	(3,25)	(1,39)	(1,36)	(1,48)	(1,38)	(2,86)	(3,07)
Bond Age (Years)	2.40	2.00	15,48***	9,68***	-4.53	3.46	-2.75	-1.08	-8,19**	-4.91	1.12	0.78
	(5,63)	(3,96)	(5,23)	(3,82)	(7,64)	(2,42)	(2,7)	(2,3)	(3,64)	(3,42)	(2,39)	(2,52)
Coupon (%)	29,9***	8.37	5.10	4.12	45,49**	10.64	44,24***	21,7***	50,51**	33,6**	25,22***	12,59**
	(10,35)	(6,09)	(8,64)	(5,27)	(18,13)	(8,93)	(8,59)	(7,6)	(14)	(13,66)	(6,64)	(5,13)
Log(Issuesize)	13.39	10.92	8.20	7,38**	12.53	4.46	-14,07**	-8.48	-7.55	-5.07	-14.57	-9.61
	(9,32)	(7,07)	(5,7)	(3,49)	(18,43)	(8,85)	(6,87)	(6,41)	(7,82)	(7,23)	(9,06)	(8,26)
Senior	-0.69	-46.11	62.76	34.07	23.04	-26.79	32,58*	7.04	48.76	35.97	-6.54	-15.85
	(41,64)	(43,19)	(70,26)	(34,72)	(53,45)	(39,55)	(18,37)	(15,96)	(32,88)	(34,46)	(18,57)	(19,28)
10Y Swap Rate (%)	-30.33	-14.55	6.27	3.58	-71,39**	-40,71**	-46,77***	-38,35***	-77,8***	-66,78***	-36,43***	-24,77***
	(23,17)	(13,86)	(10,77)	(9,11)	(35,05)	(18,65)	(11,7)	(11,06)	(17,62)	(17,51)	(9,49)	(9,67)
10Y-1Y Swap Rate (%)	-25,49**	-19,04**	-13.28	-15,25**	-36,17*	1.24	-21,03***	-14,52**	-22,18**	-12.73	-24,36***	-20,26***
	(12,59)	(9,01)	(8,59)	(7,02)	(21,1)	(14,02)	(6,54)	(6,48)	(9,46)	(9,99)	(6,09)	(5,67)
Implicit Bid-ask Spread (bp)	1,84***	1,53***	***0,95	0,85***	2,49***	1,66***	1,31***	1,32***	1,36***	1,38***	1,22***	1,18***
	(0,52)	(0,35)	(0,16)	(0,12)	(0,56)	(0,44)	(0,18)	(0,19)	(0,19)	(0,19)	(0,3)	(0,29)
Operating Income to Sales (%)	-4,08*	-3,8**	-3,5*	-3,64***	-7,73*	-5,32*	-5,19***	-3,89***	-4,41**	-3,99**	-5,25***	-4,49***
	(2,32)	(1,59)	(1,92)	(1,38)	(3,75)	(3,02)	(1,12)	(1,04)	(1,96)	(1,93)	(1,79)	(1,59)
Long-term Debt to Total Assets (%)	2,49**	2,46**	2.49	2.01	3.58	2,32**	3,87***	2,7**	1.29	0.80	4,48**	3,74**
	(1,24)	(1,22)	(1,56)	(1,3)	(2,27)	(1,09)	(1,08)	(1,17)	(1,47)	(1,6)	(1,92)	(1,88)
C1	11.54	-5.17	14.05	-2.35	189,9*	99,85*	-32,56***	-34,95***	-75,72***	-62,07***	3.34	-6.56
	(23,98)	(15,9)	(29,77)	(11,43)	(108,64)	(52,35)	(6,76)	(6,11)	(10,88)	(10,32)	(8,53)	(6,22)
C2	82,16**	60,9***	81.04	34.30	-39.33	-1.13	-0.02	10,88**	17,5***	18,75***	-34,39**	-13.89
	(36,56)	(21,43)	(59,79)	(37,08)	(103,76)	(30,04)	(6,95)	(4,58)	(6,63)	(5,95)	(14,65)	(10,72)
C3	-77,51**	-57,4**	-64,69*	-35.90	-181,67*	-124,17**	4.67	3,93*	-0.06	0.24	5.97	8,44*
	(30,77)	(23,51)	(34,11)	(25,01)	(106,9)	(54,35)	(2,89)	(2,31)	(3,7)	(2,96)	(4,95)	(5,01)
C4	6,56**	2.99	4.39	4.31			-0.32	-0.22	-0.37	-0.30	0.37	0.08
	(2,9)	(3,9)	(2,84)	(2,96)			(0,76)	(0,69)	(0,82)	(0,7)	(1,23)	(0,85)
Rating dummy variables''	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Adjusted R^2	26.55	40.81	28.84	40.43	33.08	55.94	30.89	34.8	31.75	33.9	31.32	36.19
SER	269.15	241.6	182.74	167.19	333.71	270.77	299.91	291.29	349.96	344.41	236.47	227.92
# of observations	8026	8026	4860	4860	3166	3166	57740	57740	26834	26834	30906	30906
# of bonds	1008	1008	631	631	377	377	4935	4935	2170	2170	2765	2765

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

7.3.8 Conclusion and perspectives for Blume et al.'s (1998) financial ratios

To sum up, leverage measured as long-term debt to total assets and profitability measured as operating income to sales are statistically significant for explaining variation in yield spreads of bond issued by private and listed firms. While the fit of the model is slightly improved, when separating non-financial and financial firms, the significance of the ratios decreases. Profitability is consistently associated with lower yield spreads and leverage with higher yield spreads across the model specifications.

However, their coefficients and significance for yield spreads are sensitive to controlling for ratings. The estimated coefficients on the interest coverage dummy variables are not consistent in that their significance, signs and magnitudes are sensitive to controlling for ratings and separating the sample into financial and non-financial bonds.

Unlike Campbell and Taksler (2003) this study concludes that the variation in the accounting ratios from Blume et al. (1998) together with the control variables explain more of the variation in yield spreads of bonds issued by listed firms than does the variation in ratings together with the control variables. They find that profitability is statistically significant with an expected negative coefficient and that leverage is not statistically significant with an unexpected negative coefficient after controlling for ratings for yield spreads of bonds issued by listed firms. Similar to this study, they find that the coefficients on the interest coverage dummy variables in some specifications are statistically significant, but with unexpected positive signs on their coefficients. While the adjusted-R^2 of their models are similar to the ones found in this study, they further control for equity volatility and total debt to total capitalization, their controls for bond characteristics and market conditions differ slightly and the magnitudes of their coefficients on the accounting ratios are larger.

The small improvement in the fit of the model for bonds issued by private firms to the base regressions compared to the model for bonds issued by listed firms, suggests that the ratios are not optimal controls for credit risk of private firms or that the credit risk that they control for are valued differently for private and listed firms.

7.3.9 Approach inspired by Moody's RiskCalc™

Table 13 shows descriptive statistics of the final ratios applied to control for credit risk for each subsample in the approach inspired by Moody's RiskCalc™ and Table 14 p. 59 shows the regression results. All the financial statement variables and functional forms of these considered together with their t-statistic, the adjusted-R^2 and the SER of their univariate relation to yield spreads for the defined groups can be found in Appendix 6.

7.3.9.1 Private non-financial firms

By considering a larger range of financial measures and their non-linear relation to yield spreads together with the control variables, 49.7% of the variation in yield spreads of bonds issued by private non-financial firms can be explained. The model has a superior fit compared to that of the base regression controlling for ratings and over that of the regressions applying the other credit risk

measures founded on financial ratios. Controlling for ratings slightly improves the fit of the model and results in all the financial measures included becoming statistically significant for yield spreads.

Table 13. Descriptive statistics of financial ratios applied in approach inspired by Moody's RiskCalc™

Firms		Obs	Mean	Standard deviation	Percentiles							Kurtosis	Skewness
					1st	5th	25th	50th	75th	95th	99th		
Private non-financial	Sales ($USm)	4770	5143.24	6470.97	416.6	904.1	1636	2561	4423	22414	24898	2.43	1.94
	Log(Sales to Total Assets)	4770	-1.67	0.52	-3.28	-2.94	-1.88	-1.56	-1.39	-1.05	-0.66	3.24	-1.28
	Sales to Total Assets (%)	4770	16.13	22.77	5.39	6.07	8.46	9.24	11.12	46.43	143.1	23.08	4.57
	Log(Cash to Total Assets)	4770	-3.98	1.3	-7.75	-6.19	-4.92	-3.69	-2.93	-2.39	-2.04	1.02	-0.85
	Sales growth (%)	4770	1.06	13.43	-31.08	-14.35	-7.34	0.26	8.62	23.43	30.61	5.51	-0.47
	1 to Interest Coverage	4770	1.87	1.54	0.13	0.28	0.87	1.51	2.4	4	6.89	24.93	3.18
	Retained Earnings to Total Assets (%)	4770	7.64	8.37	-34.56	2.5	5.05	7.5	9.9	19.77	32.67	32.55	-3.23
Private financial	1 to Sales ('000)	3151	0.28	0.34	0.02	0.02	0.05	0.19	0.33	1.01	1.71	6.42	2.36
	Log(Sales to Total Assets)	3151	-2.66	0.54	-4.18	-3.68	-3.02	-2.34	-2.27	-2.07	-1.82	0.62	-0.93
	1 to (Cash to Total Assets (bp))	3151	1580.29	9758.74	0.0029	0.0038	0.012	0.0281	0.2297	0.5394	56313.47	36.65	6.14
	1 to Sales Growth (%)	3151	-0.04	1.37	-1.01	-0.29	-0.05	0.04	0.11	0.56	1.42	97.94	-9.07
	Log(Interest Coverage)	3151	-0.6	0.74	-3.72	-1.88	-0.86	-0.58	-0.4	0.02	0.55	14.22	-2.33
	1 to (Total Liabilities to Total Assets)	3151	1.12	0.07	1.02	1.03	1.08	1.1	1.18	1.23	1.37	12.52	1.85
Listed non-financial	Log(Sales $USm)	26455	9.61	1.41	6.47	7.32	8.63	9.63	10.62	12.05	12.56	-0.29	-0.03
	Net Income to Total Assets (%)	26455	2.34	9.14	-35.83	-9.11	0.33	2.92	6.22	12.83	18.08	34.29	-3.99
	Log(Cash to Total Assets)	26455	-3.25	1.15	-6.37	-5.27	-3.98	-3.12	-2.42	-1.63	-1.05	0.79	-0.63
	Sales Growth (%)	26455	4.84	21.9	-54.12	-27.51	-3.17	3.96	11.28	36.11	86.92	8.54	1.17
	Positive Interest Coverage	26455	0.08	0.28	0	0	0	0	0	1	1	7.06	3.01
	Long-term Debt to Total Assets (%)	26455	50.11	27.13	8.09	18.23	32.93	43.97	60.41	95.53	161.89	5.54	1.81
Listed financial	Log(Total Assets $USm)	31019	12.73	1.39	8.64	10.25	11.76	13.09	13.76	14.6	14.7	0.62	-0.87
	Net Income to Total Assets (%)	31019	0.99	1.5	-3.82	-0.63	0.48	0.96	1.49	2.79	4.84	63.84	-3.61
	Cash to Total Assets (%)	31019	8.19	7.87	0.17	0.49	2.3	5.17	13.13	20.88	36.75	6.18	1.88
	Sales Growth (%)	31019	5.61	24.16	-46.2	-27.69	-7.93	2.87	16.56	50.65	82.43	3.29	0.86
	Positive Interest Coverage	31019	0.08	0.27	0	0	0	0	0	1	1	7.53	3.09
	Long-term Debt to Total Assets (%)	31019	18.93	17.06	1.06	2.49	8.7	13.36	21.69	57.15	86.12	4.17	2.01

Both an increase in solvency, measured as retained earnings to total assets, and sales growth are associated with lower yield spreads, which is in accordance with their expected relation to credit risk. Higher solvency implies that the firm to a higher degree has financed its business through retained earnings rather than incurring debt and that it can take larger losses before ending in financial distress, while positive sales growth implies that the firm will have a better basis for paying off its debts. An increase in the ratio of interest expenses to operating income, equivalent to 1 divided by the interest coverage ratio, is associated with higher yield spreads, which is in accordance with expectations. A higher ratio implies that interest expenses make up a larger share of the income that the company has earned and is thus, associated with higher credit risk. Furthermore, an increase in cash to total assets is associated with lower yield spreads with increases in higher levels having a smaller effect. The ratio expresses liquidity of the firm and a higher liquidity is expected to be associated with lower credit risk. An increase in sales to total assets is, however, associated with a higher yield spread, which is not intuitive as regards the ratio's expected relation to credit risk. A higher ratio expresses that the firm is more profitable in terms of generating sales from its assets and thus should more capable of paying off its debts. The result that a larger firm, measured in sales, demands a premium in yield spreads is further not in accordance with expectations. Dwyer et al.

Table 14. Regressions applying the approach inspired by Moody's RiskCalc™

Bonds issued by private non-financial firms		
Intercept	95.59	32.44
	(79,53)	(59,57)
Time to Maturity (Years)	-3.43	-3,84*
	(2,57)	(2,28)
Bond Age (Years)	7,27***	4,86**
	(2,05)	(2,15)
Coupon (%)	7,7**	5,82**
	(3,51)	(2,47)
Log(Issuesize)	-1.85	-2.01
	(4,35)	(2,99)
Senior	34.64	30.58
	(43,31)	(38,77)
10Y Swap Rate (%)	-7.42	-7.63
	(8,78)	(8,12)
10Y-1Y Swap Rate (%)	-11.17	-13,94*
	(9,69)	(7,69)
Implicit Bid-ask Spread (bp)	0,75***	0,69***
	(0,12)	(0,11)
Sales ($USm)	0,0036***	0,0047***
(Size)	(0,0012)	(0,0013)
Log(Operating Income to Sales)	115,8***	71,25*
(Profitability)	(42,23)	(42,23)
Sales to Total Assets (%)	4,35***	2,86***
(Profitability)	(0,88)	(1,03)
Log(Cash to Total Assets)	-10.49	-13,74**
(Liquidity)	(7,43)	(6,66)
Sales Growth (%)	-0.99	-1,02*
(Growth)	(0,66)	(0,54)
1 to Interest Coverage	52,93***	41,31**
(Debt coverage)	(19,84)	(20,09)
Retained Earnings to Total Assets (%)	-8,03***	-7,66***
(Solvency)	(1,9)	(2,05)
Rating dummy variables''	No	Yes
Adjusted R^2	49.7	51.9
SER	151.6	148.1
# of observations	4770	4770
# of bonds	630	630

Bonds issued by private financial firms		
Intercept	1521.64	1076.45
	(1040,64)	(714,61)
Time to Maturity (Years)	-6,73**	-3,78*
	(3,22)	(2,28)
Bond Age (Years)	1.89	6,07*
	(9,99)	(3,63)
Coupon (%)	19.30	-2.18
	(21,57)	(8,87)
Log(Issuesize)	1.22	2.37
	(14,27)	(7,46)
Senior	-25.36	-45.34
	(63,39)	(43,28)
10Y Swap Rate (%)	-107,52***	-60,76**
	(32,78)	(30,12)
10Y-1Y Swap Rate (%)	-37.72	-5.56
	(26,63)	(13,06)
Implicit Bid-ask Spread (bp)	2,32***	1,67***
	(0,5)	(0,43)
1 to Sales ('000)	-1.82	21.02
(Size)	(88,96)	(60,05)
Log(Sales to Total Assets)	277,98**	162.30
(Profitability)	(116,43)	(101,27)
1/(Cash to Total Assets (bp))	0,0025***	0,0013***
(Liquidity)	(0,0008)	(0,0004)
1 to Sales Growth in %	-52,44***	-20.32
(Growth)	(9,52)	(18,9)
Log(Interest Coverage)	47.26	40.28
(Debt coverage)	(38,77)	(30,82)
1 to (Total Liabilities to Assets)	-184.23	-385.86
(Leverage)	(548,11)	(285,69)
Rating dummy variables''	No	Yes
Adjusted R^2	39.97	57.3
SER	316.7	267.1
# of observations	3151	3151
# of bonds	378	378

Bonds issued by listed non-financial firms		
Intercept	431,75***	266,2**
	(148,92)	(132,72)
Time to Maturity (Years)	-5,78***	-5,11***
	(1,43)	(1,34)
Bond Age (Years)	-8,19**	-5,75*
	(3,48)	(3,24)
Coupon (%)	48,15***	32,82***
	(11,36)	(11,15)
Log(Issuesize)	-10.49	-13,45*
	(6,8)	(7,01)
Senior	50.18	33.89
	(31,23)	(31,36)
10Y Swap Rate (%)	-70,62***	-60,81***
	(16,74)	(16,56)
10Y-1Y Swap Rate (%)	-20,3**	-11.47
	(8,25)	(8,57)
Implicit Bid-ask Spread (bp)	1,15***	1,13***
	(0,16)	(0,16)
Log(Sales ($USm)	-25,2**	-6.79
(Size)	(8,12)	(7,35)
Net Income to Total Assets (%)	-6,47***	-5,40***
(Profitability)	(2,19)	(2,12)
Log(Cash to Total Assets)	3.92	0.05
(Liquidity)	(6,57)	(6,16)
Sales Growth (%)	-1.02	-1.07
(Growth)	(0,69)	(0,66)
Positive Interest Coverage	323,08***	304,48***
(Debt coverage)	(92,74)	(94,38)
Long-term Debt to Networth	2,68**	2,13***
(Leverage)	(1,07)	(1,17)
Rating dummy variables''	No	Yes
Adjusted R^2	34.6	37.3
SER	331.6	324.9
# of observations	26455	26455
# of bonds	2165	2165

Bonds issued by listed financial firms		
Intercept	545,05***	232,36**
	(94,81)	(95,04)
Time to Maturity (Years)	-5,62**	-6,61**
	(2,83)	(3,09)
Bond Age (Years)	1.08	-0.16
	(2,77)	(3,22)
Coupon (%)	26,00***	19,31***
	(8,04)	(7,25)
Log(Issuesize)	-11.78	-10.78
	(10,18)	(9,83)
Senior	7.18	-2.01
	(14,02)	(16,2)
10Y Swap Rate (%)	-37,58***	-22,23**
	(10,26)	(10,12)
10Y-1Y Swap Rate (%)	-29,1***	-25,96***
	(6,25)	(6,1)
Implicit Bid-ask Spread (bp)	1,23***	1,20***
	(0,25)	(0,24)
Log(Total Assets $USm)	-25,43***	-7,57*
(Size)	(5,77)	(4,56)
Net Income to Total Assets (%)	-54,74***	-49,59***
(Profitability)	(16,47)	(16,59)
Cash to Total Assets (%)	-0.61	0.09
(Liquidity)	(1,07)	(1,09)
Sales Growth (%)	-0.60	-0,72*
(Growth)	(0,39)	(0,4)
Positive Interest Coverage	159,21**	133,56**
(Debt coverage)	(69,48)	(56,61)
Long Term Debt to Total Assets (%)	3,90**	3,76**
(Leverage)	(1,78)	(1,88)
Rating dummy variables''	No	Yes
Adjusted R^2	39.3	42.1
SER	243.1	237.2
# of observations	31019	31019
# of bonds	2760	2760

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

(2012) find that larger firms exhibit lower credit risk and thus it is expected that the yield spreads of their bonds should be lower. However, if for this sample of private firms, the smaller firms, ceteris paribus, exhibit lower credit risk than the larger firms, this would explain the result. An increase in the operating margin is associated with higher yield spread with increases in higher levels having a smaller effect. This is further not intuitive, as a higher ratio expresses higher profitability, which is usually connected to lower credit risk.

Even though the explanatory power of the model is improved significantly compared to when applying the other measures of credit risk founded on financial ratios, some of the results are not intuitive in terms of how the financial measures are related to yield spreads. Considering other ratios and functional forms within the same categories, similar relations between the ratios and yield spreads are found. This result might be due to the specific composition of the sample or it might imply that investors do not take into account these variables, when considering credit risk reflected in yield spreads. However, if the latter is the case, the finding of statistical significance of these variables is peculiar.

7.3.9.2 Private financial firms

For bonds issued by private financial firms, considering a larger range of financial measures and different functional forms of these increases the explanatory power of the model over the base regression with just control variables. However, only half of the financial ratios are statistically significant for explaining variation in yield spreads and after controlling for ratings only one of the ratios remains significant.

An increase in the ratio of one to sales is associated with higher yield spreads, implying that increasing size, measured in sales, is associated with a discount as expected, while an increase in total assets to total liabilities is associated with lower yield spreads, which is intuitive, as an increase in the ratio implies that the firm is lower leveraged. Furthermore, an increase in total assets to cash is statistically significant and associated with higher yield spreads, which is intuitive, as an increase in the ratio implies that the firm is less liquid. Increases in both interest coverage and sales to total assets are associated with higher yield spreads, with increases in higher levels of both having a smaller effect. Neither of these results is intuitive as higher interest coverage and profitability are expected to be associated with lower credit risk. Furthermore, an increase in the ratio of one to sales growth is associated with lower yield spreads. The functional form of the variable implies that an increase in the ratio itself is associated with a decrease in the variable. Thus, the results imply that increasing

growth measured in sales is associated with a premium in yield spreads, which is contrary to the expectation that higher growth is associated with lower credit risk.

One explanation for the weak power of the financial ratios might be that there are few firms in the sample of private financial firms and that they, on average, have more bonds per issuer. This could imply that the accounting variables vary less in cross-section than in the other samples, where the bonds per issuer, on average, are lower.

7.3.9.3 Listed non-financial firms

For listed non-financial firms, the approach inspired by Moody's RiskCalc™ improves the fit of the model compared to the models that consider the other credit risk measures founded on financial ratios and to the base regression controlling for ratings. However, only three out of six ratios applied remain statistically significant after controlling for ratings.

An increase in net income to total assets is statistically significant and associated with lower yield spreads, which is intuitive as higher profitability is expected to be associated with lower credit risk and thus lower yield spreads. Long-term debt to net worth is also statistically significant and higher levels are associated with larger yield spreads in accordance with expectations. Furthermore, higher sales growth and a larger size, measured in terms of sales, are associated with lower yield spreads with increases in size at higher levels of sales having a smaller effect. While none of these variables are statistically significant, the results are in accordance with expectations, as a larger and growing firm is expected to exhibit lower credit risk. However, a positive interest coverage ratio is statistically significant and demands a premium in yield spreads, which is not intuitive, as higher interest coverage, ceteris paribus, imply a better basis to pay interest and thus lower credit risk and yield spreads. The sign on the estimated coefficient on liquidity is unexpectedly positive.

7.3.9.4 Listed financial firms

For listed financial firms, the approach inspired by Moody's RiskCalc™ also improves the fit of the model compared to the models that consider the other credit risk measures founded on financial ratios and to the base regression controlling for ratings. Five out of six ratios are statistically significant after controlling for ratings.

Increases in net income to total assets, sales growth and size are associated with lower yield spreads, while an increase in long-term debt to total assets is associated with higher yield spreads. These results are all statistically significant and in accordance with the expectations that higher profitability and growth, larger firm size measured in sales and lower leverage are associated with

lower credit risk and thus should be associated with lower yield spreads. However, positive interest coverage and higher liquidity are associated with higher yield spreads. This is not in accordance with expectations that a positive interest coverage related to a negative, ceteris paribus, should be associated with lower credit risk and that a more liquid firm will exhibit lower credit risk.

7.3.10 Conclusion and perspectives for the approach inspired by Moody's RiskCalc™

The approach inspired by Moody's RiskCalc™ improves the fit of the models beyond controlling for ratings and beyond controlling for other credit risk measures founded on financial ratios, except for bonds issued by private financial firms. However, the significance of the financial variables and the magnitudes and signs of their estimated coefficients vary considerably across the subsamples, while some of the results are not intuitive. While all the financial variables applied to the sample of bonds issued by private non-financial firms are statistically significant after controlling for ratings, larger size and higher profitability unexpectedly require a premium. Besides excluding activity ratios, the measures included are similar to those applied in Moody's RiskCalc™ 4.0 US (Dwyer et al., 2012). For bonds issued by private financial firms, only one of the financial variables remains statistically significant after controlling for ratings and only leverage, liquidity and size have the expected relations with yield spreads. For bonds issued by listed firms the interest coverage and liquidity variables do not have the expected relations with yield spreads, however, for non-financial bonds, three of the variables are statistically significant, while for financial bonds, five of the variables are statistically significant. The most intuitive results are thus for bonds issued by listed firms, while the least intuitive are for bonds issued by private financial firms. While the largest improvement in the fit of the model is for bonds issued by private non-financial firms, a significant part of the improvement stems from the size and profitability variables, which do not have the expected relation with yield spreads in terms of their effect on credit risk.

The weakness of the approach is the risk of over-fitting the model and including ratios that are statistically significant for yield spreads, but in reality are not considered in the valuation of the bonds. As several of the results are not intuitive in terms of the financial variables' expected relation with credit risk and yield spreads, this might suggest that the models above are not results of the true valuation of credit risk reflected in financial ratios, as statistical significance does not necessarily imply causation. If industry specific ratios or activity ratios that rely on working capital entries are more significant for credit risk reflected in yield spreads, this suggests further improvements to the model. As a last note, the results might be due to the specifics of each subsample and affected by

possible errors in categorizing the firms as private or listed and as financial or non-financial and in connected the bond to the right issuer.

7.3.11 Summary of the significance of credit risk measured by financial ratios

It is clear that the application of each credit risk measure founded on financial ratios has different implications for assessing the yield spreads of bonds issued by private and listed firms. The result that the significance of the variables, their relations with yield spreads and their estimated coefficients differ across the subsamples suggests that their bonds are valued differently.

For private firms, the z”-score and the profitability and leverage ratios used in Blume et al. (1998) are statistically significant with the expected relation to yield spreads, but only leads to a small increase in the explanatory power of the model with control variables. For the financial measures applied in Kovner and Wei (2012), the expected relations with yield spreads are not evident for all inputs and they do not add much explanatory power beyond the control variables. On the other hand, the measures that are used as inputs to the z”-score and the approach inspired by Moody’s RiskCalc™ have explanatory power similar to or beyond ratings, except for bonds issued by private financial firms, but their relations with yield spreads are not intuitive for all measures.

For bonds issued by listed firms, the financial measures applied in Kovner and Wei (2012) and the profitability and leverage ratios used in Blume et al. (1998) have similar explanatory power to ratings for variation in yield spreads with the expected signs on their coefficients. The larger improvement in the fit of the model to the base regressions compared to the improvement in the fit of the models for bonds issued by private firms suggests that these measures do not reflect credit risk valued in yield spreads of private firms as well as for listed firms. For the subsamples of non-financial firms the inputs to the z”-score also have similar explanatory power to ratings, but the expected relation with yield spreads is not evident for bonds issued by financial listed firms. The z”-score is statistically significant, but only leads to a small increase in the explanatory power of the model with control variables, while the estimated coefficient is smaller than that found in the model for private firms. Lastly, the approach inspired by Moody’s RiskCalc™ adds similar explanatory power to bonds issued by listed financial firms as it does to bonds issued by private firms, however, it does not add as much to the model for listed non-financial firms, and some of the relations between the financial measures and yield spreads found are not intuitive.

Overall, it seems that the estimated models that provide intuitive interpretations have the most explanatory power for bonds issued by listed firms, while the models for private firms with the most explanatory power do not provide intuitive results in terms of how the financial measures are expected

to be related with credit risk. This might suggest that credit risk reflected in financial measures is valued differently for the two groups or it might be due to the specific composition of the sample. If the issuer connected to the bond is not the same as the one investors base their fundamental analysis on, this could explain the peculiar relations found for private firms.

7.4 The significance of credit risk reflected in a structural model

In this section, the results on the significance and explanatory power of inputs to a structural credit risk measure will be provided and discussed. To make the measure applicable to private firms, sector averages will be used to proxy for publicly traded equity values. By applying the publicly traded equity values to the sample of listed firms the analysis will further shed light on the significance of publicly traded data for yield spreads. Results for bonds issued by private firms can be found in Table 15, while results for listed firms can be found in Table 16.

7.4.1 Estimated sector volatility and leverage

For private firms, sector volatility and estimated market value leverage are statistically significant and together with the control variables explain more of the variation in yield spreads than control variables together with ratings. Ceteris paribus, a one percentage point higher sector volatility is associated with a 6bp larger yield spread, while a one percentage point higher leverage is associated with a 2.35p higher yield spread. The coefficient on the 10-year swap rate is negative as expected, however, after controlling for ratings it is not statistically significant and the magnitude of its coefficient decreases. The initial model has an adjusted-R^2 of 40.7% and a SER of 233.0, while the fit of the model is improved when controlling for ratings.

For the subsample of private non-financial firms, both sector volatility and estimated market value leverage are statistically significant for yield spreads after controlling for ratings. Compared to the model for all private firms, the lower SER implies that the fit of the model is superior, while the adjusted-R^2 is lower and implies an inferior fit. Furthermore, the estimated coefficients on sector volatility are lower. The 10-year swap rate is not statistically significant and the magnitude and sign of its coefficient are sensitive to controlling for ratings.

Table 15. The significance of sector inputs to a structural credit risk measure for yield spreads

	Bonds issued by private firms					
	All		Non-financial		Financial	
Intercept	-232,52***	-270,99***	-235,85***	-262,11***	-24.05	-225.83
	(79,19)	(85,98)	(51,59)	(67,51)	(171,89)	(138,75)
Time to Maturity (Years)	-5,71*	-5,02*	-0.97	-3,96*	-7,26**	-3.42
	(3,45)	(2,95)	(2,73)	(2,21)	(3,7)	(2,76)
Bond Age (Years)	5.01	3.87	14,57***	10,41***	-0.22	6.09
	(4,98)	(2,77)	(2,71)	(2,89)	(7,51)	(4,45)
Coupon (%)	24,64**	2.66	7.77	3.78	38,48***	-1.76
	(11,22)	(6,74)	(7,01)	(3,7)	(14,45)	(10,15)
Log(Issuesize)	4.20	5.06	3.82	5,42**	0.90	-3.11
	(4,73)	(3,84)	(3)	(2,53)	(10,99)	(6,86)
Senior	49.65	-13.20	34.85	22.76	136,45*	-3.58
	(35,55)	(25,07)	(37,49)	(26,87)	(81,25)	(40,04)
10Y Swap Rate (%)	-17,89*	-2.28	0.72	-0.61	-39,59*	-5.23
	(10,73)	(7,7)	(7,3)	(6,24)	(21,54)	(15,65)
10Y-1Y Swap Rate (%)	-51,1***	-40,87***	-27,07***	-26,07***	-72,15***	-21.36
	(17,33)	(12,35)	(7,04)	(5,83)	(21,09)	(14,14)
Implicit Bid-ask Spread (bp)	1,19***	0,97***	0,65***	0,56***	1,69***	1,18***
	(0,26)	(0,19)	(0,13)	(0,09)	(0,29)	(0,27)
Sector Volatility (%)	6,47***	6***	4,28***	4,35***	6,58**	4,75**
	(2,49)	(2,09)	(1,27)	(1,16)	(2,84)	(2,1)
Estimated Market Value Leverage (%)	1,76*	2,35***	1.83	2,15***	-1.42	1.67
	(1,05)	(0,77)	(1,22)	(0,83)	(2,85)	(1,2)
Rating dummy variables''	No	Yes	No	Yes	No	Yes
Adjusted R^2	40.7	52.8	34.9	44.8	45.1	62.6
SER	233.0	207.8	150.3	138.3	300.1	247.7
# of Observations	8077	8077	4825	4825	3252	3252
# of Bonds	1009	1009	631	631	378	378

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

For private financial firms, all three inputs are statistically significant with the expected signs on their coefficients. However, only sector volatility is significant after controlling for ratings, which also results in large changes in the magnitudes of the variables' coefficients. While the higher adjusted-R^2 of the initial model implies a superior fit compared to the model for all private firms, the higher SER implies that the errors have a larger proliferation around the regression line. The large improvement in the fit of the model after controlling for ratings implies that some of the credit risk reflected in yield spreads is not reflected in the sector measures.

For listed firms, sector volatility and estimated market value leverage are statistically significant for yield spreads with higher values of both, ceteris paribus, being associated with higher yield spreads. While the estimated coefficient on the 10-year swap rate is negative as expected, the variable is only statistically significant, when ratings are not included. This overall conclusion also applies to the subsample of non-financial firms, however, with the estimated coefficients on the variables being larger, with an inferior fit of the model and with the 10-year swap rate being

significant after controlling for ratings. For listed financial firms, sector volatility is statistically significant for yield spreads, while the estimated market value leverage is only significant after controlling for ratings. Controlling for ratings further has implications for the magnitude of the coefficient on leverage and results in an unexpectedly positive coefficient on the 10-year swap rate, which is not statistically significant. The fit of the model, however, is still better than that of the model applied to all listed firms.

Table 16. The significance of sector and publicly traded data inputs to a structural credit risk measure for yield spreads

	Bonds issued by listed firms											
	All				Non-financial				Financial			
Intercept	-259,92**	-242,6***	-209,79**	-177,51**	-250,57*	-249,95**	-268,97**	-243,29**	-50.93	-176,26**	17.84	-32.21
	(114,55)	(95,61)	(89,81)	(76,81)	(139,8)	(119)	(130,78)	(118,1)	(85,31)	(84,66)	(49,35)	(39,84)
Time to Maturity (Years)	-3,82***	-3,93***	-2,14**	-2,37***	-5,43***	-4,16***	-3,23***	-2,76***	-3.25	-5.01	-1.68	-3.36
	(1,37)	(1,3)	(0,87)	(0,84)	(1,52)	(1,37)	(1,04)	(0,99)	(2,8)	(3,17)	(1,84)	(2,04)
Bond Age (Years)	-3.66	-1.09	-0.53	0.90	-11,29***	-4.91	-1.44	0.72	0.50	0.03	1.57	0.71
	(2,8)	(2,06)	(2,03)	(1,71)	(4,31)	(3,89)	(2,74)	(2,63)	(3,8)	(3,66)	(2,7)	(2,63)
Coupon (%)	55,38***	20,5**	42,52***	20,18***	71,01***	37,65**	30,5***	19,26*	25,75***	8,60*	21,38***	10,85**
	(10,83)	(8,53)	(9,29)	(7,56)	(16,48)	(16,43)	(11,25)	(11,36)	(7,35)	(4,56)	(6,58)	(4,96)
Log(Issuesize)	-18,96**	-12,11*	-25,77***	-21,05***	-16,03**	-10.46	-6.97	-6.46	-14.59	-11.53	-21,52**	-18,62**
	(8,86)	(7,3)	(6,96)	(6,57)	(7,56)	(6,37)	(6,11)	(5,87)	(10,53)	(8,67)	(10,43)	(9,43)
Senior	88,42***	38,45**	69,09***	34,69***	67,11*	53.72	34.94	32.21	39,61*	27,08**	29,53**	20,23**
	(23,76)	(15,72)	(18,43)	(13,7)	(38,88)	(37,96)	(31,23)	(31,52)	(20,53)	(12,17)	(14,27)	(9,67)
10Y Swap Rate (%)	-17,02**	-6.24	-6.71	-2.14	-36,64***	-22,19*	-15.87	-11.22	-14.82	2.65	-11.16	-1.61
	(7,72)	(7,49)	(6,94)	(6,47)	(11,83)	(12,03)	(10,67)	(10,34)	(9,75)	(11,04)	(8,69)	(8,24)
10Y-1Y Swap Rate (%)	-30,55***	-24,08***	-42,96***	-36,65***	-31,17***	-22,51***	-52,58***	-45,47***	-38,46***	-33,56***	-45,56***	-42,23***
	(6,85)	(5,86)	(6,28)	(5,91)	(6,19)	(5,66)	(9,49)	(9,58)	(6,58)	(5,19)	(8,04)	(7,27)
Implicit Bid-ask Spread (bp)	1,12***	1,05***	0,71***	0,72***	1,1***	1,06***	0,61***	0,63***	1,12***	1,00***	0,71***	0,69**
	(0,19)	(0,18)	(0,1)	(0,1)	(0,22)	(0,2)	(0,13)	(0,12)	(0,34)	(0,29)	(0,15)	(0,14)
Sector Volatility (%)	4,28***	4,17***			5,17***	5,39***			4,26***	4,06***		
	(1,12)	(1,06)			(1,11)	(1,07)			(1,18)	(1,06)		
Estimated Market Value Leverage (%)	2,61***	2,64***			4,29***	3,24**			1.02	1,9**		
	(1,02)	(0,95)			(1,56)	(1,6)			(1,04)	(0,95)		
Equity Volatility (%)			6,53***	6,02***			9,53***	9,00***			5,61***	5,23***
			(1)	(0,99)			(1,03)	(1,02)			(1,47)	(1,33)
Market Value Leverage (%)			1,34***	1,34***			3,13***	2,87***			0.11	0.22
			(0,41)	(0,39)			(0,67)	(0,68)			(0,33)	(0,31)
Rating dummy variables''	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Adjusted R^2	28.3	36.9	46.8	50.9	26.9	32.9	51.1	52.6	33.5	42.0	51.0	55.0
SER	295.4	277.1	254.5	244.3	328.1	314.3	268.2	264.1	253.7	236.8	217.8	208.7
# of Observations	57147	57147	57147	57147	26028	26028	26028	26028	31119	31119	31119	31119
# of Bonds	4929	4929	4929	4929	2160	2160	2160	2160	2769	2769	2769	2769

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

7.4.2 Equity volatility and market value leverage

Using equity volatility and market value leverage over sector values significantly improves the fit of the model for all listed firms. This is evident in that the adjusted-R^2 is over 18 percentage points higher and in that the SER decreases. The coefficient on volatility is higher, while the coefficient on the market value leverage is lower than in the model using sector values. The 10-year swap rate is not significant and the magnitude of its coefficient is sensitive to controlling for ratings. The fit of the model is further improved, when applied to bonds issued by non-financial and financial firms separately. The conclusions from the model applied to all listed firms apply to the subsample of non-financial firms, but again with larger coefficients on the variables. For financial firms, however, only

volatility is statistically significant for yield spreads, while the estimated coefficient on market value leverage is positive as expected, but small compared to that found in the other models.

7.4.3 Conclusion and perspectives for credit risk reflected in structural models

Sector volatility and estimated market value leverage are statistically significant for yield spreads of bonds issued by private firms and the model provides a superior fit in terms of lower SERs compared to the regressions applying financial ratios to control for credit risk. Furthermore, the model provides an intuitive interpretation with higher volatility and leverage demanding a premium and a higher 10-year swap rate being associated with a discount in most of the specifications as in accordance with the variables' expected relation to credit risk in a structural model.

For listed firms, the specifications using sector values lead to a slightly smaller increase in the explanatory power of the model with control variables, which suggest that yield spreads of bonds issued by private firms to a higher degree are affected by sector valuations. The use of publicly traded data add up to over 30% to the adjusted-R^2 of the model with control variables for listed firms and the fit of the model is clearly improved over the models applying financial ratios to control for credit risk, which is both demonstrated by the adjusted-R^2 and the SER. This implies that publicly traded data is highly significant for the yield spreads of bonds issued by listed firms and that it provides superior explanatory power over the data sources available for private firms. Campbell and Taksler (2003) similarly find that equity volatility can explain more of the variation in yield spreads than accounting variables can. Using the credit default swap spread as the dependent variable, arguing that it might more quickly reflect changes in credit risk, Ericsson et al. (2009) find that equity volatility, market value leverage and the risk free rate can explain about 60% of its variation. To the extent that yield spreads contain non-default components such as liquidity it can be expected that the variables will explain less of their variation compared to the variation in credit default swap spreads.

7.5 Robustness of results

The robustness of the results are assessed by considering the effect of adding the credit risk measures founded on financial ratios to the model applying the inputs to a structural credit risk measure, the effect of controlling for months by adding 125 dummy variables for each, but one, month in the period and lastly, the effect of applying the model employing the inputs to a structural credit risk measure separately to each rating group.

7.5.1 Credit risk reflected in a structural model combined with and financial ratios

Appendix 7 shows the results of adding the different credit risk measures founded on financial ratios to the model considering the inputs to a structural credit risk measure.

For bonds issued by private firms, the different measures founded on financial ratios add less than 2% in explanatory power to the model, while the magnitudes of the coefficients on leverage and volatility are robust across the different specifications. Few of the financial ratios remain statistically significant, while the counterintuitive relations found in Section 7.3 remain. Furthermore, the correlation between the estimated market value leverage and the other financial ratios affects its significance, which is also evident for the subsamples of non-financial and financial firms.

For bonds issued by private non-financial firms, some of the financial ratios remain statistically significant and add explanatory power to the model. While, Altman's z"-score is no longer significant and has a much lower coefficient, the result of considering the inputs applied in the score remain the same with a change in the magnitudes of their coefficients. None of the measures applied in Kovner and Wei (2012) remain statistically significant. While the approach inspired by Moody's RiskCalc^{TM} still adds significantly to the explanatory power of the model, the relations between some of the ratios and yield spreads remain counterintuitive in terms of their expected relation to credit risk. Finally, the profitability and leverage ratio used in Blume et al. (1998) remain statistically significant with the expected signs on their coefficients, but only add little explanatory power to the model.

For bonds issued by private financial firms, the financial ratios add little explanatory power to the model. The results on the financial ratios used as inputs to the z"-score remain the same, while the measures from Kovner and Wei (2012) that are statistically significant have the unexpected signs. The relations with yield spreads for the ratios in the approach inspired by Moody's RiskCalc^{TM} are still not intuitive in terms of their expected relation to credit risk. Finally, the leverage ratio from Blume et al. (1998) is more significant than the estimated market value leverage, but the other ratios add little explanatory power to the model.

For listed firms, adding financial ratios to the model considering inputs to a structural measure of credit risk adds less than 4% in explanatory power. Most of the ratios remain statistically significant, but the significance of some of the leverage ratios is affected by their high correlation with market value leverage. Altman's z"-score is no longer statistically significant and has a much lower coefficient. In broad terms these conclusions carry over to the subsamples of non-financial

firms and financial firms. For the approach inspired by Moody's RiskCalc™ fewer of the financial measures are statistically significant and the magnitudes of their coefficients decrease.

To sum up, adding financial ratios to the model with inputs to a structural model of credit risk that provide intuitive results only results in a small improvement in the explanatory power for both bonds issued by private and listed firms, which suggests that the credit risk that they control for is already reflected in the other variables in the model.

7.5.2 The effect of controlling for months

Appendix 8 shows the results of adding 125 dummy variables for each, but one, month in the period.

The z"-score remains significant, but with a lower magnitude on its coefficient, except for financial listed firms, where it is no longer significant. For the measures applied in Kovner and Wei (2012) the magnitude and signs of some of the variables are sensitive to controlling for months for private firms, while they are robust for listed firms. With small changes in the magnitudes of the coefficients, the results on the profitability and leverage ratios from Blume et al. (1998) are robust to controlling for months. For the approach inspired by Moody's RiskCalc™ few of the ratios applied to private non-financial firms remain significant, while none of the ratios applied to private financial firms remain significant and some of the estimated coefficients change signs. The results are more robust for listed firms. For the inputs to a structural credit risk measure, the results on volatility and leverage remain significant after controlling for months for bonds issued by private non-financial firms and listed firms. For private financial firms, the significance and magnitude of the coefficient on sector volatility is sensitive to controlling for months, which might be due to it being derived from the average across the financial firms, which result in no cross-section variation in the variable that is not the case for the sector averages derived for non-financial firms.

The improvement in explanatory power of the models applying financial ratios from controlling for months is larger for bonds issued by private firms compared to bond issued by listed firms. Furthermore, within these samples the improvement is much larger for models for bonds issued by financial firms. These relations are the same for models applying the inputs to a structural measure of credit risk, but with the improvement being smaller across all the subsamples. This suggests that the inputs to a structural measure of credit risk to a larger degree reflect time-specific elements of credit risk significant for yield spreads than do financial ratios. Furthermore, the larger improvement in models considering bonds issued by financial firms might be due to these firms having more bonds per issuer or that credit risk of financial firms in general is more sensitive to time effects.

The improvement in the models suggests that the yield spreads might be further determined by time varying factors. The results of Tang and Yan (2010) that variation in macroeconomic conditions reflected in the economic growth rate, growth volatility, investor sentiment and jump risk explain 6% of the variation in credit default swap spreads supports this observation and suggests further improvements to the model.

7.5.3 The significance of credit risk reflected in a structural model for each rating group

Applying the inputs to a structural credit risk measure in a model for yield spreads of bonds in different rating groups provides further insights to the significance of credit risk for yield spreads. The results are displayed in Table 17.

Table 17. The significance of inputs to a structural credit risk measure for yield spreads of bonds in different rating groups

Bonds issued by private firms												
	All				*Non-financial*				*Financial*			
	AAA&AA	A	BBB	HY	AAA&AA	A	BBB	HY	AAA&AA	A	BBB	HY
Intercept	227,52**	-182,53***	320.34	-792,18***	96,41***	-219,18***	219.92	-640,59***	383,05*	-129.06	533.54	-361,49*
	(108,22)	(48,82)	(501,08)	(203,9)	(30,02)	(83,85)	(355,78)	(138,53)	(217,64)	(112,33)	(682,68)	(206,59)
Time to Maturity (Years)	-1.47	-1.55	-7.35	-0.88	-6.03	-2.31	-0.31	-8.66	0.64	-0.72	-100,28***	-12.96
	(2,13)	(2,3)	(6,55)	(8,13)	(5,75)	(3,34)	(2,92)	(8,77)	(2,08)	(1,57)	(30,93)	(16,38)
Bond Age (Years)	-1.27	9,83***	10.77	3.63	4.32	14,92***	2.06	-15.87	1.59	3.01	-26,64***	-17,08**
	(4,87)	(2,7)	(6,62)	(6,73)	(3,16)	(2,21)	(4,06)	(18,96)	(6,05)	(5,04)	(3,69)	(8,38)
Coupon (%)	12,65**	7.00	-33.82	19.39	-20,42***	0.87	-24.83	180,86***	10.07	16,76*	57.48	1.76
	(6,48)	(4,66)	(30,83)	(15,22)	(4,47)	(3,67)	(30,54)	(59,64)	(13,04)	(9,99)	(76,45)	(10,06)
Log(Issuesize)	-11,18**	3.86	9.71	-9.26	-14,89***	5,07**	12.44	-6.91	-18,04*	-0.19	-35.42	-8.82
	(5,6)	(3,59)	(14,58)	(7,84)	(2,79)	(2,45)	(23,91)	(43,74)	(9,86)	(7,25)	(22,05)	(5,42)
Senior	-53,61**	20.98	-12.95	292,6***	-31.82	46.89	27.38	-19.01	-24.25	35.58		
	(27,58)	(20,87)	(56,81)	(96,07)	(21,25)	(61,15)	(45,07)	(107,24)	(33,47)	(28,32)		
10Y Swap Rate (%)	-37,34*	3.95	-46.72	34.35	38,33***	4.55	-41.91	-81,53***	-59,41**	3.87	-147.05	51.12
	(21,78)	(5,86)	(57,81)	(25,49)	(3,87)	(4,73)	(48,7)	(34,47)	(27,91)	(17,26)	(125,89)	(35,8)
10Y-1Y Swap Rate (%)	-29,98***	-23,11***	-190,7***	26.43	-27,47***	-24,56***	-64,12**	79,42*	-29.70	-31,12***	-280,98***	19.87
	(8,96)	(7,3)	(37,52)	(44,36)	(5,64)	(5,94)	(31,57)	(40,81)	(20,71)	(9,59)	(71,79)	(41,51)
Implicit Bid-ask Spread (bp)	0,40***	0,65***	1,14***	0,91***	0.13	0,46***	0.58	0.50	0,39**	0,88**	1,09**	0,88***
	(0,09)	(0,18)	(0,33)	(0,27)	(0,1)	(0,08)	(0,36)	(0,32)	(0,16)	(0,38)	(0,47)	(0,24)
Sector Volatility (%)	1,40***	3,21***	13,32***	12,65***	2,37***	4,61***	9,24***	1.98	1,45**	2,59**	13,33***	14,5***
	(0,5)	(1,07)	(1,55)	(2,41)	(0,67)	(1,22)	(2,86)	(2,53)	(0,5)	(1,19)	(3,34)	(2,02)
Estimated Market Value Leverage (%)	1.13	1,85***	2.95	5,48***	-0,82**	1,24***	-0.15	5,35***	0.30	1.37	11,11*	4.93
	(0,76)	(0,54)	(2,02)	(1,36)	(0,36)	(0,65)	(1,46)	(0,94)	(1,3)	(0,86)	(6,73)	(3,33)
Adjusted R^2	25.92	36.03	74.67	53.01	33.14	42.67	27.27	52.55	33.41	29.53	69.47	61.65
SER	116.43	129.88	332.67	313.76	79.37	108.76	216.63	261.28	118.16	158.53	436.91	301.69
# of Observations	1163	5706	624	552	384	3841	424	170	779	1865	200	382
# of Bonds	107	765	137	59	40	447	106	25	67	288	31	34
Bonds issued by listed firms												
	All				*Non-financial*				*Financial*			
	AAA&AA	A	BBB	HY	AAA&AA	A	BBB	HY	AAA&AA	A	BBB	HY
Intercept	129,04***	25.12	-304,72*	-382.23	46.03	-49.22	-294.90	-369.38	135,33***	63.34	22.36	1075,99***
	(46,8)	(56,84)	(171,66)	(348,59)	(61,94)	(69,58)	(226,53)	(302,88)	(49,72)	(51,72)	(192,09)	(407,66)
Time to Maturity (Years)	-0.79	-1.15	-2,33*	-5,75**	-0.32	-0.56	-1.62	-5,84**	-0.36	-1.92	-5,09**	-8.88
	(0,83)	(0,77)	(1,29)	(2,56)	(0,71)	(0,8)	(1,39)	(2,51)	(1,03)	(1,27)	(2,57)	(7,9)
Bond Age (Years)	1.21	3,93***	5,92**	-3.84	6,52***	6,80***	3.57	-4.00	1.36	3.03	6.29	-10.41
	(2,06)	(1,29)	(2,84)	(5,39)	(1,93)	(1,69)	(3,74)	(6,56)	(2,58)	(2,01)	(4,95)	(6,66)
Coupon (%)	13,20**	5.55	26,57**	70,82***	-5.96	-6.17	19.13	53,4**	14,59**	8,86*	13.21	23.08
	(5,76)	(4,08)	(13,04)	(26,98)	(5,68)	(5,76)	(13,01)	(23,56)	(6,61)	(4,67)	(16,5)	(19,13)
Log(Issuesize)	-12,41**	-13,54***	-30,19***	-43.35	-6.10	-4.51	-13.37	-23.64	-11,62**	-12,07*	-45.42	-130,12***
	(4,99)	(4,53)	(11,04)	(28,11)	(6,65)	(3,06)	(9,15)	(30,48)	(5,2)	(6,93)	(31,47)	(42,44)
Senior	-5.91	35,25***	24.20	57.09	-9.09	26,5*	9.72	35.57	1.55	32,12**	-8.24	45.37
	(7,42)	(12,83)	(40,08)	(60,93)	(21,17)	(15,74)	(54,24)	(72,91)	(8,84)	(13,31)	(44,75)	(66,41)
10Y Swap Rate (%)	-18,09***	-10,89*	15.16	-24.72	-0.31	-1.17	0.77	-29.85	-20,36***	-14,32*	9.10	-70,64***
	(5,83)	(6,56)	(11,3)	(17,59)	(5,78)	(7,82)	(16,23)	(20,54)	(6,53)	(8,15)	(12,98)	(21,8)
10Y-1Y Swap Rate (%)	-31,81***	-35,5***	-36,50***	-36,44**	-21,8***	-36,05***	46,03***	-39,73*	-33,66***	-38,01***	-46,52**	-33.64
	(4,5)	(4,58)	(8,41)	(17,18)	(4,02)	(5,71)	(9,57)	(20,54)	(5,03)	(5,84)	(18,88)	(23,87)
Implicit Bid-ask Spread (bp)	0,38***	0,61***	0,63***	1,10***	0,19***	0,44***	0,51***	1,18***	0,41***	0,67***	0,80***	0,70***
	(0,07)	(0,11)	(0,12)	(0,23)	(0,05)	(0,08)	(0,16)	(0,29)	(0,09)	(0,19)	(0,16)	(0,21)
Equity Volatility (%)	2,16***	4,75***	7,39***	9,14***	2,78***	5,22***	8,77***	9,99***	2,11***	4,76***	7,07***	8,51***
	(0,42)	(1,06)	(1,06)	(0,59)	(0,53)	(0,79)	(1,13)	(1,25)	(0,43)	(1,22)	(1,7)	(0,58)
Market Value Leverage (%)	0.26	0,57***	3,62***	4,35***	0,94*	1,65***	4,30***	4,85***	0,06***	-0.06	2.16	-0.91
	(0,21)	(0,26)	(0,86)	(1,59)	(0,49)	(0,4)	(0,88)	(1,8)	(0,32)	(0,31)	(1,39)	(1,51)
Adjusted R^2	27.35	44.92	54.36	55.55	28.37	39.23	51.43	50.24	27.98	47.57	59.89	79.85
SER	116.77	181.06	266.41	394.31	94.83	142.59	241.42	396.35	120.1	200	311.61	330.45
# of Observations	16868	21167	12145	6809	2942	8352	8776	5896	13926	12815	3369	913
# of Bonds	1604	2357	1213	459	287	950	838	358	1317	1407	375	101

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

The adjusted-R^2 of the models is inversely related to the credit quality of the bonds considered implying that credit risk reflected in a structural model has more power for yield spreads of lower rated bonds. On the other hand, the models considering higher rated bonds have a lower SER implying a superior fit of these models. This is evident both for the samples of private and listed firms.

For private firms, the coefficients on sector volatility and estimated market value leverage are inversely related to the credit quality of their bonds, implying that an increase in one of the variables, ceteris paribus, will result in a larger increase in yield spreads of lower rated bonds than for bonds with a higher rating. This result also applies to the equity volatility and market value leverage of listed firms and the subsample of listed non-financial firms. The results for bonds issued by private non-financial firms are not robust to dividing the sample into rating groups with some of the coefficients on leverage being negative, not statistically significant and of smaller magnitude and with sector volatility not being statistically significant for speculative grade bonds. For bonds issued by private financial firms, the results of the model for all private firms apply with the difference that leverage is only statistically significant for bonds with a BBB-rating, for which the coefficient on leverage is also larger than for speculative grade bonds. Finally, for bonds issued by listed financial firms, the results of the overall model for listed firms apply to equity volatility, but for market value leverage, the magnitude and sign of its coefficient and its significance for yield spreads vary across rating groups.

While the significance and the sign of the estimated coefficient of the 10-year swap rate vary across the groups, the sign is negative in accordance with expectations, when the variable is statistically significant.

The larger estimated coefficients on the variables together with the higher adjusted-R^2 for the models of lower rated bonds indicate that credit risk is more significant for the determination of yield spreads of these bonds. This conclusion is also made by Longstaff et al. (2005), who finds that the default component represents 51% of the corporate spread of AAA/AA rated bonds, 56% for A- rated bonds, 71% for BBB-rated bonds and 83% for BB-rated bonds. Furthermore, Ericsson et al. (2009) find that the inputs to the structural model of credit default risk accounts for 65.5% of variation in credit default swap spreads for lower rated bonds and 57.3% for higher rated bonds.

7.6 The significance of the applied control variables

7.6.1 Bond characteristics

In the majority of the models, time to maturity is not statistically significant for yield spreads and its estimated coefficient is negative implying that a longer maturity is associated with lower yield spreads. This is not in accordance with the expectation that a longer maturity is connected to higher yield spreads as the bond is exposed to interest rate and credit risk for longer.

For bonds issued by private and financial firms, the coefficient on bond age is positive in most of the model specifications implying that the expected relation that bonds become less liquid as they become part of investors' buy-and-hold strategies and require a premium for illiquidity holds. However, the statistical significance of the variable varies across the specifications and for bonds issued by listed firms the estimated coefficient on bond age is negative, which is counterintuitive.

The estimated coefficient on the coupon rate is positive which is in accordance with the existence of a tax premium as a larger share of the cash flow to investors during the life of the bond is taxed for higher coupon bonds. It is statistically significant in the majority of the specifications for bonds issued by listed firms, but less consistently so for bonds issued by private firms.

For bonds issued by private firms, the estimated coefficients on the log of issue size of the bond are positive and not statistically significant in the majority of the specifications. This is not in accordance with the expectation that a larger issue size means that the bond is more available on the market, less liquid and will have lower yield spreads. For bonds issued by listed firms, the significance of the log of issue size varies, but it is statistically significant in several of the specifications with a negative coefficient. Thus, a larger issue size is connected to lower yield spreads for bonds issued by listed firms. An explanation for the changing significance might be that the variable is not a good proxy and that the amount outstanding might be a better indicator of the availability of the bond in the market.

In the majority of the specifications, the estimated coefficient on the senior dummy variable is positive. This is counterintuitive as investors are more protected when investing in senior bonds compared to subordinated bonds. However, as most of the bonds in the sample are senior bonds, the dummy variable might not capture the expected relation between subordination and yield spreads.

For most of the variables, their magnitude and significance for yield spreads vary across the model specifications and the subsamples, implying that they are not robust determinants for yield spreads.

7.6.2 Market conditions

While the estimated coefficient on the 10-year swap rate is negative in most of the model specifications, the degree of its statistical significance for yield spreads vary. The slope of the swap rate curve has a negative coefficient and is statistically significant in more of the specifications than the 10-year swap rate. Negative coefficients on both variables is in accordance with the expectation that a higher risk free rate through the decreasing effect it has on credit risk via asset drift in a structural model should be associated with a discount in yield spreads.

7.7 The significance of liquidity and the size of the liquidity component

The implicit bid-ask spread is statistically significant at a 1% significance level for yield spreads of bonds issued by private and listed firms and has a positive coefficient. This implies that there is a significant premium for illiquidity in corporate bond yield spreads. While bond age and the log of issue size are also considered to proxy for the liquidity of the bond, the interpretation of their estimated coefficients across the groups is not intuitive. Thus, when estimating the liquidity component the focus will be on the implicit bid-ask spread. It should be noted that other factors could be relevant and that the actual liquidity component might be larger than estimated. In the following, liquidity will be discussed in the context of the model controlling for credit risk reflected in a structural model using sector values for private firms and publicly traded data for listed firms.

The median implicit bid-ask spread is lower, while its estimated coefficient is higher, for bonds issued by private firms than for bonds issued by listed firms. For private firms, both the median implicit bid-ask spread and its estimated coefficient is lower for bonds issued by non-financial firms than for bonds issued by financial firms. This indicates that the liquidity premium for bonds issued by private non-financial firms is lower than that of bonds issued by private financial firms. For listed firms, however, the median implicit bid-ask spread is higher, while its estimated coefficient is lower for bonds issued by non-financial firms than for bonds issued by financial firms. However, these relations might be due to differences in credit quality of the issuers, maturities of the bonds and the observation months.

To investigate the relations further the liquidity component in basis points for the groups are calculated following the methodology applied in Dick-Nielsen et al. (2012). The liquidity score is calculated as $\beta^{RF} * \lambda_{it}$, where β is the coefficient on the implicit bid-ask spread from the regressions for each rating group in Section 7.5.3, R is the rating group (AAA&AA, A, BBB, Speculative grade), F is the firm group (listed/private, non-financial/financial), λ is the implicit bid-ask spread, i is the bond and t is the observation month. Within each rating group and maturity bucket (0-2years, 2-5years, 5-30years) the liquidity score is sorted in increasing value and the liquidity component is then defined as $\beta(\lambda^{50} - \lambda^{5})$, where λ^{50} and λ^{5} are the 50th percentile and the 5th percentile of the liquidity score, respectively. The liquidity component thus expresses the difference in yield spreads of a median liquid bond and a very liquid bond. The results for each firm group for the whole period are displayed in Table 18.

Table 18. The liquidity component in basis points

Bonds issued by private firms												
	All				Non financial				Financial			
	All	0-2 years	2-5 years	5-30 years	All	0-2 years	2-5 years	5-30 years	All	0-2 years	2-5 years	5-30 years
AAA	5.99	2.82	6.74	13.33	1.38	0.83	1.65	5.76	7.13	2.62	5.20	18.11
Observations	1164	373	444	347	385	201	148	36	779	172	296	311
A	16.26	11.33	17.88	31.53	10.23	6.60	11.34	19.73	27.87	12.61	21.66	37.69
Observations	5718	2600	2198	920	3841	1706	1535	600	1877	894	663	320
BBB	70.33	44.86	110.73	66.69	24.82	12.95	38.67	31.59	101.22	24.28	72.52	59.25
Observations	624	271	241	112	424	177	142	105	200	94	99	7
SPEC	37.33	41.82	40.79	26.59	24.84	21.14	27.52	21.71	33.86	37.36	48.65	38.37
Observations	592	194	256	142	210	74	65	71	382	120	191	71
Bonds issued by listed firms												
	All				Non financial				Financial			
	All	0-2 years	2-5 years	5-30 years	All	0-2 years	2-5 years	5-30 years	All	0-2 years	2-5 years	5-30 years
AAA	7.42	3.30	8.28	17.21	4.04	1.67	4.79	9.45	7.83	3.51	8.75	17.98
Observations	16949	6898	5817	4234	1183	848	990	3021	13928	5715	4969	3244
A	17.04	7.39	17.88	30.84	12.68	5.10	12.41	25.74	18.41	8.27	19.96	29.08
Observations	21291	7649	6390	7252	3021	2141	3306	8468	12823	4628	4249	3946
BBB	20.19	8.50	18.23	32.23	14.21	5.53	12.39	25.46	34.20	22.83	32.68	41.03
Observations	12375	3493	3442	5440	2640	2326	4017	8983	3392	853	1116	1423
SPEC	48.21	28.65	50.76	51.51	47.33	29.27	50.66	54.54	41.72	39.99	53.24	36.93
Observations	7261	1901	2137	3223	1669	1929	2750	6348	913	232	208	473

For bonds issued by private firms, it is evident that the liquidity component is increasing with maturity and decreasing with credit quality for bonds with an AAA/AA or A-rating and for shorter maturities of BBB-rated bonds. However, the results for speculative grade bonds and lower rated bonds with a 5-30-year maturity are unexpectedly lower. These results are most likely due to the thin samples of these groups and thus, a less reliable estimated coefficient. This explanation is motivated by the SER for the models of BBB-rated and speculative grade bonds being at least double of the SER for the models of AAA/AA and A-rated bonds. Thus, the results are most reliable for higher rated bonds. Furthermore, it is evident that the liquidity component of bonds issued by non-financial firms is consistently lower than for bonds issued by financial firms.

For listed firms, it is evident that the liquidity component is increasing with maturity and decreasing with credit quality for all bonds. The observation that the liquidity component is lower for financial bonds than non-financial bonds is also evident for bonds issued by listed firms. Comparing bonds issued by private firms to those issued by listed firms, there is no clear conclusion in terms of the differences in their liquidity components. However, there is a trend that the liquidity component of bonds issued by private firms is lower than for bonds issued by listed firms for the higher rated bonds and the reverse for lower rated bonds.

The result of repeating the estimation separately for the period before and after the latest US recession can be found in Appendix 9. While there is a trend of higher liquidity components after the recession, there are no clear conclusions to be drawn. This is likely due to the sample groups becoming even smaller and thus, the models are less reliable, which is especially evident for private firms. Furthermore, the periods considered are likely too long to conclude on the effect of the recession on the liquidity component as the higher values from the recession period are likely averaged out by observations from later years. In order to make reliable conclusions for shorter periods, more data is needed.

Dick-Nielsen et al. (2012) estimate the average liquidity component for speculative grade bonds to be 57.6 for 2005:Q1 to 2007:Q1 and 198.8bp for 2007:Q2 to 2009:Q2, where the liquidity component of an A-rated bond increased to 50.7bp, indicating a significant increase in the liquidity premium during the US subprime crisis. For listed firms, this study finds a liquidity component of 51.8bp for speculative grade bonds in the period July 2002 to December 2007 and a liquidity component of 35.72b for the period January 2008 to December 2012. The difference in these results is likely due to the different periods considered and the smaller sample for the latter period, which is likely connected to the data requirements for the implicit bid-ask spreads biasing the sample towards more liquid bonds.

To sum up, there is a significant liquidity premium in corporate bond yield spreads. For private firms, however, there is not enough data to make reliable estimates of the liquidity component of lower rated bonds, while there for higher rated bonds is a clear trend in a larger liquidity component in yield spreads of bonds issued by financial firms. Considering the credit quality and maturity buckets of the bonds, there is no clear conclusion in terms of differences in the liquidity component for bonds issued by private and listed firms. However, for listed firms, it is evident that the liquidity component is increasing with maturity and decreasing with credit quality for all bonds. As a last note,

the results are affected by the length of the period considered and the smaller sample for the last half of the period.

8 Conclusion

This study finds that the implicit bid-ask spread, sector volatility and leverage are statistically significant for yield spreads of bonds issued by private firms and that this model provides a superior fit in terms of a lower SER compared to the regressions applying financial ratios to control for credit risk. The conclusion is robust to controlling for rating and time-fixed effects reflected in 125 month dummy variables. Together with the control variables for liquidity and credit risk reflected in bond specific characteristics and market conditions, these variables explain 40.7% of the variation in yield spreads of bonds issued by private firms. Furthermore, the model provides an intuitive interpretation with higher volatility and leverage demanding a premium and a higher 10-year swap rate being associated with a discount in most of the specifications as in accordance with the variables' expected relation with a structural measure of credit risk.

For listed firms, the specifications using sector values lead to a slightly smaller increase in the explanatory power of the model with control variables, which suggest that yield spreads of bonds issued by private firms to a higher degree are affected by sector valuations. The use of publicly traded data add up to over 30% to the adjusted-R^2 of the model with control variables for listed firms and the fit of the model is clearly improved over the models applying financial ratios to control for credit risk. This is in accordance with the conclusion of Campbell and Taksler (2003) and implies that publicly traded data is highly significant for the yield spreads of bonds issued by listed firms and that it provides superior explanatory power over the data available for private firms.

Furthermore, it is clear that the application of each credit risk measure founded on financial ratios applicable to private firms has different implications for assessing the yield spreads of bonds issued by private and listed firms. The differing results suggest that the firms might be fundamentally different and that their credit risk accordingly is valued differently, which suggest that benchmarking private firms to public firms in valuing their bonds could possible lead to erroneous results. Overall it seems that the estimated models that provide intuitive interpretations have the most explanatory power for bonds issued by listed firms, while the models for private firms with the most explanatory power do not provide intuitive results in terms of how the financial measures are expected to be related with credit risk. For private firms, the z''-score and the profitability and leverage ratios used in Blume et al (1998) are statistically significant with the expected relation to yield spreads, but only

leads to a small increase in the explanatory power of the model with control variables. For the financial measures applied in Kovner and Wei (2012), the expected relations with yield spreads are not evident for all inputs for private firms and they do not add much explanatory power beyond the control variables. On the other hand, the measures that are used as inputs to the z''-score and the approach inspired by Moody's RiskCalc have explanatory power similar to or beyond ratings for private firms, except for the subsample of financial firms, but their expected relations with yield spreads are not evident for all measures. Furthermore, adding the financial ratios to the model with inputs to a structural credit risk measure that provide intuitive results only results in a small improvement in the explanatory power for both bonds issued by private and listed firms, which suggests that the credit risk that they control for is already reflected in the other variables. Furthermore, the improvement in explanatory power of the models applying financial ratios from controlling for months is larger, while the robustness of the financial variables are weaker for bonds issued by private firms compared to bond issued by listed firms. This conclusion further carries over to financial bonds versus non-financial bonds within these samples. These relations are the same for models applying the inputs to a structural measure of credit risk, but with the improvement being smaller across all the subsamples. This suggests that the inputs to a structural measure of credit risk to a larger degree reflect time-specific elements of credit risk significant for yield spreads than do financial ratios.

Separating the sample into rating groups, the larger estimated coefficients on the variables together with the higher adjusted-R^2 for the models of lower rated bonds indicate that credit risk is more significant for the determination of yield spreads of these bonds. This is in accordance with the conclusions of Longstaff et al. (2005) and Ericsson et al. (2009).

Separating the sample in to financial and non-financial bonds improves the fit of the models in the majority of the specifications with the change in the estimated coefficients and the statistical significance of the variables indicating that the bonds are valued differently in terms of the credit risk and liquidity premium.

While this study finds that there is a statistically significant liquidity premium stemming from variance in the implicit bid-ask spread, there are no clear indications in terms of the difference in the liquidity component for private and listed firms. There is however, a clear trend in the liquidity component being larger for financial bonds than non-financial bonds. The results on the liquidity premium are affected by the sample for bonds issued by private firms being smaller, as separating it into bonds in different rating groups and maturity buckets do not provide enough observations for all

groups to make reliable conclusions. Furthermore, the higher liquidity premium during the US subprime crisis likely affects the size of the liquidity premiums found. The sample is thinner later in the sample period, which might be due to fewer observations during the US recession and its effect on liquidity.

8.1 Conclusion on limitations and assumptions

The study is most valid for relatively more liquid non-defaulted fixed coupon bullet bonds denominated in USD with a maturity of less than 30 years and more than a month traded in the US between July 1 2002 and December 31 2012 issuers that are more transparent.

The weaker explanatory power of the financial ratios is likely due to the infrequency and lag of the publishing of financial statements, while publicly traded data and the sector values derived from it are available at all times and thus, reflect changes in valuations much faster. Furthermore, for private firms and especially financial firms the higher number of bonds per issuer might explain the inferior performance of the financial ratios in en explaining variation in yield spreads as there will be less cross-section variation in the variables.

While the results of applying the financial ratios to listed firms are more intuitive in terms of their effect on credit risk, the results on private firms might be due to errors. If the issuer connected to the bond is not the same as the one investors base their fundamental analysis on, this could explain some of the peculiar relations found for private firms. This source of error will not affect the approach of using average sector values and thus, might explain why they provide more intuitive results for private firms. The error might further explain why controlling for ratings and time effects leads to a relatively larger increase in explanatory power for bonds issued by private firms as these variables are not affected by the issuer connected to the final bond. However, this result might also indicate that the valuation of private bonds to a larger degree depends on ratings and time varying effects, which are more accessible than firm-specific data for private firms.

8.2 Recommendations for further research

The large increase in the explanatory power from adding month dummy variables for private firms, might suggest that the valuation of their bonds to a larger degree is affected by macro economic conditions, which could be a topic for further research. If this was the sole focus of a study, one would avoid making the possible errors in connecting the bond to the issuer, whose credit risk is valued in the yield spreads of the bonds.

Another improvement to the model can likely be found in using better proxies for sector valuations. As the sector values used in this study are derived from the listed firms in the sample, the results of the study rely on the relation between the listed firms and private firms included. Using industry values instead of sector values might further improve the results, but a larger dataset is needed to make reliable industry estimates. An alternative approach would be to use industry indices available or construct them from firms relevant for the analysis. The power of adding industry data, when assessing the credit risk of private firms, is also motivated in the Moody's RiskCalc^{TM} models and Altman et al. (2011).

Another approach would be to collaborate with rating agencies or banks, which have more extensive databases on private firms and knowledge of the ownership status of the issuers. Another aspect of such collaboration could be to investigate their qualitative valuations of the bonds and the degree to which they affect quantitative valuations, similar to the approach of Blochwitz et al. (2000) that investigate the power of credit risk models and conclude that adding a qualitative scoring system to the quantitative models improves their power.

9 Bibliography

Akhavein, Jalal, Bohn, Jeff, Kocagil, Ahmet E. and Roger M. Stein, and. "Systematic And Idiosyncratic Risk In Middle-Market Default Prediction: A Study of The Performance of The RiskCalc™ and PFM™ Models." Moody's Investors Service (February, 2003)

Altman, Edward I. "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy." *The Journal of Finance* XXIII, no. 4 (1968): 589–609.

Altman, Edward I. "Predicting Financial Distress of Companies: Revisiting the Z-score and Zeta® Models." Working Paper, Stern School of Business, New York University. (2000)

Altman, Edward I, Neil Fargher, and Egon Kalotay. "A Simple Empirical Model of Equity-Implied Probabilities of Default." *The Journal of Fixed Income* 20, no. 3 (2011): 71-85.

Amihud, Yakov. "Illiquidity and stock returns: cross-section and timeseries effects." *Journal of Financial Markets* 5, no. 1 (2002): 31–56.

Bao, Jack, Pan, Jun, and Jiang Wang. "The illiquidity of corporate bonds." *Journal of Finance* 66, no.3 (2011): 911–946

Black, Fisher and Myron Scholes. "The Pricing of Options and Corporate Liabilities." *The Journal of Political Economy* 81, no. 3 (1973): 637-654

Blume, Marshall E., Lim, Felix and A. Craig MacKinlay. "The declining credit quality of U.S. corporate debt: Myth or reality?" *Journal of Finance* 53, no. 4 (1998): 1389–1401

Blochwitz, Stefan, Liebig, Thilo and Mikael Nyberg. "Benchmarking Deutsche Bundesbank's Default Risk Model, the KMV® Private Firm Model® and Common Financial Ratios for German Corporations." Workshop on Applied Banking Research, Basel Committee on Banking Supervision, https://www.bis.org/bcbs/events/oslo/liebigblo.pdf (Last accessed July 29th 2015) (2000)

Boral, Andrew, Carty, Lea V. and Eric Falkenstein. "RiskCalc™ for Private Companies: Moody's Default Model." Moody's Investors Service (May, 2000)

Bharath, Sreedhar T and Tyler Shumway. "Forecasting Default with the KMV-Merton Model" AFA 2006 Boston Meetings Paper (December 17, 2004).

Bohn, Jeff, and Peter Crosbie. "Modeling Default Risk." Moody's KMV (2003).

Butera, Giovanni and Robert Faff. "An Integrated Multi-model Credit Rating System for Private Firms." *Review of Quantitative Finance and Accounting* 27 (2006): 311-340.

Campbell, John Y, and Glen B Taksler. "Equity Volatility and Corporate Bond Yields." *The Journal of Finance* LVIII, no. 6 (2003): 2321–2349.

Chen, Long, Lesmond, David A. and Jason Wei. "Corporate yield spreads and bond liquidity." *Journal of Finance* 62, no.1 (2007):119–149.

Collin-Dufresne, Pierre, Goldstein, Robert S and J Spencer Martin. "The Determinants of Credit Spread Changes." *The Journal of Finance* LVI, no. 6 (2001): 2177–2207.

Dick-Nielsen, Jens. "Liquidity Biases in TRACE." *Journal of Fixed Income* 19, no.2 (2009): 43-55.

Dick-Nielsen, Jens, Peter Feldhütter, and David Lando. "Corporate Bond Liquidity Before and After the Onset of the Subprime Crisis." *Journal of Financial Economics* 103 (March 2012): 471–492.

Dick-Nielsen, Jens. "How to Clean Enhanced TRACE Data." Working Paper, Copenhagen Business School (2014)

Elton, Edwin J, Gruber, Martin J., Agrawal, Deepak and Christopher Mann. "Explaining the Rate Spread on Corporate Bonds." *The Journal of Finance* LVI, no. 1 (2001): 247–277.

Ericsson, Jan and Olivier Renault. "Liquidity and credit risk." *Journal of Finance* 61, no.5 (2006): 2219–2250

Ericsson, Jan, Jacobs, Kris and Rodolfo Oviedo. "The Determinants of Credit Default Swap Premia." *Journal of Financial and Quantitative Analysis* 44, no. 1 (April 21, 2009): 109–132.

Feldhütter, Peter, Hotchkiss, Edith and Oğuzhan Karakaş. "Value of Creditor Control in Corporate Bonds." *Journal of Financial Economics*, Forthcoming (2015).

FINRA. "FINRA Brings 144A Corporate Debt Transactions Into the Light." https://www.finra.org/newsroom/2014/finra-brings-144a-corporate-debt-transactions-light (Last accessed July 29, 2015) (June 30, 2014a)

FINRA. " TRACE: The Source for Real-Time Market Transaction Data" https://www.finra.org/sites/default/files/AppSupportDoc/p014320.pdf (Last accessed July 29th 2015) (June, 2014b)

Dwyer, Douglas W., Irina Korablev, Uliana Makarov, Xiaoyun Wang, Andrew Zhang and Yinqing Zhao. "Moody's Analytics RiskCalc™ 4.0 U.S." Moody's Analytics (July 16, 2012)

Dwyer, Douglas W. and Janet Y. Zhao. "Moody's KMV RiskCalc™ V3.1 North America Large Firm Model." Moody's KMV (2009)

Dwyer, Douglas W., Kocagil, Ahmet E and Roger M. Stein. "Moody's KMV RiskCalc™ v3.1 Model." Moody's KMV (2004).

Hayes, Suzanne K., Hodge, Kay A. and Larry W. Hughes. "A Study of The Efficacy of Altman's Z to Predict Bankruptcy of Specialty Retail Firms Doing Business in Contemporary Times." *Economics*

and Business Journal: Inquires and Perspectives 3, no.1 (2010): 122-134.

Huang, Jing-Zhi, and Ming Huang. "How much of Corporate-Treasury Yield Spread Is Due to Credit Risk?" *Review of Asset Pricing Studies* 2, no.2 (2012): 153-202.

Jessen, Cathrine and David Lando. "Robustness of Distance-to-default" *Journal of Banking and Finance* 50, no.1 (2015): 493-505

Kovner, Anna and Jason Wei. "The Private Premium in Public Bonds." *Federal Reserve Bank of New York Staff Reports* no. 553 (2012).

Lesmond, David A., Ogden, Joseph P. and Charles A. Trzcinka, "A new estimate of transaction costs." *Review of Financial Studies* 12, no. 5 (1999): 1113–1141.

Livingston, Miles and Lei Zhou. "The Impact of Rule 144A Debt Offerings Upon Bond Yields and Underwriter Fees." *Financial Management* 31, no. 4 (2002): 5-27.

Longstaff, Francis A., Neis, Eric and Sanjay Mithal. "Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit-Default Swap Market." *Journal of Finance* 60 (2005): 2213-2253.

Merton, Robert C. "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates." *The Journal of Finance* 29, no. 2 (May 30, 1974): 449–470.

Oderda, Gianluca, Dacorogna, Michel M. and Tobias Jung. "Credit risk Models – Do they Deliver Their Promises? A Quantitative Assessment." *Economic Notes by Banca Monte dei Paschi di Siena SpA* 32, no. 2 (2003): 177-195

Petersen, Mitchell A. "Estimating Standard Errors in Panel Data Sets." *Review of Financial Studies* 22, no.1 (2009): 425-480.

"Ratings Policy and Approach." *Moody's.* https://www.moodys.com/Pages/amr002003.aspx (Last accessed July 29, 2015)

"RiskCalc™ Plus US Banks 4.0." *Moody's Analytics* http://www.moodysanalytics.com/~/media/Brochures/Enterprise-Risk-Solutions/RiskCalc/RiskCalc-US-Banks-4-Fact-Sheet.pdf (Last accessed July 29, 2015) (2013)

Roll, Richard. "A simple implicit measure of the effective bid–ask spread in an efficient market." *Journal of Finance* 39, no. 4 (1984):1127–1139.

Rossi, Marco. "Realized Volatility, Liquidity and Corporate Yield Spreads." *Quarterly Journal of Finance* 4, no. 1 (2014): 1-42.

Sarig, Oded and Arthur Warga. "Bond price data and bond market liquidity." *Journal of Financial and Quantitative Analysis* 24, no. 3 (1989): 367–378.

Stock, James H., and Mark W. Watson. *Introduction to Econometrics*. Boston: Pearson Eduction, 2011.

Tang, Dragon Yongjun and Hong Yan. "Market Conditions, Default Risk and Credit Spreads." *Journal of Banking & Finance* 34 (April 2010): 743–753.

Thompson, Samuel B. "Simple Formulas for standard errors that cluster by both firm and time". *Journal of Financial Economics* 99, no.1 (2011): 1-10

10 Appendices

1 Appendix: 1 Measures of statistical significance and explanatory power

The statistical significance of each variable included in the regressions is assessed through the t-test, which tests whether the coefficient beta is significantly different from zero. The t-statistic is calculated as the estimated coefficient beta divided by the standard error of beta (Stock & Watson, (2011): 216). The critical values for rejecting the hypothesis and concluding that the estimated coefficient beta is statistically significantly different from zero at a 1%, 5% and 10% significance level and thus significant for the dependent variable are the absolute values of 2.53, 1.96 and 1.65, respectively.

The adjusted-R^2 and the standard error of the regression (SER) are used to determine the fit of the regression models in explaining variation in yield spreads. R^2 measures the share of variation of the dependent variable in the dataset explained by the independent variables, while the adjusted-R^2 measures the same, but includes an adjustment for the number of explanatory variables. While R^2 increases with the number of explanatory variables added to the regression, this is not necessarily true for the adjusted-R^2, which is thus, better to use when assessing regressions with a different number of explanatory variables. SER is an estimate of the standard deviation of the error term and thus measures the proliferation of the observations around the regressions line, which means that a low SER indicates a good fit of the regression in explaining variation in yield spreads (Stock & Watson, (2011): 193-195).

2 Appendix 2: Use of operating income instead of EBIT and EBITDA

2.1 Altman's z''-score: productivity

Operating income is used instead of EBIT, which was not available for the last trailing 12 months through Bloomberg. While the trailing 12 months EBITDA was also considered, it was not available for 28.5% of the observations and for the observations where it was available, the correlation between the two ratios was 92%, the estimated magnitudes of their coefficients were similar and the fit of the model only slightly improved when using EBITDA, which motivates the use of operating income as it covers the whole sample. The use of EBITDA would bias the result to the extent that the firms' depreciation and amortization expenses relative to total assets differ significantly and to the extent that EBIT is the variable to include in a ratio for productivity that optimally reflects credit risk. While EBIT is not a GAAP measure, it is similar to operating income in that they both reflect the earnings of the firm excluding interest and tax expenses, but they might differ slightly in terms of allowances

and adjustments made in calculating earnings. However, as long as the use of operating income will still lead to the same ranking of the firms in terms of productivity, this should not have a significant effect on the results.

2.2 Kovner and Wei's (2012) measure for profitability

As trailing 12 months EBITDA is not available for the whole dataset, the trailing 12 months operating income is used instead. Thus, the profitability ratio is the same as the productivity ratio applied in Altman's z''-score. The use of operating income will bias the result to the extent that the firms' depreciation and amortization expenses relative to total assets differs significantly and to the extent that the use of EBITDA better reflects profitability significant for assessing credit risk reflected in yield spreads.

3 Appendix 3: Use of infrequent accounting information

If quarterly information is not available, semi-annual or yearly data is used throughout the period it covers. This can be criticized as it makes the analysis more static and as it is implicitly assumed that the investors' expectations for the information reflected in a firm's financial statements are not reflected in the pricing of its bond. This is an extreme assumption. However, adjusting for this problem can be problematic as well. The optimal solution would be access to consensus estimates of financial statement entries for all the firms at all data points. For listed firms, both summary and individual analyst forecasts of company earnings, cash flows, and other important financial items can be obtained via Thomson Reuters I/B/E/S, however, as it is not available for private firms, this study will restrict itself to use accounting data directly from the firm's financial statements. Another approach could be to linearly interpolate the value of the financial statement entries between the periods. This however, implies that the entries develop linearly over the period and that investors would correctly infer this, when valuing the bond. To avoid making those assumptions, this study takes the simple approach of using the last available financial statements at each observation date and thus does not directly adjust for investor expectations for the information reflected in the financial statements of the firm.

4 Appendix 4: Dealing with outliers

4.1 Yield spreads

The distribution of yield spreads for the whole sample has a skewness of 110.96 and a kurtosis of 15959.09 implying that there are significant outliers. To deal with these, the yield spread observations for the overall sample are winzorised at the 0.5th percentile at -29bp and at the 99.5th percentile at 3299bp. The result is a distribution with a skewness of 5.13 and a kurtosis of 34.34.

4.2 Implicit bid-ask spreads

The distribution of implicit bid-ask spreads for the whole sample has skewness of 69.93 and a kurtosis of 6003.73 implying that there are significant outliers. To deal with these, the implicit bid-ask spreads of the overall sample are winzorised at the 99.5th percentile at 577bp, while its lower bound is zero by construction of the dataset. The result is a distribution with skewness of 3.12 and a kurtosis of 12.3.

4.3 Inputs to Altman's z''-score

In applying Altman's z''-score, observations with book value of equity to total liabilities higher than the 99th percentile at 159% are deleted as the distribution of the ratio for the whole sample has a skewness of 41.32 and a kurtosis of 2758.77, implying that there are some significant outliers. The smaller sample has a distribution of the ratio with a skewness of 1.43 and a kurtosis of 1.77.

4.4 Inputs to Blume et al (1998)

In applying the proxies for credit risk used in Blume et al (1998), observations where operating income to sales is lower than the 0.5th percentile at -39.72% and higher than the 99.5th percentile at 90.69% are deleted as the distribution of the ratio for the whole sample has a skewness of -64.28 and a kurtosis of 9773.70 implying the existence of extreme outliers. The smaller sample has a distribution of the ratio with a skewness of -0.03 and a kurtosis of 3.15. Furthermore, some of the distributions of the dummy variables for interest coverage have extreme kurtosis, however, the outliers are kept, motivated by their categorical nature.

4.5 Inputs to approach inspired by Moody's

4.5.1 Private non-financial firms

Observations for which sales are above $300.000m are deleted, as the original distribution had a kurtosis of 780.37 and a skewness of 18.57 implying the existence of extreme outliers. Furthermore, observations where sales growth is above 100% are deleted as the original distribution had a kurtosis of 153.29 and a skewness of 9.37 implying the existence of significant outliers. This results in 0.25% of the observations being excluded from the analysis

4.5.2 Private financial firms

Observations for which the ratio of 1 to sales is above 0.04375 are deleted, as the original distribution had a kurtosis of 1385.71 and a skewness of 35.8 implying the existence of extreme outliers. Furthermore, observations where 1 to total liabilities to total assets is above 2 are deleted as the original distribution had a kurtosis of 320.22 and a skewness of 17.1 implying the existence of significant outliers. This results in 0.61% of the observations being excluded from the analysis.

4.5.3 Listed non-financial firms

Observations where sales growth is above 150% are deleted as the original distribution had a kurtosis of 6248.35 and a skewness of 52.72 implying the existence of significant outliers. Furthermore, observations where long-term debt to total assets is below 0 or above 2 are removed as the original distribution had a kurtosis of 1552.78 and a skewness of 37.38 implying the existence of significant outliers. This results in 1.5% of the observations being excluded from the analysis

4.5.4 Listed financial firms

Observations where sales growth is below -100% and above 150% are removed, as the original distribution had a kurtosis of 805.98 and a skewness of 25.8 implying the existence of significant outliers. This results in 0.43% of the observations being excluded from the analysis.

4.6 Inputs to a structural measure of credit risk

In applying the inputs of a structural model to control for credit risk observations with an estimated market value leverage below the 0.5^{th} percentile at 1.2% and above the 99.5^{th} percentile at 134.57% are deleted as the distribution for the whole sample has a skewness of 169.31 and a kurtosis of 39149.41, which implies that there are significant outliers. The new smaller sample has a distribution with a skewness of 0.06 and a kurtosis of 0.22.

5 Appendix 5: Correlation matrices

5.1 Subsamples with working capital entries available

Correlation Matrix: Bonds issued by private firms with working capital entries available

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Working Capital/ Total Assets	Retained Earnings/T otal Assets	Operating Income/Tot al Assets	Book Equity/Tot al Liabilities	Z''-score
Yield Spread	1.00	0.15	0.13	0.13	0.12	0.13	0.36	-0.10	0.06	0.46	-0.64	0.22	-0.51	-0.35
Maturity	0.15	1.00	0.37	0.35	-0.05	0.18	0.17	-0.20	-0.11	0.04	-0.15	-0.10	0.04	-0.13
Bond Age	0.13	0.37	1.00	0.60	-0.05	-0.04	0.01	-0.43	-0.20	-0.07	0.06	-0.16	0.20	0.02
Coupon	0.13	0.35	0.60	1.00	-0.04	0.06	0.07	-0.18	-0.06	0.11	-0.02	-0.15	0.04	0.02
Log(issue)	0.12	-0.05	-0.05	-0.04	1.00	0.31	-0.01	-0.12	-0.06	0.26	-0.13	0.06	-0.11	0.06
SENIOR	0.13	0.18	-0.04	0.06	0.31	1.00	0.05	-0.17	-0.19	0.32	0.00	-0.05	-0.03	0.21
BID-ASK	0.36	0.17	0.01	0.07	-0.01	0.05	1.00	-0.08	0.15	0.15	-0.19	0.14	-0.20	-0.08
10Y Swap	-0.10	-0.20	-0.43	-0.18	-0.12	-0.17	-0.08	1.00	-0.17	0.06	-0.10	0.12	-0.20	-0.07
Swap Slope	0.06	-0.11	-0.20	-0.06	-0.06	-0.19	0.15	-0.17	1.00	-0.16	0.05	0.22	0.02	0.02
Working Capital/ Total Assets	0.46	0.04	-0.07	0.11	0.26	0.32	0.15	0.06	-0.16	1.00	-0.61	0.03	-0.55	-0.01
Retained Earnings/Total Assets	-0.64	-0.15	0.06	-0.02	-0.13	0.00	-0.19	-0.10	0.05	-0.61	1.00	-0.18	0.79	0.71
Operating Income/Total Assets	0.22	-0.10	-0.16	-0.15	0.06	-0.05	0.14	0.12	0.22	0.03	-0.18	1.00	-0.20	0.20
Book Equity/Total Liabilities	-0.51	0.04	0.20	0.04	-0.11	-0.03	-0.20	-0.20	0.02	-0.55	0.79	-0.20	1.00	0.65
Z''-score	-0.35	-0.13	0.02	0.02	0.06	0.21	-0.08	-0.07	0.02	-0.01	0.71	0.20	0.65	1.00

Correlation Matrix: Bonds issued by listed firms with working capital entries available

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Working Capital/ Total Assets	Retained Earnings/T otal Assets	Operating Income/Tot al Assets	Book Equity/Tot al Liabilities	Z''-score
Yield Spread	1.00	0.06	0.10	0.24	-0.03	0.01	0.36	-0.09	0.06	-0.03	-0.24	-0.36	-0.25	-0.29
Maturity	0.06	1.00	0.16	0.24	0.08	0.02	0.31	-0.06	0.01	0.06	-0.08	-0.07	-0.01	-0.03
Bond Age	0.10	0.16	1.00	0.59	-0.08	-0.08	0.08	-0.20	-0.11	0.10	-0.10	0.05	0.10	0.02
Coupon	0.24	0.24	0.59	1.00	-0.02	-0.09	0.11	0.07	0.06	0.11	-0.15	-0.03	0.07	-0.03
Log(issue)	-0.03	0.08	-0.08	-0.02	1.00	0.10	-0.08	-0.08	-0.07	-0.11	-0.06	-0.01	-0.04	-0.10
SENIOR	0.01	0.02	-0.08	-0.09	0.10	1.00	0.01	-0.02	-0.01	0.05	0.03	0.02	0.07	0.06
BID-ASK	0.36	0.31	0.08	0.11	-0.08	0.01	1.00	-0.12	0.10	-0.06	-0.09	-0.24	-0.17	-0.17
10Y Swap	-0.09	-0.06	-0.20	0.07	-0.08	-0.02	-0.12	1.00	-0.22	-0.03	0.03	0.04	0.07	0.03
Swap Slope	0.06	0.01	-0.11	0.06	-0.07	-0.01	0.10	-0.22	1.00	0.07	0.00	-0.07	-0.04	0.01
Working Capital/ Total Assets	-0.03	0.06	0.10	0.11	-0.11	0.05	-0.06	-0.03	0.07	1.00	0.08	0.17	0.31	0.62
Retained Earnings/Total Assets	-0.24	-0.08	-0.10	-0.15	-0.06	0.03	-0.09	0.03	0.00	0.08	1.00	0.30	0.31	0.76
Operating Income/Total Assets	-0.36	-0.07	0.05	-0.03	-0.01	0.02	-0.24	0.04	-0.07	0.17	0.30	1.00	0.36	0.57
Book Equity/Total Liabilities	-0.25	-0.01	0.10	0.07	-0.04	0.07	-0.17	0.07	-0.04	0.31	0.31	0.36	1.00	0.61
Z''-score	-0.29	-0.03	0.02	-0.03	-0.10	0.06	-0.17	0.03	0.01	0.62	0.76	0.57	0.61	1.00

Correlation Matrix: Bonds issued by non-financial firms with working capital entries available

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Working Capital/ Total Assets	Retained Earnings/T otal Assets	Operating Income/Tot al Assets	Book Equity/Tot al Liabilities	Z''-score
Yield Spread	1.00	0.05	0.06	0.22	-0.01	0.01	0.37	-0.12	0.06	-0.08	-0.08	-0.23	-0.41	-0.30	-0.33
Maturity	0.05	1.00	0.16	0.22	0.11	0.05	0.31	-0.08	0.01	0.04	-0.08	-0.09	-0.10	-0.03	-0.06
Bond Age	0.06	0.16	1.00	0.50	-0.03	-0.05	0.10	-0.35	-0.15	-0.02	-0.06	-0.15	-0.03	0.00	-0.07
Coupon	0.22	0.22	0.50	1.00	0.06	-0.06	0.13	-0.05	0.01	-0.06	-0.06	-0.15	-0.18	-0.09	-0.18
Log(issue)	-0.01	0.11	-0.03	0.06	1.00	0.15	-0.03	-0.04	-0.07	-0.09	0.05	-0.08	0.03	-0.01	-0.08
SENIOR	0.01	0.05	-0.05	-0.06	0.15	1.00	0.02	-0.02	-0.02	0.06	-0.02	0.03	0.02	0.07	0.06
BID-ASK	0.37	0.31	0.10	0.13	-0.03	0.02	1.00	-0.10	0.10	-0.07	-0.09	-0.09	-0.25	-0.18	-0.18
10Y Swap	-0.12	-0.08	-0.35	-0.05	-0.04	-0.02	-0.10	1.00	-0.23	-0.06	0.05	-0.02	0.01	0.00	0.00
Swap Slope	0.06	0.01	-0.15	0.01	-0.07	-0.02	0.10	-0.23	1.00	0.02	0.01	0.01	0.03	-0.06	-0.02
Working Capital/ Total Assets	-0.08	0.04	-0.02	-0.09	-0.09	0.06	-0.07	-0.06	0.02	1.00	0.11	0.32	0.12	0.25	0.59
Retained Earnings/Total Assets	-0.23	-0.08	-0.09	-0.15	-0.08	0.03	-0.09	0.05	0.01	0.11	1.00	0.32	0.34	0.80	
Operating Income/Total Assets	-0.41	-0.10	-0.03	-0.18	0.03	0.02	-0.25	-0.02	-0.09	0.12	0.32	1.00	0.31	0.55	
Book Equity/Total Liabilities	-0.30	-0.03	0.00	-0.09	-0.01	0.07	-0.18	0.01	-0.06	0.25	0.34	0.31	1.00	0.59	
Z''-score	-0.33	-0.06	-0.07	-0.18	-0.08	0.06	-0.18	0.00	-0.02	0.59	0.80	0.55	0.59	1.00	

Correlation Matrix: Bonds issued by listed financial firms with working capital entries available

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Working Capital/ Total Assets	Retained Earnings/T otal Assets	Operating Income/Tot al Assets	Book Equity/Tot al Liabilities	Z''-score
Yield Spread	1.00	0.25	0.23	0.26	-0.04	-0.15	0.34	-0.26	0.06	0.05	-0.08	-0.13	0.09	0.02
Maturity	0.25	1.00	0.11	0.36	-0.01	-0.27	0.35	-0.06	0.05	0.17	0.03	0.06	0.15	0.18
Bond Age	0.23	0.11	1.00	0.69	-0.08	-0.32	-0.06	0.08	-0.01	0.26	0.30	0.23	0.52	0.38
Coupon	0.26	0.36	0.69	1.00	-0.04	-0.31	0.08	0.11	0.16	0.27	0.18	0.26	0.41	0.35
Log(issue)	-0.04	-0.01	-0.08	-0.04	1.00	-0.07	-0.33	-0.08	-0.07	-0.09	-0.05	-0.07	-0.07	-0.10
SENIOR	-0.15	-0.27	-0.32	-0.31	-0.07	1.00	-0.04	-0.04	0.03	-0.06	0.08	0.01	0.05	-0.02
BID-ASK	0.34	0.35	-0.06	0.08	-0.33	-0.04	1.00	-0.23	0.12	-0.01	-0.09	-0.11	-0.07	-0.05
10Y Swap	-0.26	-0.06	0.08	0.11	-0.08	-0.04	-0.23	1.00	-0.24	-0.24	0.14	0.27	0.14	0.38	0.11
Swap Slope	0.06	0.05	-0.01	0.16	0.27	0.03	0.12	-0.24	1.00	0.36	0.17	-0.15	-0.04	0.24	
Working Capital/ Total Assets	0.06	0.17	0.26	0.27	-0.09	-0.06	-0.01	-0.24	0.36	1.00	0.26	-0.03	0.38	0.92	
Retained Earnings/Total Assets	-0.08	0.03	0.30	0.18	-0.05	0.08	-0.09	0.14	-0.17	0.26	1.00	0.44	0.73	0.55	
Operating Income/Total Assets	-0.13	0.06	0.23	0.26	-0.07	0.01	-0.11	0.38	-0.15	-0.03	0.44	1.00	0.61	0.28	
Book Equity/Total Liabilities	0.09	0.15	0.52	0.41	-0.07	0.05	-0.07	0.12	-0.04	0.38	0.73	0.61	1.00	0.68	
Z''-score	0.02	0.18	0.38	0.35	-0.10	-0.02	-0.05	-0.11	0.24	0.92	0.55	0.28	0.68	1.00	

5.2 Private firms

Correlation Matrix: Bonds issued by private firms

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Retained Earnings	Operating Income/	Book Equity/Total	Log((Total Assets)	Operating Income/	Total Debt to Total	Operating Income/	LT Debt to Total Assets	C1	C2	C3	C4	Estimated Market	Sector volatility
Yield Spread	1.00	-0.01	0.13	0.21	0.02	0.02	0.43	-0.04	0.02	-0.03	0.04	-0.01	0.13	0.04	-0.05	-0.13	0.13	-0.04	0.06	0.02	0.02	0.26	0.53
Maturity	-0.01	1.00	-0.01	0.17	0.11	-0.45	0.19	-0.13	-0.02	-0.16	-0.04	0.02	0.09	-0.04	-0.37	-0.07	-0.25	0.02	-0.01	0.00	0.00	-0.11	0.03
Bond Age	0.13	-0.01	1.00	0.60	-0.09	-0.22	0.08	0.17	0.00	0.04	0.23	0.31	0.03	0.23	-0.28	-0.08	-0.11	0.24	0.08	0.11	0.12	-0.10	0.00
Coupon	0.21	0.17	0.60	1.00	-0.01	-0.17	0.18	0.31	0.19	0.09	0.15	0.27	0.06	0.15	-0.24	-0.15	0.01	0.11	0.00	0.07	0.08	0.04	0.14
Log(issue)	0.02	0.11	-0.09	-0.01	1.00	-0.10	-0.14	-0.23	-0.03	-0.09	-0.07	-0.12	0.26	-0.07	-0.03	-0.05	-0.05	-0.09	0.03	0.01	0.00	0.07	0.07
SENIOR	0.02	-0.45	-0.22	-0.17	-0.10	1.00	-0.03	0.04	-0.01	0.24	0.00	-0.01	-0.26	0.00	0.67	0.17	0.53	-0.13	-0.04	0.00	0.01	0.14	-0.04
BID-ASK	0.43	0.19	0.08	0.18	-0.14	-0.03	1.00	0.00	0.10	-0.03	-0.01	-0.01	0.11	-0.01	-0.05	-0.11	0.05	-0.06	-0.02	0.00	0.00	0.15	0.34
10Y Swap	-0.04	-0.13	0.17	0.31	-0.23	0.04	0.00	1.00	-0.12	0.04	0.09	0.08	-0.07	0.09	0.04	-0.06	0.05	0.02	-0.08	-0.01	0.00	0.08	-0.14
Swap Slope	0.02	-0.02	0.00	0.19	-0.03	-0.01	0.10	-0.12	1.00	0.05	-0.01	0.05	0.02	-0.01	-0.02	-0.13	0.07	-0.02	-0.03	-0.02	-0.01	0.07	0.31
Retained Earnings/Total Assets	-0.03	-0.16	0.04	0.09	-0.09	0.24	-0.03	0.04	0.05	1.00	0.36	0.71	-0.35	0.36	-0.04	0.31	0.01	0.40	0.13	0.20	0.19	-0.38	0.01
Operating Income/Total Assets	0.04	-0.04	0.23	0.15	-0.07	0.00	-0.01	0.09	-0.01	0.36	1.00	0.54	-0.38	1.00	-0.20	0.58	-0.04	0.81	0.62	0.14	0.11	-0.24	-0.05
Book Equity/Total Liabilities	-0.01	0.02	0.31	0.27	-0.12	-0.01	-0.01	0.08	0.05	0.71	0.54	1.00	-0.46	0.54	-0.38	0.24	-0.18	0.65	0.13	0.18	0.16	-0.52	-0.02
Log((Total Assets)	0.13	0.09	0.03	0.06	0.26	-0.26	0.11	-0.07	0.02	-0.35	-0.38	-0.46	1.00	-0.38	-0.21	-0.36	-0.19	-0.36	-0.05	-0.02	-0.03	0.32	0.06
Operating Income/Total Assets	0.04	-0.04	0.23	0.15	-0.07	0.00	-0.01	0.09	-0.01	0.36	1.00	0.54	-0.38	1.00	-0.20	0.58	-0.04	0.81	0.62	0.14	0.11	-0.24	-0.05
Total Debt to Total Assets	-0.05	-0.37	-0.28	-0.24	-0.03	0.67	-0.05	0.04	-0.02	-0.04	-0.20	-0.38	-0.21	-0.20	1.00	0.15	0.68	-0.37	-0.11	-0.11	-0.09	0.30	-0.05
Operating Income/Sales	-0.13	-0.07	-0.08	-0.15	-0.05	0.17	-0.11	-0.06	-0.13	0.31	0.58	0.24	-0.36	0.58	0.15	1.00	0.13	0.45	0.35	-0.02	-0.03	-0.17	-0.25
LT Debt to Total Assets	0.13	-0.25	-0.11	0.01	-0.05	0.53	0.05	0.05	0.07	0.01	-0.04	-0.18	-0.19	-0.04	0.68	0.13	1.00	-0.26	-0.01	-0.08	-0.07	0.21	-0.01
C1	-0.04	0.02	0.24	0.11	-0.09	-0.13	-0.06	0.02	-0.02	0.40	0.81	0.65	-0.36	0.81	-0.37	0.45	-0.26	1.00	0.46	0.18	0.14	-0.38	-0.08
C2	0.06	-0.01	0.08	0.00	0.03	-0.04	-0.02	-0.08	-0.03	0.13	0.62	0.13	-0.05	0.62	-0.11	0.35	-0.01	0.46	1.00	0.45	0.35	-0.04	0.00
C3	0.02	0.00	0.11	0.07	0.01	0.00	0.00	-0.01	-0.02	0.20	0.14	0.18	-0.02	0.14	-0.11	-0.02	-0.08	0.18	0.45	1.00	0.91	-0.10	0.01
C4	0.02	0.00	0.12	0.08	0.00	0.01	0.00	0.00	-0.01	0.19	0.11	0.16	-0.03	0.11	-0.09	-0.03	-0.07	0.14	0.35	0.91	1.00	-0.10	0.01
Estimated Market Value Leverage	0.26	-0.11	-0.10	0.04	0.07	0.14	0.15	0.08	0.07	-0.38	-0.24	-0.52	0.32	-0.24	0.30	-0.17	0.21	-0.38	-0.04	-0.10	-0.10	1.00	0.31
Sector volatility	0.53	0.03	0.00	0.14	0.07	-0.04	0.34	-0.14	0.31	0.01	-0.05	-0.02	0.06	-0.05	-0.05	-0.25	-0.01	-0.08	0.00	0.01	0.01	0.31	1.00

5.3 Private non-financial firms

Correlation Matrix: Bonds issued by private non-financial firms

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Retained Earnings/Total Assets	Operating Income/Total Assets	Book Equity/Total Liabilities	Log((Total Assets)	Operating Income/Total Assets	Total Debt to Total Assets	Operating Income/Sales	LT Debt to Total Assets	C1	C2	C3	C4	Sales	Log(Operating Income/ Total	Log(Cash/ Total Assets)	Sales growth	1/IRC	Sales/ Total Assets	Estimated Market Value Leverage	Sector volatility
Yield Spread	1.00	0.03	0.39	0.37	-0.03	-0.04	0.37	0.17	0.04	-0.24	0.20	-0.04	0.11	0.20	-0.09	-0.19	0.11	0.01	0.12	0.05	0.06	0.36	-0.31	0.12	-0.11	0.24	0.35	0.27	0.35
Maturity	0.03	1.00	-0.03	0.17	0.02	0.00	0.26	-0.10	0.05	-0.03	0.10	0.10	-0.18	0.10	-0.08	0.04	0.08	0.09	-0.01	0.01	0.01	-0.13	0.00	-0.05	0.03	-0.07	0.15	-0.13	0.02
Bond Age	0.39	-0.03	1.00	0.64	-0.06	-0.27	0.17	0.20	0.02	0.08	0.32	0.33	0.16	0.32	-0.44	-0.20	-0.09	0.29	0.17	0.15	0.15	0.52	-0.31	0.04	-0.17	0.05	0.47	-0.01	0.08
Coupon	0.37	0.17	0.64	1.00	-0.05	-0.20	0.26	0.39	0.22	0.10	0.26	0.33	0.04	0.26	-0.40	-0.31	0.07	0.18	0.12	0.11	0.10	0.40	-0.37	0.02	-0.21	0.16	0.42	0.08	0.26
Log(issue)	-0.03	0.02	-0.06	-0.05	1.00	0.11	-0.14	-0.21	-0.01	-0.05	-0.10	-0.14	0.30	-0.10	0.15	-0.05	-0.02	-0.08	-0.02	0.01	0.01	0.21	-0.08	0.17	-0.10	0.08	-0.06	0.00	-0.01
SENIOR	-0.04	0.00	-0.27	-0.20	0.11	1.00	-0.01	-0.11	-0.09	-0.06	-0.38	-0.34	0.23	-0.38	0.45	0.00	0.26	-0.47	-0.21	0.01	0.01	0.03	0.01	0.24	0.05	0.19	-0.26	0.19	-0.11
BID-ASK	0.37	0.26	0.17	0.26	-0.14	-0.01	1.00	0.07	0.15	-0.05	0.06	0.00	0.11	0.06	-0.03	-0.11	0.12	-0.04	0.04	0.01	0.01	0.20	-0.17	0.12	-0.15	0.17	0.10	0.15	0.32
10Y Swap	0.17	-0.10	0.20	0.39	-0.21	-0.11	0.07	1.00	-0.14	-0.01	0.16	0.10	-0.03	0.16	-0.16	-0.10	-0.04	0.05	0.04	0.00	-0.01	0.18	-0.12	-0.25	0.16	0.08	0.16	0.25	-0.01
Swap Slope	0.04	0.05	0.02	0.22	-0.01	-0.09	0.15	-0.14	1.00	0.07	-0.01	0.07	0.03	-0.01	-0.07	-0.30	0.10	-0.03	0.01	-0.01	-0.01	0.13	-0.31	0.23	-0.44	0.30	0.01	0.14	0.46
Retained Earnings/Total Assets	-0.24	-0.03	0.08	0.10	-0.05	-0.06	-0.05	-0.01	0.07	1.00	0.28	0.71	-0.13	0.28	-0.48	0.12	-0.34	0.40	0.15	0.24	0.23	-0.03	0.12	-0.21	-0.10	-0.16	0.08	-0.47	0.05
Operating Income/Total Assets	0.20	0.10	0.32	0.26	-0.10	-0.38	0.06	0.16	-0.01	0.28	1.00	0.60	-0.35	1.00	-0.66	0.41	-0.30	0.80	0.53	0.14	0.14	0.01	0.26	-0.26	-0.02	-0.46	0.56	-0.29	0.09
Book Equity/Total Liabilities	-0.04	0.10	0.33	0.33	-0.14	-0.34	0.00	0.10	0.07	0.71	0.60	1.00	-0.43	0.60	-0.81	0.19	-0.39	0.72	0.24	0.21	0.19	-0.04	0.11	-0.38	-0.16	-0.33	0.41	-0.53	0.05
Log((Total Assets)	0.11	-0.18	0.16	0.04	0.30	0.23	0.11	-0.03	0.03	-0.13	-0.35	-0.43	1.00	-0.35	0.43	-0.31	0.16	-0.37	-0.08	-0.03	-0.03	0.76	-0.30	0.45	-0.17	0.42	-0.30	0.38	0.06
Operating Income/Total Assets	0.20	0.10	0.32	0.26	-0.10	-0.38	0.06	0.16	-0.01	0.28	1.00	0.60	-0.35	1.00	-0.66	0.41	-0.30	0.80	0.53	0.14	0.14	0.01	0.26	-0.26	-0.02	-0.46	0.56	-0.29	0.09
Total Debt to Total Assets	-0.09	-0.08	-0.44	-0.40	0.15	0.45	-0.03	-0.16	-0.07	-0.48	-0.66	-0.81	0.43	-0.66	1.00	0.02	0.50	-0.77	-0.26	-0.17	-0.16	-0.08	0.09	0.40	0.08	0.34	-0.62	0.42	-0.07
Operating Income/Sales	-0.19	0.04	-0.20	-0.31	-0.05	0.00	-0.11	-0.10	-0.30	0.12	0.41	0.19	-0.31	0.41	0.02	1.00	-0.08	0.30	0.15	-0.07	-0.06	-0.43	0.91	-0.14	0.05	-0.55	-0.24	-0.22	-0.18
LT Debt to Total Assets	0.11	0.08	-0.09	0.07	-0.02	0.26	0.12	-0.04	0.10	-0.34	-0.30	-0.39	0.16	-0.30	0.50	-0.08	1.00	-0.49	-0.16	-0.11	-0.11	0.03	-0.06	0.39	-0.13	0.28	-0.22	0.14	-0.08
C1	0.01	0.09	0.29	0.18	-0.08	-0.47	-0.04	0.05	-0.03	0.40	0.80	0.72	-0.37	0.80	-0.77	0.30	-0.49	1.00	0.36	0.16	0.16	-0.01	0.25	-0.44	0.01	-0.57	0.51	-0.40	0.02
C2	0.12	-0.01	0.17	0.12	-0.02	-0.21	0.04	0.04	0.01	0.15	0.53	0.24	-0.08	0.53	-0.26	0.15	-0.16	0.36	1.00	0.62	0.60	0.09	0.05	-0.03	0.05	-0.11	0.32	-0.14	0.08
C3	0.05	0.01	0.15	0.11	0.01	0.01	0.01	0.00	-0.01	0.24	0.14	0.21	-0.03	0.14	-0.17	-0.07	-0.11	0.16	0.62	1.00	0.97	0.12	-0.08	0.01	0.01	-0.05	0.35	-0.11	0.03
C4	0.06	0.01	0.15	0.10	0.01	0.01	0.01	-0.01	-0.01	0.23	0.14	0.19	-0.03	0.14	-0.16	-0.06	-0.11	0.16	0.60	0.97	1.00	0.12	-0.08	0.01	0.01	-0.05	0.34	-0.11	0.04
Sales	0.36	-0.13	0.52	0.40	0.21	0.03	0.20	0.18	0.13	-0.03	0.01	-0.04	0.76	0.01	-0.08	-0.43	0.03	-0.01	0.09	0.12	0.12	1.00	-0.53	0.26	-0.25	0.35	0.20	0.32	0.19
Log(Operating Income/ Total Assets)	-0.31	0.00	-0.31	-0.37	-0.08	0.01	-0.17	-0.12	-0.31	0.12	0.26	0.11	-0.30	0.26	0.09	0.91	-0.06	0.25	0.05	-0.08	-0.08	-0.53	1.00	-0.18	0.12	-0.66	-0.37	-0.21	-0.21
Log(Cash/ Total Assets)	0.12	-0.05	0.04	0.02	0.17	0.24	0.12	-0.25	0.23	-0.21	-0.26	-0.38	0.45	-0.26	0.40	-0.14	0.39	-0.44	-0.03	0.01	0.01	0.26	-0.18	1.00	-0.36	0.37	-0.18	0.21	0.12
Sales growth	-0.11	0.03	-0.17	-0.21	-0.10	0.05	-0.15	0.16	-0.44	-0.10	-0.02	-0.16	-0.17	-0.02	0.08	0.05	-0.13	0.01	0.05	0.01	0.01	-0.25	0.12	-0.36	1.00	-0.16	0.02	-0.01	-0.27
1/IRC	0.24	-0.07	0.05	0.16	0.08	0.19	0.17	0.08	0.30	-0.16	-0.46	-0.33	0.42	-0.46	0.34	-0.55	0.28	-0.57	-0.11	-0.05	-0.05	0.35	-0.66	0.37	-0.16	1.00	-0.25	0.36	0.29
Sales/ Total Assets	0.35	0.15	0.47	0.42	-0.06	-0.26	0.10	0.16	0.01	0.08	0.56	0.41	-0.30	0.56	-0.62	-0.24	-0.22	0.51	0.32	0.35	0.34	0.20	-0.37	-0.18	0.02	-0.25	1.00	-0.16	0.05
Estimated Market Value Leverage	0.27	-0.13	-0.01	0.08	0.00	0.19	0.15	0.25	0.14	-0.47	-0.29	-0.53	0.38	-0.29	0.42	-0.22	0.14	-0.40	-0.14	-0.11	-0.11	0.32	-0.21	0.21	-0.01	0.36	-0.16	1.00	0.30
Sector volatility	0.35	0.02	0.08	0.26	-0.01	-0.11	0.32	-0.01	0.46	0.05	0.09	0.05	0.06	0.09	-0.07	-0.18	-0.08	0.02	0.08	0.03	0.04	0.19	-0.21	0.12	-0.27	0.29	0.05	0.30	1.00

5.4 Private financial firms

Correlation Matrix: Bonds issued by private financial firms

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Retained Earnings/Total Assets	Operating Income/Total Assets	Book Equity/Total Liabilities	Log((Total Assets)	Operating Income/Total Assets	Total Debt to Total Assets	Operating Income/Sales	LT Debt to Total Assets	C1	C2	C3	1/ Sales	Log(Sales/ Assets)	1/(Cash/ Total Assets)	1/ Growth	Log(Interest Coverage)	1/ (Total Liabilities/ Total Assets)	Estimated Market Value Leverage	Sector volatility
Yield Spread	1.00	-0.07	0.01	0.11	-0.02	0.13	0.49	-0.15	0.01	0.22	0.01	0.20	-0.03	0.01	0.09	-0.11	0.15	-0.02	-0.01	-0.01	-0.16	0.27	-0.05	-0.25	0.10	0.17	0.26	0.56
Maturity	-0.07	1.00	-0.03	0.15	0.15	-0.60	0.14	-0.16	-0.08	-0.32	-0.25	-0.16	0.19	-0.25	-0.50	-0.14	-0.45	-0.01	-0.01	-0.01	-0.11	-0.38	0.04	0.00	0.06	-0.16	-0.19	0.00
Bond Age	0.01	-0.03	1.00	0.53	-0.12	-0.30	-0.02	0.13	-0.01	-0.16	-0.02	-0.08	0.07	-0.02	-0.16	-0.08	-0.13	0.04	0.02	0.00	-0.10	0.00	-0.02	0.01	-0.02	-0.09	-0.14	-0.02
Coupon	0.11	0.15	0.53	1.00	0.04	-0.12	0.02	0.13	0.12	0.09	0.22	0.10	-0.03	0.22	0.04	0.07	0.01	0.11	0.00	-0.01	-0.15	0.23	-0.02	-0.01	0.07	0.07	-0.05	0.05
Log(issue)	-0.02	0.15	-0.12	0.04	1.00	-0.19	-0.16	-0.22	-0.08	-0.10	-0.11	0.00	0.13	-0.11	-0.12	-0.09	-0.11	-0.16	0.00	0.00	-0.09	-0.06	0.07	-0.02	-0.04	-0.01	0.08	0.08
SENIOR	0.13	-0.60	-0.30	-0.12	-0.19	1.00	-0.01	0.16	0.08	0.53	0.37	0.32	-0.39	0.37	0.77	0.22	0.72	0.02	-0.03	-0.04	0.21	0.51	0.06	-0.01	-0.01	0.31	0.33	0.03
BID-ASK	0.49	0.14	-0.02	0.02	-0.16	-0.01	1.00	-0.11	0.03	0.04	-0.04	0.01	0.04	-0.04	0.00	-0.09	0.01	0.01	0.00	0.00	-0.09	0.02	-0.06	-0.12	0.09	-0.01	0.16	0.36
10Y Swap	-0.15	-0.16	0.13	0.13	-0.22	0.16	-0.11	1.00	-0.13	0.15	0.29	0.03	-0.13	0.29	0.25	0.09	0.22	0.16	0.03	0.03	-0.18	0.46	-0.01	0.06	0.08	0.05	-0.24	-0.25
Swap Slope	0.01	-0.08	-0.01	0.12	-0.08	0.08	0.03	-0.13	1.00	0.04	0.16	0.04	-0.04	0.16	0.08	0.07	0.05	0.19	-0.04	-0.03	0.04	0.05	0.04	-0.03	0.26	-0.01	-0.11	0.27
Retained Earnings/Total Assets	0.22	-0.32	-0.16	0.09	-0.10	0.53	0.04	0.15	0.04	1.00	0.71	0.84	-0.69	0.71	0.52	0.53	0.56	0.35	-0.05	-0.04	0.29	0.52	-0.12	-0.05	0.23	0.81	-0.01	0.03
Operating Income/Total Assets	0.01	-0.25	-0.02	0.22	-0.11	0.37	-0.04	0.29	0.16	0.71	1.00	0.63	-0.48	1.00	0.38	0.75	0.46	0.62	0.00	-0.01	0.04	0.57	-0.05	-0.04	0.27	0.60	-0.11	-0.13
Book Equity/Total Liabilities	0.20	-0.16	-0.08	0.10	0.00	0.32	0.01	0.03	0.04	0.84	0.63	1.00	-0.60	0.63	0.19	0.36	0.31	0.41	-0.02	-0.02	0.09	0.52	-0.18	-0.06	0.33	0.97	-0.18	0.01
Log((Total Assets)	-0.03	0.19	0.07	-0.03	0.13	-0.39	0.04	-0.13	-0.04	-0.69	-0.48	-0.60	1.00	-0.48	-0.53	-0.40	-0.54	-0.23	0.00	-0.01	-0.69	-0.26	-0.08	0.02	-0.11	-0.58	-0.02	-0.10
Operating Income/Total Assets	0.01	-0.25	-0.02	0.22	-0.11	0.37	-0.04	0.29	0.16	0.71	1.00	0.63	-0.48	1.00	0.38	0.75	0.46	0.62	0.00	-0.01	0.04	0.57	-0.05	-0.04	0.27	0.60	-0.11	-0.13
Total Debt to Total Assets	0.09	-0.50	-0.16	0.04	-0.12	0.77	0.00	0.25	0.08	0.52	0.38	0.19	-0.53	0.38	1.00	0.24	0.88	-0.10	-0.08	-0.07	0.38	0.52	0.13	0.01	-0.15	0.17	0.40	0.04
Operating Income/Sales	-0.11	-0.14	-0.08	0.07	-0.09	0.22	-0.09	0.09	0.07	0.53	0.75	0.36	-0.40	0.75	0.24	1.00	0.29	0.63	-0.01	0.00	0.31	0.06	-0.01	-0.03	0.20	0.35	-0.13	-0.27
LT Debt to Total Assets	0.15	-0.45	-0.13	0.01	-0.11	0.72	0.01	0.22	0.05	0.56	0.46	0.31	-0.54	0.46	0.88	0.29	1.00	-0.01	-0.07	-0.06	0.36	0.51	0.19	0.00	-0.07	0.29	0.33	0.04
C1	-0.02	-0.01	0.04	0.11	-0.16	0.02	0.01	0.16	0.19	0.35	0.62	0.41	-0.23	0.62	-0.10	0.63	-0.01	1.00	0.38	0.32	0.02	0.13	-0.09	-0.05	0.57	0.39	-0.35	-0.14
C2	-0.01	-0.01	0.02	0.00	0.00	-0.03	0.00	0.03	-0.04	-0.05	0.00	-0.02	0.00	0.00	-0.08	-0.01	-0.07	0.38	1.00	0.89	0.00	0.01	0.00	-0.04	0.15	-0.02	-0.12	-0.01
C3	-0.01	-0.01	0.00	-0.01	0.00	-0.04	0.00	0.03	-0.03	-0.04	-0.01	-0.02	-0.01	-0.01	-0.07	0.00	-0.06	0.32	0.89	1.00	0.01	-0.02	0.00	-0.03	0.13	-0.02	-0.10	-0.01
1/ Sales	-0.16	-0.11	-0.10	-0.15	-0.09	0.21	-0.09	-0.18	0.04	0.29	0.04	0.09	-0.69	0.04	0.38	0.31	0.36	0.02	0.00	0.01	1.00	-0.34	0.10	0.01	-0.11	0.09	0.14	0.03
Log(Sales/ Assets)	0.27	-0.38	0.00	0.23	-0.06	0.51	0.02	0.46	0.05	0.52	0.57	0.52	-0.26	0.57	0.52	0.06	0.51	0.13	0.01	-0.02	-0.34	1.00	-0.10	-0.03	0.08	0.50	0.07	0.03
1/(Cash/ Total Assets)	-0.05	0.04	-0.02	-0.02	0.07	0.06	-0.06	-0.01	0.04	-0.12	-0.05	-0.18	-0.08	-0.05	0.13	-0.01	0.19	-0.09	0.00	0.00	0.10	-0.10	1.00	0.00	0.01	-0.17	0.18	0.19
1/ Growth	-0.25	0.00	0.01	-0.01	-0.02	-0.01	-0.12	0.06	-0.03	-0.05	-0.04	-0.06	0.02	-0.04	0.01	-0.03	0.00	-0.05	-0.04	-0.03	0.01	-0.03	0.00	1.00	-0.03	-0.05	-0.11	-0.30
Log(Interest Coverage)	0.10	0.06	-0.02	0.07	-0.04	-0.01	0.09	0.08	0.26	0.23	0.27	0.33	-0.11	0.27	-0.15	0.20	-0.07	0.57	0.15	0.13	-0.11	0.08	0.01	-0.03	1.00	0.32	-0.27	0.12
1/ (Total Liabilities/ Total Assets)	0.17	-0.16	-0.09	0.07	-0.01	0.31	-0.01	0.05	-0.01	0.81	0.60	0.97	-0.58	0.60	0.17	0.35	0.29	0.39	-0.02	-0.02	0.09	0.50	-0.17	-0.05	0.32	1.00	-0.19	-0.02
Estimated Market Value Leverage	0.26	-0.19	-0.14	-0.05	0.08	0.33	0.16	-0.24	-0.11	-0.01	-0.11	-0.18	-0.02	-0.11	0.40	-0.13	0.33	-0.35	-0.12	-0.10	0.14	0.07	0.18	-0.11	-0.27	-0.19	1.00	0.39
Sector volatility	0.56	0.00	-0.02	0.05	0.08	0.03	0.36	-0.25	0.27	0.03	-0.13	0.01	-0.10	-0.13	0.04	-0.27	0.04	-0.14	-0.01	-0.01	0.03	0.03	0.19	-0.30	0.12	-0.02	0.39	1.00

5.5 Listed firms

Correlation Matrix: Bonds issued by listed firms

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Retained Earnings/ Total Assets	Operating Income/ Total Assets	Book Equity/ Total Liabilities	Log(Total Assets)	Operating Income /Total Assets	Total Debt/ Total Assets	Operating Income/ Sales	LT Debt/ Total Assets	C1	C2	C3	C4	Estimated Market Value Leverage	Sector volatility	Volatility	Market Value Leverage
Yield Spread	1.00	0.07	0.11	0.20	-0.08	0.06	0.37	-0.11	0.05	-0.18	-0.19	-0.07	-0.18	-0.19	0.15	-0.31	0.28	-0.22	-0.15	-0.12	-0.06	0.18	0.34	0.59	0.23
Maturity	0.07	1.00	0.14	0.25	0.03	0.03	0.30	-0.04	0.03	-0.05	0.04	0.12	-0.14	0.04	-0.05	-0.11	0.08	0.07	0.02	-0.01	0.02	-0.08	0.02	0.02	-0.07
Bond Age	0.11	0.14	1.00	0.65	-0.17	-0.08	0.07	-0.01	-0.05	-0.05	0.21	0.28	-0.25	0.21	-0.09	-0.09	0.04	0.14	0.04	0.02	0.06	-0.20	-0.04	-0.04	-0.21
Coupon	0.20	0.25	0.65	1.00	-0.15	-0.10	0.11	0.20	0.11	-0.07	0.18	0.27	-0.41	0.18	-0.03	-0.11	0.11	0.05	-0.06	-0.07	0.00	-0.21	-0.03	0.02	-0.16
Log(issue)	-0.08	0.03	-0.17	-0.15	1.00	-0.02	-0.14	-0.17	-0.06	-0.05	-0.11	-0.14	0.27	-0.11	0.05	-0.03	-0.02	-0.10	-0.02	-0.03	-0.03	0.15	0.06	0.05	0.21
SENIOR	0.06	0.03	-0.08	-0.10	-0.02	1.00	0.02	-0.03	0.01	0.01	0.19	0.25	-0.19	0.19	0.17	-0.17	0.25	0.23	0.18	0.12	0.06	-0.12	0.00	0.02	-0.11
BID-ASK	0.37	0.30	0.07	0.11	-0.14	0.02	1.00	-0.13	0.12	-0.06	-0.13	-0.05	0.00	-0.13	0.05	-0.21	0.13	-0.09	-0.05	-0.07	-0.02	0.11	0.28	0.32	0.13
10Y Swap	-0.11	-0.04	-0.01	0.20	-0.17	-0.03	-0.13	1.00	-0.22	0.02	0.12	0.09	-0.21	0.12	0.12	0.14	0.07	0.01	-0.01	0.06	0.02	-0.12	-0.33	-0.26	-0.09
Swap Slope	0.05	0.03	-0.05	0.11	-0.06	0.01	0.12	-0.22	1.00	0.01	-0.04	0.01	-0.09	-0.04	-0.04	-0.17	-0.01	-0.05	-0.08	-0.06	-0.01	-0.08	0.33	0.26	0.04
Retained Earnings/Total Assets	-0.18	-0.05	-0.05	-0.07	-0.05	0.01	-0.06	0.02	0.01	1.00	0.26	0.23	0.02	0.26	-0.20	0.09	-0.23	0.28	0.29	0.22	0.11	-0.20	-0.01	-0.15	-0.19
Operating Income/Total Assets	-0.19	0.04	0.21	0.18	-0.11	0.19	-0.13	0.12	-0.04	0.26	1.00	0.56	-0.44	1.00	-0.13	0.26	0.06	0.65	0.54	0.46	0.27	-0.49	-0.13	-0.23	-0.56
Book Equity/Total Liabilities	-0.07	0.12	0.28	0.27	-0.14	0.25	-0.05	0.09	0.01	0.23	0.56	1.00	-0.50	0.56	-0.30	-0.03	-0.06	0.53	0.35	0.27	0.18	-0.62	-0.05	-0.13	-0.58
Log((Total Assets))	-0.18	-0.14	-0.25	-0.41	0.27	-0.19	0.00	-0.21	-0.09	0.02	-0.44	-0.50	1.00	-0.44	0.00	0.11	-0.35	-0.26	-0.06	-0.03	-0.03	0.43	0.06	-0.01	0.40
Operating Income/Total Assets	-0.19	0.04	0.21	0.18	-0.11	0.19	-0.13	0.12	-0.04	0.26	1.00	0.56	-0.44	1.00	-0.13	0.26	0.06	0.65	0.54	0.46	0.27	-0.49	-0.13	-0.23	-0.56
Total Debt to Total Assets	0.15	-0.05	-0.09	-0.03	0.05	0.17	0.05	0.12	-0.04	-0.20	-0.13	-0.30	0.00	-0.13	1.00	-0.02	0.76	-0.26	-0.13	-0.11	-0.10	0.51	-0.01	0.10	0.59
Operating Income/Sales	-0.31	-0.11	-0.09	-0.11	-0.03	-0.17	-0.21	0.14	-0.17	0.09	0.26	-0.03	0.11	0.26	-0.02	1.00	-0.11	0.14	0.02	0.05	0.04	-0.02	-0.29	-0.39	-0.07
LT Debt to Total Assets	0.28	0.08	0.04	0.11	-0.02	0.25	0.13	0.07	-0.01	-0.23	0.06	-0.06	-0.35	0.06	0.76	-0.11	1.00	-0.06	-0.06	-0.09	-0.08	0.26	0.04	0.16	0.30
C1	-0.22	0.07	0.14	0.05	-0.10	0.23	-0.09	0.01	-0.05	0.28	0.65	0.53	-0.26	0.65	-0.26	0.14	-0.06	1.00	0.70	0.45	0.20	-0.50	-0.12	-0.28	-0.59
C2	-0.15	0.02	0.04	-0.06	-0.02	0.18	-0.05	-0.01	-0.08	0.29	0.54	0.35	-0.06	0.54	-0.13	0.02	-0.06	0.70	1.00	0.74	0.33	-0.32	-0.04	-0.17	-0.44
C3	-0.12	-0.01	0.02	-0.07	-0.03	0.12	-0.07	0.06	-0.06	0.22	0.46	0.27	-0.03	0.46	-0.11	0.05	-0.09	0.45	0.74	1.00	0.56	-0.26	-0.09	-0.13	-0.35
C4	-0.06	0.02	0.06	0.00	-0.03	0.06	-0.02	0.02	-0.01	0.11	0.27	0.18	-0.03	0.27	-0.10	0.04	-0.08	0.20	0.33	0.56	1.00	-0.16	-0.03	-0.06	-0.21
Estimated Market Value Leverage	0.18	-0.08	-0.20	-0.21	0.15	-0.12	0.11	-0.12	-0.08	-0.20	-0.49	-0.62	0.43	-0.49	0.51	-0.02	0.26	-0.50	-0.32	-0.26	-0.16	1.00	0.17	0.21	0.66
Sector volatility	0.34	0.02	-0.04	-0.03	0.06	0.00	0.28	-0.33	0.33	-0.01	-0.13	-0.05	0.06	-0.13	-0.01	-0.29	0.04	-0.12	-0.04	-0.09	-0.03	0.17	1.00	0.78	0.15
Volatility	0.59	0.02	-0.04	0.02	0.05	0.02	0.32	-0.26	0.26	-0.15	-0.23	-0.13	-0.01	-0.23	0.10	-0.39	0.16	-0.28	-0.17	-0.13	-0.06	0.21	0.78	1.00	0.30
Market Value Leverage	0.23	-0.07	-0.21	-0.16	0.21	-0.11	0.13	-0.09	0.04	-0.19	-0.56	-0.58	0.40	-0.56	0.59	-0.07	0.30	-0.59	-0.44	-0.35	-0.21	0.66	0.15	0.30	1.00

5.6 Listed non-financial firms

Correlation Matrix: Bonds issued by listed non-financial firms

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Retained Earnings/ Total Assets	Operating Income/ Total Assets	Book Equity/ Total Liabilities	Log(Total Assets)	Operating Income /Total Assets	Total Debt/ Total Assets
Yield Spread	1.00	0.04	0.04	0.22	-0.03	0.01	0.33	-0.10	0.06	-0.21	-0.39	-0.28	-0.11	-0.39	0.26
Maturity	0.04	1.00	0.15	0.24	0.11	0.06	0.31	-0.08	0.01	-0.08	-0.09	-0.03	0.08	-0.09	-0.01
Bond Age	0.04	0.15	1.00	0.52	-0.04	-0.06	0.09	-0.35	-0.15	-0.10	-0.04	0.01	0.13	-0.04	-0.10
Coupon	0.22	0.24	0.52	1.00	0.06	-0.05	0.14	-0.05	0.02	-0.16	-0.19	-0.09	-0.07	-0.19	0.11
Log(issue)	-0.03	0.11	-0.04	0.06	1.00	0.15	-0.03	-0.04	-0.07	-0.08	0.04	0.01	0.28	0.04	0.01
SENIOR	0.01	0.06	-0.06	-0.05	0.15	1.00	0.02	-0.02	-0.01	0.02	0.02	0.07	0.07	0.02	-0.07
BID-ASK	0.33	0.31	0.09	0.14	-0.03	0.02	1.00	-0.08	0.11	-0.08	-0.23	-0.17	0.11	-0.23	0.13
10Y Swap	-0.10	-0.08	-0.35	-0.05	-0.04	-0.02	-0.08	1.00	-0.23	0.04	-0.02	-0.02	-0.05	-0.02	0.05
Swap Slope	0.06	0.01	-0.15	0.02	-0.07	-0.01	0.11	-0.23	1.00	0.03	-0.08	-0.06	-0.07	-0.08	0.05
Retained Earnings/Total Assets	-0.21	-0.08	-0.10	-0.16	-0.08	0.02	-0.08	0.04	0.03	1.00	0.31	0.28	0.01	0.31	-0.29
Operating Income/Total Assets	-0.39	-0.09	-0.04	-0.19	0.04	0.02	-0.23	-0.02	-0.08	0.31	1.00	0.32	-0.07	1.00	-0.29
Book Equity/Total Liabilities	-0.28	-0.03	0.01	-0.09	0.01	0.07	-0.17	-0.02	-0.06	0.28	0.32	1.00	0.00	0.32	-0.66
Log((Total Assets)	-0.11	0.08	0.13	-0.07	0.28	0.07	0.11	-0.05	-0.07	0.01	-0.07	0.00	1.00	-0.07	-0.13
Operating Income/Total Assets	-0.39	-0.09	-0.04	-0.19	0.04	0.02	-0.23	-0.02	-0.08	0.31	1.00	0.32	-0.07	1.00	-0.29
Total Debt to Total Assets	0.26	-0.01	-0.10	0.11	0.01	-0.07	0.13	0.05	0.05	-0.29	-0.29	-0.66	-0.13	-0.29	1.00
Operating Income/Sales	-0.31	-0.10	0.02	-0.11	0.04	-0.09	-0.18	-0.01	-0.08	0.14	0.66	0.29	0.05	0.66	-0.13
LT Debt to Total Assets	0.28	0.02	-0.05	0.17	0.01	-0.07	0.13	0.03	0.05	-0.33	-0.28	-0.62	-0.21	-0.28	0.93
C1	-0.45	-0.09	0.02	-0.25	0.03	0.06	-0.23	-0.04	-0.10	0.37	0.72	0.44	0.19	0.72	-0.52
C2	-0.25	-0.05	0.00	-0.20	0.11	0.11	-0.15	-0.05	-0.09	0.33	0.66	0.34	0.14	0.66	-0.42
C3	-0.17	-0.05	-0.02	-0.21	0.07	0.08	-0.10	-0.05	-0.07	0.23	0.53	0.26	0.12	0.53	-0.33
C4	-0.09	0.00	0.01	-0.12	0.02	0.03	-0.04	-0.03	-0.04	0.10	0.26	0.13	0.13	0.26	-0.18
Log(Sales)	-0.14	0.09	0.15	-0.10	0.25	0.13	0.07	-0.08	-0.09	0.11	0.08	0.01	0.88	0.08	-0.21
Net Income/ Total Assets	-0.36	-0.06	-0.01	-0.18	0.00	0.00	-0.17	0.02	-0.16	0.42	0.66	0.23	0.02	0.66	-0.25
Log(Casht/ Total Assets)	0.04	0.07	-0.02	-0.03	0.12	0.14	0.07	-0.06	-0.05	-0.04	0.03	0.04	0.08	0.03	-0.06
Sales Growth	-0.18	-0.02	-0.01	0.01	0.01	-0.01	-0.11	0.07	-0.09	0.10	0.15	0.14	-0.02	0.15	-0.09
Positive IRC	0.40	0.10	0.04	0.16	0.03	0.05	0.22	0.00	0.00	-0.21	-0.51	-0.24	0.02	-0.51	0.18
Long-term Debt/ Net Worth	0.37	0.06	-0.01	0.17	0.03	-0.06	0.19	0.02	0.02	-0.40	-0.35	-0.82	-0.09	-0.35	0.85
Estimated Market Value Leverage	0.35	0.07	0.02	0.12	0.01	-0.06	0.20	-0.02	-0.02	-0.26	-0.39	-0.53	0.01	-0.39	0.60
Sector volatility	0.28	0.02	-0.04	0.06	-0.04	-0.01	0.21	-0.29	0.47	0.02	-0.17	-0.04	0.01	-0.17	0.07
Volatility	0.65	0.04	-0.04	0.17	-0.04	0.02	0.27	-0.19	0.30	-0.21	-0.37	-0.23	-0.12	-0.37	0.20
Market Value Leverage	0.47	0.05	-0.07	0.18	-0.02	-0.07	0.28	0.04	0.12	-0.25	-0.57	-0.57	0.08	-0.57	0.69

	Operating Income/ Sales	LT Debt/ Total Assets	C1	C2	C3	C4	Log(Sales)	Net Income/ Total Assets	Log(Casht/ Total Assets)	Sales Growth	Positive IRC	Long-term Debt/ Net Worth	Estimated Market Value Leverage	Sector volatility	Volatility	Market Value Leverage
Yield Spread	-0.31	0.28	-0.45	-0.25	-0.17	-0.09	-0.14	-0.36	0.04	-0.18	0.40	0.37	0.35	0.28	0.65	0.47
Maturity	-0.10	0.02	-0.09	-0.05	-0.05	0.00	0.09	-0.06	0.07	-0.02	0.10	0.06	0.07	0.02	0.04	0.05
Bond Age	0.02	-0.05	0.02	0.00	-0.02	0.01	0.15	-0.01	-0.02	-0.01	0.04	-0.01	0.02	-0.04	-0.04	-0.07
Coupon	-0.11	0.17	-0.25	-0.20	-0.21	-0.12	-0.10	-0.18	-0.03	0.01	0.16	0.17	0.12	0.06	0.17	0.18
Log(issue)	0.04	0.01	0.03	0.11	0.07	0.02	0.25	0.00	0.12	0.01	0.03	0.03	0.01	-0.04	-0.04	-0.02
SENIOR	-0.09	-0.07	0.06	0.11	0.08	0.03	0.13	0.00	0.14	-0.01	0.05	-0.06	-0.06	-0.01	0.02	-0.07
BID-ASK	-0.18	0.13	-0.23	-0.15	-0.10	-0.04	0.07	-0.17	0.07	-0.11	0.22	0.19	0.20	0.21	0.27	0.28
10Y Swap	-0.01	0.03	-0.04	-0.05	-0.05	-0.03	-0.08	0.02	-0.06	0.07	0.00	0.02	-0.02	-0.29	-0.19	0.04
Swap Slope	-0.08	0.05	-0.10	-0.09	-0.07	-0.04	-0.09	-0.16	-0.05	-0.09	0.00	0.02	-0.02	0.47	0.30	0.12
Retained Earnings/Total Assets	0.14	-0.33	0.37	0.33	0.23	0.10	0.11	0.42	-0.04	0.10	-0.21	-0.40	-0.26	0.02	-0.21	-0.25
Operating Income/Total Assets	0.66	-0.28	0.72	0.66	0.53	0.26	0.08	0.66	0.03	0.15	-0.51	-0.35	-0.39	-0.17	-0.37	-0.57
Book Equity/Total Liabilities	0.29	-0.62	0.44	0.34	0.26	0.13	0.01	0.23	0.04	0.14	-0.24	-0.82	-0.53	-0.04	-0.23	-0.57
Log((Total Assets)	0.05	-0.21	0.19	0.14	0.12	0.13	0.88	0.02	0.08	-0.02	0.02	-0.09	0.01	0.01	-0.12	0.08
Operating Income/Total Assets	0.66	-0.28	0.72	0.66	0.53	0.26	0.08	0.66	0.03	0.15	-0.51	-0.35	-0.39	-0.17	-0.37	-0.57
Total Debt to Total Assets	-0.13	0.93	-0.52	-0.42	-0.33	-0.18	-0.21	-0.25	-0.06	-0.09	0.18	0.85	0.60	0.07	0.20	0.69
Operating Income/Sales	1.00	-0.12	0.49	0.29	0.23	0.14	-0.11	0.44	-0.16	0.12	-0.53	-0.26	-0.31	-0.14	-0.32	-0.30
LT Debt to Total Assets	-0.12	1.00	-0.56	-0.44	-0.35	-0.20	-0.30	-0.26	-0.12	-0.07	0.17	0.87	0.56	0.05	0.21	0.64
C1	0.49	-0.56	1.00	0.63	0.40	0.20	0.34	0.55	0.05	0.16	-0.54	-0.56	-0.41	-0.13	-0.43	-0.66
C2	0.29	-0.44	0.63	1.00	0.74	0.37	0.32	0.48	0.22	0.11	-0.19	-0.41	-0.36	-0.09	-0.23	-0.58
C3	0.23	-0.35	0.40	0.74	1.00	0.61	0.25	0.37	0.21	0.09	-0.12	-0.31	-0.29	-0.10	-0.16	-0.46
C4	0.14	-0.20	0.20	0.37	0.61	1.00	0.18	0.19	0.13	0.03	-0.06	-0.18	-0.14	-0.05	-0.09	-0.24
Log(Sales)	-0.11	-0.30	0.34	0.32	0.25	0.18	1.00	0.12	0.14	0.01	-0.01	-0.14	-0.01	0.01	-0.14	-0.07
Net Income/ Total Assets	0.44	-0.26	0.55	0.48	0.37	0.19	0.12	1.00	0.05	0.17	-0.37	-0.31	-0.26	-0.23	-0.43	-0.43
Log(Casht/ Total Assets)	-0.16	-0.12	0.05	0.22	0.21	0.13	0.14	0.05	1.00	-0.05	0.16	-0.01	0.08	-0.04	0.05	-0.13
Sales Growth	0.12	-0.07	0.16	0.11	0.09	0.03	0.01	0.17	-0.05	1.00	-0.14	-0.11	-0.10	-0.20	-0.28	-0.21
Positive IRC	-0.53	0.17	-0.54	-0.19	-0.12	-0.06	-0.01	-0.37	0.16	-0.14	1.00	0.31	0.26	0.10	0.33	0.30
Long-term Debt/ Net Worth	-0.26	0.87	-0.56	-0.41	-0.31	-0.18	-0.14	-0.31	-0.01	-0.11	0.31	1.00	0.67	0.04	0.26	0.66
Estimated Market Value Leverage	-0.31	0.56	-0.41	-0.36	-0.29	-0.14	-0.01	-0.26	0.08	-0.10	0.26	0.67	1.00	0.14	0.23	0.55
Sector volatility	-0.14	0.05	-0.13	-0.09	-0.10	-0.05	0.01	-0.23	-0.04	-0.20	0.10	0.04	0.14	1.00	0.64	0.20
Volatility	-0.32	0.21	-0.43	-0.23	-0.16	-0.09	-0.14	-0.43	0.05	-0.28	0.33	0.26	0.23	0.64	1.00	0.42
Market Value Leverage	-0.30	0.64	-0.66	-0.58	-0.46	-0.24	-0.07	-0.43	-0.13	-0.21	0.30	0.66	0.55	0.20	0.42	1.00

5.7 Listed financial firms

Correlation Matrix: Bonds issued by listed financial firms

	Yield Spread	Maturity	Bond Age	Coupon	Log(issue)	SENIOR	BID-ASK	10Y Swap	Swap Slope	Retained Earnings/ Total Assets	Operating Income/ Total Assets	Book Equity/ Total Liabilities	Log(Total Assets)	Operating Income /Total Assets
Yield Spread	1.00	0.05	0.08	0.09	-0.08	0.02	0.42	-0.17	0.03	-0.19	-0.18	0.01	-0.11	-0.18
Maturity	0.05	1.00	-0.03	0.17	0.04	-0.08	0.29	-0.07	0.04	0.07	0.04	0.11	-0.12	0.04
Bond Age	0.08	-0.03	1.00	0.64	-0.17	-0.34	0.01	0.10	-0.02	0.11	0.05	0.09	-0.03	0.05
Coupon	0.09	0.17	0.64	1.00	-0.14	-0.37	0.07	0.24	0.14	0.07	0.11	0.10	-0.20	0.11
Log(issue)	-0.08	0.04	-0.17	-0.14	1.00	0.02	-0.20	-0.19	-0.05	-0.05	-0.15	-0.12	0.17	-0.15
SENIOR	0.02	-0.08	-0.34	-0.37	0.02	1.00	0.00	-0.11	-0.01	0.02	0.07	0.12	0.04	0.07
BID-ASK	0.42	0.29	0.01	0.07	-0.20	0.00	1.00	-0.18	0.12	-0.05	-0.13	0.02	-0.01	-0.13
10Y Swap	-0.17	-0.07	0.10	0.24	-0.19	-0.11	-0.18	1.00	-0.23	0.02	0.27	-0.01	-0.20	0.27
Swap Slope	0.03	0.04	-0.02	0.14	-0.05	-0.01	0.12	-0.23	1.00	-0.01	-0.15	0.01	-0.05	-0.15
Retained Earnings/Total Assets	-0.19	0.07	0.11	0.07	-0.05	0.02	-0.05	0.02	-0.01	1.00	0.39	0.38	0.06	0.39
Operating Income/Total Assets	-0.18	0.04	0.05	0.11	-0.15	0.07	-0.13	0.27	-0.15	0.39	1.00	0.59	-0.37	1.00
Book Equity/Total Liabilities	0.01	0.11	0.09	0.10	-0.12	0.12	0.02	-0.01	0.01	0.38	0.59	1.00	-0.42	0.59
Log((Total Assets)	-0.11	-0.12	-0.03	-0.20	0.17	0.04	-0.01	-0.20	-0.05	0.06	-0.37	-0.42	1.00	-0.37
Operating Income/Total Assets	-0.18	0.04	0.05	0.11	-0.15	0.07	-0.13	0.27	-0.15	0.39	1.00	0.59	-0.37	1.00
Total Debt to Total Assets	0.09	-0.09	-0.09	-0.08	0.06	0.27	0.00	0.17	-0.09	-0.22	0.06	-0.05	0.04	0.06
Operating Income/Sales	-0.28	-0.05	0.02	0.06	-0.13	-0.11	-0.23	0.29	-0.21	0.03	0.60	0.09	-0.19	0.60
LT Debt to Total Assets	0.24	0.02	-0.16	-0.17	0.07	0.26	0.11	0.01	-0.11	-0.15	0.16	0.06	-0.15	0.16
C1	-0.13	0.12	-0.06	-0.10	-0.07	0.16	-0.01	-0.08	-0.06	0.50	0.51	0.40	-0.11	0.51
C2	-0.07	0.05	-0.09	-0.13	-0.05	0.17	0.04	-0.04	-0.08	0.49	0.36	0.32	0.04	0.36
C3	-0.09	-0.01	-0.07	-0.09	-0.08	0.11	-0.03	0.12	-0.06	0.37	0.33	0.23	0.04	0.33
C4	-0.03	-0.02	0.02	0.02	-0.05	0.05	-0.02	0.04	0.04	0.25	0.23	0.20	-0.03	0.23
Log(Total Assets)	-0.11	-0.12	-0.03	-0.20	0.17	0.04	-0.01	-0.20	-0.05	0.06	-0.37	-0.42	1.00	-0.37
Net Income/ Total Assets	-0.32	-0.01	-0.01	0.02	-0.07	0.05	-0.16	0.20	-0.17	0.48	0.77	0.48	-0.14	0.77
Cash/ Total Assets	-0.06	-0.04	-0.02	-0.07	-0.01	-0.10	0.00	-0.18	0.04	0.15	-0.04	0.05	0.24	-0.04
Sales Growth	-0.13	-0.01	0.05	0.00	-0.03	-0.02	-0.13	0.24	-0.34	0.00	0.17	0.01	0.03	0.17
Positive IRC	0.29	0.03	-0.01	-0.07	0.09	0.05	0.15	-0.18	0.14	-0.13	-0.45	-0.03	0.02	-0.45
Estimated Market Value Leverage	0.15	-0.13	-0.09	-0.14	0.16	0.09	0.07	-0.10	-0.11	-0.28	-0.23	-0.37	0.40	-0.23
Sector volatility	0.46	0.03	-0.02	-0.03	0.08	0.02	0.35	-0.35	0.31	-0.10	-0.25	-0.01	0.05	-0.25
Volatility	0.62	0.03	-0.04	-0.02	0.08	0.04	0.37	-0.29	0.26	-0.24	-0.32	-0.07	-0.01	-0.32
Market Value Leverage	0.15	-0.05	-0.03	-0.07	0.26	0.07	0.04	-0.07	0.02	-0.36	-0.29	-0.29	0.24	-0.29

	Total Debt/ Total Assets	Operating Income/ Sales	LT Debt/ Total Assets	C1	C2	C3	C4	Log(Total Assets)	Net Income/ Total Assets	Cash/ Total Assets	Sales Growth	Positive IRC	Estimated Market Value Leverage	Sector volatility	Volatility	Market Value Leverage
Yield Spread	0.09	-0.28	0.24	-0.13	-0.07	-0.09	-0.03	-0.11	-0.32	-0.06	-0.13	0.29	0.15	0.46	0.62	0.15
Maturity	-0.09	-0.05	0.02	0.12	0.05	-0.01	-0.02	-0.12	-0.01	-0.04	-0.01	0.03	-0.13	0.03	0.03	-0.05
Bond Age	-0.09	0.02	-0.16	-0.06	-0.09	-0.07	0.02	-0.03	-0.01	-0.02	0.05	-0.01	-0.09	-0.02	-0.04	-0.03
Coupon	-0.08	0.06	-0.17	-0.10	-0.13	-0.09	0.02	-0.20	0.02	-0.07	0.00	-0.07	-0.14	-0.03	-0.02	-0.07
Log(issue)	0.06	-0.13	0.07	-0.07	-0.05	-0.08	-0.05	0.17	-0.07	-0.01	-0.03	0.09	0.16	0.08	0.08	0.26
SENIOR	0.27	-0.11	0.26	0.16	0.17	0.11	0.05	0.04	0.05	-0.10	-0.02	0.05	0.09	0.02	0.04	0.07
BID-ASK	0.00	-0.23	0.11	-0.01	0.04	-0.03	-0.02	-0.01	-0.16	0.00	-0.13	0.15	0.07	0.35	0.37	0.04
10Y Swap	0.17	0.29	0.01	-0.08	-0.04	0.12	0.04	-0.20	0.20	-0.18	0.24	-0.18	-0.10	-0.35	-0.29	-0.07
Swap Slope	-0.09	-0.21	-0.11	-0.06	-0.08	-0.06	0.04	-0.05	-0.17	0.04	-0.34	0.14	-0.11	0.31	0.26	0.02
Retained Earnings/Total Assets	-0.22	0.03	-0.15	0.50	0.49	0.37	0.25	0.06	0.48	0.15	0.00	-0.13	-0.28	-0.10	-0.24	-0.36
Operating Income/Total Assets	0.06	0.60	0.16	0.51	0.36	0.33	0.23	-0.37	0.77	-0.04	0.17	-0.45	-0.23	-0.25	-0.32	-0.29
Book Equity/Total Liabilities	-0.05	0.09	0.06	0.40	0.32	0.23	0.20	-0.42	0.48	0.05	0.01	-0.03	-0.37	-0.01	-0.07	-0.29
Log((Total Assets)	0.04	-0.19	-0.15	-0.11	0.04	0.04	-0.03	1.00	-0.14	0.24	0.03	0.02	0.40	0.05	-0.01	0.24
Operating Income/Total Assets	0.06	0.60	0.16	0.51	0.36	0.33	0.23	-0.37	0.77	-0.04	0.17	-0.45	-0.23	-0.25	-0.32	-0.29
Total Debt to Total Assets	1.00	0.02	0.75	-0.12	0.10	0.07	-0.02	0.04	0.01	-0.10	0.03	-0.01	0.62	-0.03	0.06	0.63
Operating Income/Sales	0.02	1.00	0.02	0.13	-0.10	-0.03	-0.01	-0.19	0.46	-0.06	0.29	-0.63	-0.03	-0.38	-0.45	-0.15
LT Debt to Total Assets	0.75	0.02	1.00	0.06	0.18	0.08	-0.01	-0.15	0.02	-0.08	0.02	0.06	0.42	0.07	0.17	0.40
C1	-0.12	0.13	0.06	1.00	0.78	0.50	0.17	-0.11	0.49	0.15	0.02	-0.28	-0.38	-0.11	-0.23	-0.38
C2	0.10	-0.10	0.18	0.78	1.00	0.73	0.25	0.04	0.39	0.22	-0.03	-0.11	-0.15	-0.01	-0.13	-0.21
C3	0.07	-0.03	0.08	0.50	0.73	1.00	0.45	0.04	0.33	0.21	0.00	-0.07	-0.12	-0.10	-0.13	-0.17
C4	-0.02	-0.01	-0.01	0.17	0.25	0.45	1.00	-0.03	0.21	0.08	0.01	-0.03	-0.10	-0.03	-0.03	-0.11
Log(Total Assets)	0.04	-0.19	-0.15	-0.11	0.04	0.04	-0.03	1.00	-0.14	0.24	0.03	0.02	0.40	0.05	-0.01	0.24
Net Income/ Total Assets	0.01	0.46	0.02	0.49	0.39	0.33	0.21	-0.14	1.00	0.02	0.13	-0.42	-0.19	-0.27	-0.41	-0.28
Cash/ Total Assets	-0.10	-0.06	-0.08	0.15	0.22	0.21	0.08	0.24	0.02	1.00	-0.02	-0.01	0.06	0.02	-0.05	-0.10
Sales Growth	0.03	0.29	0.02	0.02	-0.03	0.00	0.01	0.03	0.13	-0.02	1.00	-0.24	-0.06	-0.28	-0.24	-0.04
Positive IRC	-0.01	-0.63	0.06	-0.28	-0.11	-0.07	-0.03	0.02	-0.42	-0.01	-0.24	1.00	0.04	0.25	0.37	0.15
Estimated Market Value Leverage	0.62	-0.03	0.42	-0.38	-0.15	-0.12	-0.10	0.40	-0.19	0.06	-0.06	0.04	1.00	0.23	0.26	0.67
Sector volatility	-0.03	-0.38	0.07	-0.11	-0.01	-0.10	-0.03	0.05	-0.27	0.02	-0.28	0.25	0.23	1.00	0.83	0.13
Volatility	0.06	-0.45	0.17	-0.23	-0.13	-0.13	-0.03	-0.01	-0.41	-0.05	-0.24	0.37	0.26	0.83	1.00	0.27
Market Value Leverage	0.63	-0.15	0.40	-0.38	-0.21	-0.17	-0.11	0.24	-0.28	-0.10	-0.04	0.15	0.67	0.13	0.27	1.00

6 Appendix 6: Financial ratios investigated in Approach inspired by Moody's RiskCalc™

Appendix 6. Variables and functional forms considered in approach inspired by Moody's Risk Calc™

		Private non-financial firms			Private financial firms			Listed non-financial firms			Listed financial firms		
	Variable	t-statistic	Adjusted R^2	SER	t-statistic	Adjusted R^2	SER	t-statistic	Adjusted R^2	SER	t-statistic	Adjusted R^2	SER
Size measures	Total Assets ($USm)	2.67	4.4%	211.8	-1.31	0.5%	403.3	-0.21	0.0%	425.9	-0.62	0.2%	312.3
	1 to Total Assets ($USm)	1.93	4.7%	211.5	-1.03	0.3%	403.7	*1.99*	*0.6%*	*415.3*	*2.94*	*0.9%*	*311.7*
	Log(Total Assets ($USm))	0.02	0.0%	216.7	-0.32	2.0%	404.4	-1.60	0.9%	424.0	-2.06	1.5%	310.2
	Total Assets ($USm)^2	5.06	6.2%	209.8	-1.79	0.6%	403.2	0.65	0.1%	425.7	0.30	0.0%	312.5
	Sales ($USm)	*5.94*	*8.2%*	*207.5*	0.11	0.0%	404.4	-0.68	0.2%	425.5	-1.54	0.9%	311.2
	1 to Sales ($USm)	-0.91	0.9%	215.6	*-2.13*	*2.0%*	*400.3*	*2.53*	*0.9%*	*417.0*	*1.78*	*0.5%*	*311.3*
	Log(Sales ($USm))	2.60	6.0%	210.0	1.45	0.9%	402.9	-1.86	1.3%	423.1	-2.11	1.9%	305.7
	Sales ($USm)^2	*6.45*	*7.6%*	*208.2*	-0.33	0.0%	404.3	-0.70	0.1%	425.7	-1.18	0.3%	312.0
Profitability ratios	Sales to Total Assets	3.51	20.2%	193.6	2.81	7.2%	389.7	-0.40	0.1%	425.8	-0.63	0.1%	312.5
	1 to (Sales to Total Assets)	-1.82	8.3%	207.5	*-1.46*	*0.1%*	*404.2*	0.96	0.2%	425.5	*0.24*	*0.0%*	*308.3*
	Log(Sales to Total Assets)	2.31	13.6%	201.4	3.10	6.1%	392.3	-0.84	0.2%	425.6	-0.67	0.1%	308.4
	Sales to Total Assets^2	3.51	22.6%	190.6	*1.85*	*5.2%*	*393.8*	-0.09	0.0%	425.9	*-0.27*	*0.0%*	*312.6*
	Change in Sales to Assets	*0.83*	*0.4%*	*216.2*	*1.85*	*0.2%*	*406.0*	*0.02*	*0.0%*	*426.3*	*-1.89*	*0.4%*	*311.0*
	1 to Change in Sales to Assets	*1.19*	*0.2%*	*216.0*	-0.35	0.0%	405.6	*1.37*	*0.1%*	*424.3*	*0.52*	*0.0%*	*281.3*
	Log(Change in Sales to Assets)	*1.26*	*0.9%*	*271.6*	-1.99	1.8%	444.4	3.21	0.5%	452.9	1.52	0.5%	251.0
	Change in Sales to Assets^2	-0.95	0.0%	216.4	*-1.90*	*0.5%*	*405.4*	*0.93*	*0.0%*	*425.8*	*3.45*	*2.3%*	*308.1*
	Net Income to Total Assets	*-0.33*	*0.2%*	*195.4*	0.48	0.0%	404.3	-3.51	12.6%	398.1	-2.82	15.4%	287.5
	1 to (Net Income to Total Assets)	0.30	0.1%	216.5	*-0.72*	*0.0%*	*406.8*	*-2.19*	*0.0%*	*426.3*	*-1.68*	*0.9%*	*311.9*
	Log(Net Income to Total Assets)	-0.45	0.6%	168.6	1.78	1.6%	380.3	-4.89	5.9%	240.4	-3.65	2.3%	172.5
	Net Income to Total Assets^2	*1.79*	*1.5%*	*189.9*	2.58	0.1%	404.1	*1.74*	*2.1%*	*417.2*	*1.37*	*1.7%*	*303.0*
	Net Income to Sales	*-2.38*	*10.5%*	*200.9*	*-0.61*	*0.2%*	*404.6*	-2.38	4.8%	415.7	*-2.55*	*21.5%*	*270.5*
	1 to Net Income to Sales	*-0.24*	*0.1%*	*213.9*	*-2.77*	*0.0%*	*405.1*	*-3.06*	*0.4%*	*425.8*	*-1.69*	*1.4%*	*310.1*
	Log(Net Income to Sales)	-3.10	11.8%	158.8	-0.29	0.0%	383.1	-4.66	3.2%	243.8	-3.35	2.5%	180.4
	Net Income to Sales^2	*-0.92*	*1.5%*	*210.7*	*-0.99*	*0.3%*	*404.5*	*1.73*	*0.7%*	*422.8*	*1.44*	*7.2%*	*294.1*
	Operating Income to Sales	-1.79	4.2%	212.1	*-0.19*	*0.0%*	*405.6*	-4.19	9.0%	406.4	*-2.75*	*10.9%*	*288.3*
	1 to (Operating Income to Sales)	*2.83*	*10.4%*	*203.3*	*-1.24*	*0.4%*	*404.4*	*-0.21*	*0.0%*	*423.4*	*-1.44*	*0.9%*	*312.2*
	Log(Operating Income to Sales)	-3.01	10.7%	201.3	0.43	0.1%	358.7	-4.11	4.4%	311.2	-3.15	3.4%	216.0
	Operating Income to Sales^2	-2.52	6.9%	208.1	*-0.58*	*0.0%*	*405.6*	*-2.50*	*0.9%*	*422.0*	*-0.29*	*0.0%*	*305.4*
	Operating Income to Total Assets	1.83	4.8%	211.4	0.68	0.2%	403.9	-4.81	14.0%	395.0	-2.98	7.5%	300.7
	1 to (Operating Income to Total Assets)	-0.02	0.0%	216.9	*-1.22*	*0.2%*	*404.7*	*-0.94*	*0.2%*	*424.9*	*-1.53*	*0.7%*	*311.9*
	Log(Operating Income to Total Assets)	0.70	1.3%	211.7	1.83	2.9%	353.9	-4.70	8.1%	305.2	-3.10	2.7%	210.5
	Operating Income to Total Assets^2	*2.68*	*4.9%*	*211.3*	2.64	0.2%	404.0	-1.03	0.4%	425.1	*-0.37*	*0.0%*	*305.9*
Liquidity ratios	Cash to Total Assets	1.49	1.0%	215.6	-0.81	0.2%	404.1	0.89	0.2%	425.6	-1.95	0.4%	311.9
	1 to (Cash to Total Assets)	*-0.98*	*0.2%*	*216.7*	-3.46	0.5%	407.0	*-0.98*	*0.1%*	*425.7*	*0.59*	*0.0%*	*312.7*
	Log(Cash to Total Assets)	1.40	1.1%	215.7	1.37	0.8%	406.5	1.36	0.4%	425.4	-0.77	0.1%	312.4
	Cash to Total Assets^2	1.10	0.4%	216.2	-2.12	0.6%	403.2	*0.65*	*0.1%*	*426.6*	-2.39	0.4%	311.9
Growth variables	Sales Growth	*-2.15*	*1.8%*	*214.9*	0.67	0.0%	404.4	*-3.89*	*2.7%*	*420.8*	*-1.92*	*2.5%*	*308.0*
	1 to Sales Growth	*-0.56*	*0.0%*	*216.7*	*1.33*	*0.8%*	*385.7*	*-0.01*	*0.0%*	*426.7*	*1.16*	*0.0%*	*311.9*
	Sales Growth2	*1.18*	*0.5%*	*216.4*	*-1.30*	*0.5%*	*405.9*	*1.46*	*0.3%*	*426.0*	*1.88*	*0.5%*	*311.1*
Debt coverage variables	Interest coverage"	*0.20*	*0.0%*	*216.3*	0.83	0.1%	404.3	*-4.58*	*5.3%*	*415.2*	*-2.90*	*1.2%*	*310.8*
	1 to Interest Coverage"	1.33	2.7%	213.7	-0.73	0.0%	404.5	*2.01*	*1.0%*	*424.5*	*2.92*	*0.2%*	*312.3*
	Log(Interest Coverage)"	-0.48	0.4%	216.3	1.82	0.7%	403.1	-6.65	14.6%	394.2	*-2.56*	*1.3%*	*310.5*
	Interest coverage^2"	*0.28*	*0.0%*	*216.3*	1.16	0.0%	404.3	*-4.70*	*1.5%*	*423.5*	*-1.67*	*0.4%*	*312.0*
	Positive Interest Coverage Dummy Variable	0.89	0.3%	216.4	0.42	0.3%	403.9	5.03	17.3%	387.4	2.51	11.6%	393.9
Leverage ratios	Long-term Debt to Net Worth	2.15	9.6%	206.0	1.29	0.5%	403.5	*3.04*	*12.6%*	*382.9*	1.07	0.9%	311.1
	1 to (Long-term Debt to Net Worth)	*-0.89*	*1.0%*	*219.0*	*-1.80*	*0.5%*	*404.3*	*-3.60*	*3.7%*	*404.8*	*-0.63*	*0.1%*	*311.6*
	Log(Long-term Debt to Net Worth)	1.03	2.0%	218.2	1.59	0.4%	403.7	4.19	8.9%	393.3	1.00	0.5%	310.2
	Long-term Debt to Net Worth^2	3.51	18.4%	195.6	0.87	0.3%	403.8	*2.12*	*12.5%*	*394.7*	*1.36*	*2.1%*	*304.3*
	Total Debt to Total Assets	-0.57	0.3%	216.3	1.29	0.7%	402.9	2.94	6.4%	412.0	0.94	0.9%	311.2
	1 to (Total Debt to Total Assets)	*0.50*	*0.1%*	*216.6*	*-1.16*	*0.0%*	*405.0*	*-3.69*	*2.9%*	*420.5*	-0.25	0.0%	312.5
	Log(Total Debt to Total Assets)	-0.65	0.2%	216.4	1.80	1.1%	402.2	4.23	5.7%	413.7	0.42	0.1%	312.4
	Total Debt to Total Assets^2	-0.49	0.2%	216.4	0.52	0.1%	404.1	1.85	3.9%	417.6	1.34	1.9%	309.5
	Long-term Debt to Total Assets	1.53	3.1%	213.2	1.54	2.0%	400.3	2.79	6.7%	411.4	1.70	6.5%	302.2
	1 to (Long-term Debt to Total Assets)	*-0.66*	*0.3%*	*219.9*	*-0.84*	*0.1%*	*405.1*	*-3.99*	*2.5%*	*421.3*	-1.08	0.2%	312.2
	Log(Long-term Debt to Total Assets)	0.66	0.4%	220.0	1.91	1.9%	400.6	4.23	5.6%	413.9	1.40	2.2%	309.1
	Long-term Debt to Total Assets^2	1.65	7.1%	208.8	1.09	1.2%	402.0	1.78	3.9%	417.5	1.52	8.8%	2998.4
	Change in Leverage	0.25	0.0%	216.4	-0.48	0.0%	405.5	*3.68*	*1.1%*	*423.7*	*-1.33*	*0.1%*	*313.2*
	1 to Change in Leverage	1.16	0.1%	216.4	*-0.58*	*0.0%*	*406.5*	*0.54*	*0.0%*	*422.4*	*-0.97*	*0.8%*	*313.0*
	Log(Change in Leverage)	1.36	2.6%	236.9	0.58	0.3%	308.9	1.57	0.2%	522.7	0.26	0.0%	252.0
	Change in Leverage^2	*0.30*	*0.0%*	*216.8*	-1.89	0.5%	404.9	*0.50*	*0.0%*	*425.9*	*-1.04*	*0.0%*	*313.2*
	Total Liabilities to Total Assets	1.64	7.2%	208.7	-1.57	1.6%	401.2	3.26	10.7%	402.5	0.32	0.0%	312.5
	1 to (Total Liabilities to Total Assets)	-0.88	1.1%	215.4	*2.95*	*2.8%*	*399.2*	*-3.61*	*5.7%*	*413.7*	-0.23	0.0%	312.5
	Log(Total Liabilities to Total Assets)	1.22	3.2%	213.1	*-1.11*	*0.7%*	*403.0*	3.61	7.9%	408.7	0.26	0.0%	312.5
	Total Liabilities to Total Assets^2	2.34	12.9%	202.1	-1.96	2.1%	400.1	2.50	10.8%	402.2	0.38	0.0%	312.5
Solvency ratios	Book Value of Equity to Total Liabilities	-0.88	1.1%	215.4	*2.77*	*3.9%*	*396.9*	*-3.58*	*6.0%*	*413.4*	-0.24	0.0%	312.5
	1 to (Book Value of Equity to Total Liabilities)	*-0.27*	*0.2%*	*215.5*	-1.68	1.3%	401.8	*-1.48*	*0.7%*	*423.1*	*0.27*	*0.0%*	*311.4*
	Log(Book Value of Equity to Total Liabilities)	-0.21	0.1%	169.0	1.93	2.4%	399.5	-5.32	5.2%	341.9	-0.18	0.0%	307.5
	Book Value of Equity to Total Liabilities^2	*1.08*	*0.4%*	*216.5*	*1.39*	*2.0%*	*400.9*	*-2.32*	*1.0%*	*424.2*	*0.18*	*0.0%*	*312.8*
	Retained Earnings to Total Liabilities	-1.60	5.7%	210.3	*2.04*	*3.6%*	*397.0*	*-2.81*	*3.8%*	*418.7*	-2.03	3.3%	307.3
	1 to (Retained Earnings to Total Liabilities)	*-1.43*	*0.1%*	*216.8*	-0.67	0.0%	404.4	*-2.01*	*0.5%*	*425.1*	*-1.96*	*1.5%*	*310.8*
	Log(Retained Earnings to Total Liabilities)	-0.61	0.4%	159.8	2.52	3.5%	410.5	-3.04	2.7%	285.2	-1.13	0.2%	197.6
	Retained Earnings to Total Liabilities^2	*1.14*	*2.0%*	*214.4*	*2.88*	*5.2%*	*394.1*	*-0.15*	*0.0%*	*426.9*	*0.31*	*0.0%*	*313.7*
	Retained Earnings to Total Assets	-3.05	17.3%	197.0	2.48	4.5%	395.1	-2.79	5.3%	414.6	-2.51	5.5%	303.9
	1 to (Retained Earnings to Total Assets)	*-0.35*	*0.0%*	*217.0*	-0.67	0.0%	404.4	*-1.95*	*0.2%*	*427.2*	*-1.98*	*1.5%*	*310.8*
	Log(Retained Earnings to Total Assets)	-0.79	0.5%	159.6	2.42	3.4%	410.7	-3.13	2.6%	285.4	-1.33	0.2%	197.5
	Retained Earnings to Total Assets^2	*1.89*	*5.8%*	*189.9*	*2.78*	*5.5%*	*393.5*	*1.57*	*0.4%*	*424.8*	*-0.03*	*0.0%*	*310.7*

"Note that negative interest coverage ratios are set to zero

Note: Numbers in italics indicate that extreme outliers of the variable has been removed

7 Appendix 7: Applying both inputs to a structural measure of credit risk and financial ratios

7.1 Altman's z"-score

Altman's (2000) z''-score					
Private firms		**Bonds issued by listed firms**			
	Non-financial		All	Non-financial	Financial
Intercept	-480.52**	Intercept	-353.06***	-237.47**	106.85
	(235.18)		(122.63)	(115.83)	(103.77)
Time to Maturity (Years)	-1.33	Time to Maturity (Years)	-2.61**	-3.14***	2.76***
	(3.9)		(1.09)	(1.07)	(0.78)
Bond Age (Years)	18.96***	Bond Age (Years)	0.40	-1.72	4.39*
	(5.93)		(2.72)	(2.95)	(2.6)
Coupon (%)	-13.72	Coupon (%)	35.09***	29.66***	4.41
	(17.91)		(10.59)	(11.28)	(4.1)
Log(Issuesize)	30.52**	Log(Issuesize)	-9.37**	-8.11	-4.02***
	(14.25)		(3.91)	(5.89)	(1.17)
Senior	94.90	Senior	28.38	36.88	-28.65
	(70.16)		(29.56)	(32.13)	(31.81)
10Y Swap Rate (%)	27.87	10Y Swap Rate (%)	0.55	-15.75	-18.79**
	(29.58)		(11.98)	(10.9)	(7.5)
10Y-1Y Swap Rate (%)	-23.96**	10Y-1Y Swap Rate (%)	-48.53***	-52.15***	-29.76***
	(11.65)		(8.57)	(9.29)	(4.01)
Implicit Bid-ask Spread (bp)	0.97***	Implicit Bid-ask Spread (bp)	0.55***	0.61***	0.2***
	(0.17)		(0.12)	(0.13)	(0.04)
Sector Volatility (%)	4.81***	Equity Volatility (%)	9.51***	9.58***	4.24***
	(1.42)		(0.99)	(1.01)	(0.91)
Estimated Market Value Leverage (%)	4.51*	Market Value Leverage (%)	2.51***	2.86***	-0.20
	(2.38)		(0.51)	(0.59)	(1.02)
Altman's z''-score	-18.49	Altman's z''-score	-5.12	-7.79	5.38
	(42.47)		(7.06)	(7.2)	(9.74)
Adjusted R^2	675.0	Adjusted R^2	50.3	51.7	41.0
SER	237.8	SER	258.6	268.6	102.8
# of observations	675	# of observations	27352	25469	3758
# of bonds	98	# of bonds	2617	2141	476

* Significant at a 1% significance level, ** Significant at a 5% significance level,
*** Significant at a 10% significance level

7.2 Inputs to Altman's z"-score

Inputs to Altman's (2000) z''-score							
Bonds issued by private firms				**Bonds issued by listed firms**			
	All	Non-financial	Financial		All	Non-financial	Financial
Intercept	-242.53***	-222.46***	-142.96	Intercept	-172.15**	-181.5*	40.20
	(87.29)	(60.75)	(142.39)		(80.89)	(107.82)	(50.19)
Time to Maturity (Years)	-5.86*	-3.74	-6.37*	Time to Maturity (Years)	-2.29***	-3.29***	-1.72
	(3.39)	(2.99)	(3.78)		(0.89)	(1.1)	(1.8)
Bond Age (Years)	3.48	13.3***	2.12	Bond Age (Years)	-0.53	-1.95	1.92
	(4.53)	(2.75)	(9.05)		(1.94)	(2.88)	(2.31)
Coupon (%)	25.59**	9.80	27.20	Coupon (%)	41.55***	29.56***	20.67***
	(11.2)	(6.24)	(20.33)		(9.5)	(11.45)	(6.54)
Log(Issuesize)	4.29	2.60	-0.87	Log(Issuesize)	-25.74***	-6.52	-20.2**
	(4.98)	(4.69)	(9.37)		(7.02)	(6.4)	(9.57)
Senior	58.02*	113.19***	35.38	Senior	71.96***	33.33	28.68**
	(29.8)	(39.82)	(61.12)		(21.39)	(31.17)	(14.46)
10Y Swap Rate (%)	-19.07*	1.89	-33.79*	10Y Swap Rate (%)	-5.56	-17.20	-9.37
	(10.09)	(6.5)	(20.04)		(6.92)	(10.88)	(6.9)
10Y-1Y Swap Rate (%)	-50.75***	-21.68***	-63.22***	10Y-1Y Swap Rate (%)	-42.1***	-52.39***	-45.1***
	(17.62)	(6.56)	(21.82)		(6.14)	(9.51)	(7.28)
Implicit Bid-ask Spread (bp)	1.18***	0.61***	1.65***	Implicit Bid-ask Spread (bp)	0.71***	0.61***	0.72***
	(0.27)	(0.1)	(0.32)		(0.1)	(0.13)	(0.15)
Sector Volatility (%)	6.52***	4.81***	6.37**	Equity Volatility (%)	6.39***	9.42***	5.35***
	(2.39)	(1.34)	(2.64)		(1.03)	(1.01)	(1.49)
Estimated Market Value Leverage (%)	1.81**	0.31	0.92	Market Value Leverage (%)	0.96***	2.48***	-0.09
	(0.92)	(0.97)	(2)		(0.33)	(0.53)	(0.34)
Retained Earnings to Total Assets (%)	-2.37	-8.75***	7.58	Retained Earnings to Total Assets (%)	-0.85*	-0.09	-4.66***
(Profitability)	(3.98)	(2.99)	(5.75)	(Profitability)	(0.43)	(0.21)	(1.7)
Operating Income to Total Assets (%)	7.83	10.75**	2.87	Operating Income to Total Assets (%)	-4.31**	-3.67*	-7.95
(Productivity)	(5.12)	(5.07)	(5.26)	(Productivity)	(1.85)	(1.94)	(5.67)
Book Value of Equity to Total Liabilities (%)	0.18	0.13	4.49***	Book Value of Equity to Total Liabilities (%)	0.29	-0.23	1.82***
(Solvency)	(0.66)	(0.8)	(1.66)	(Solvency)	(0.34)	(0.37)	(0.65)
Adjusted R^2	41.2	42.1	47.3	Adjusted R^2	47.5	51.9	51.6
SER	232.0	141.7	294.2	SER	253.4	268.0	216.3
# of observations	8063	4819	3244	# of observations	56579	25469	31110
# of bonds	1007	630	377	# of bonds	4909	2141	2768

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

7.3 Financial measures applied in Kovner and Wei (2012)

Financial measures from Kovner and Wei (2012)

	Bonds issued by private firms			Bonds issued by listed firms			
	All	Non-financial	Financial		All	Non-financial	Financial
Intercept	-468.32***	-201.38	-374.58	Intercept	348.49***	93.10	419.27***
	(159.09)	(164.27)	(263.95)		(91.68)	(131.86)	(104.28)
Time to Maturity (Years)	-5.41	-2.40	-6.64**	Time to Maturity (Years)	-2.76***	-3.22***	-1.99
	(3.38)	(3.03)	(3.37)		(0.89)	(1.06)	(1.78)
Bond Age (Years)	3.31	15.68***	-0.84	Bond Age (Years)	0.92	0.92	2.88
	(4.7)	(3.06)	(6.26)		(1.96)	(2.88)	(2.23)
Coupon (%)	22.55**	8.50	36.34***	Coupon (%)	29.06***	21.18*	17.45***
	(10.95)	(6.37)	(11.26)		(7.99)	(11.04)	(6.05)
Log(Issuesize)	1.01	6.18	-1.40	Log(Issuesize)	-15.6**	8.82	-18.5**
	(5.96)	(5.35)	(10.1)		(7.62)	(6.07)	(9.27)
Senior	100.96	58.17	123.26	Senior	48.97***	41.04	19.61
	(67.3)	(37.04)	(116.1)		(16.95)	(29.54)	(13.38)
10Y Swap Rate (%)	-16.91*	-2.26	-39.76**	10Y Swap Rate (%)	-15.1**	-16.67	-19.24***
	(10.07)	(8.73)	(18.87)		(6.57)	(10.23)	(7.26)
10Y-1Y Swap Rate (%)	-50.71***	-25.00***	-76.56***	10Y-1Y Swap Rate (%)	-45.4***	-52.16***	-46.37***
	(17.75)	(7.16)	(23.11)		(6.02)	(9.31)	(6.88)
Implicit Bid-ask Spread (bp)	1.14***	0.66***	1.63***	Implicit Bid-ask Spread (bp)	0.74***	0.65***	0.71***
	(0.26)	(0.15)	(0.29)		(0.1)	(0.11)	(0.15)
Sector Volatility (%)	6.56***	4.05***	7.12***	Equity Volatility (%)	6.05***	8.93***	5.3***
	(2.45)	(1.35)	(2.82)		(1.05)	(1)	(1.47)
Estimated Market Value Leverage (%)	1.73	2.13	-2.76	Market Value Leverage (%)	1.41***	3.68***	-0.45
	(1.14)	(1.51)	(2.69)		(0.78)	(0.7)	(0.59)
Log(Total Assets ($USm))	22.97	-16.80	32.89**	Log(Total Assets ($USm))	-38.01***	-34.08***	-25.81***
(Size)	(14.62)	(22.13)	(15.52)	(Size)	(8.44)	(8.24)	(6.15)
Operating Income to Total Assets (%)	8.94**	8.74	15.32*	Operating Income to Total Assets (%)	-7.89***	-3.39*	-13.86***
Profitability	(4)	(6.2)	(9.03)	Profitability	(2.42)	(1.77)	(5)
Total Debt to Total Assets (%)	-0.64	0.98	0.79	Total Debt to Total Assets (%)	0.12	-1.21	1.09
(Leverage)	(0.99)	(0.78)	(1.82)	(Leverage)	(0.6)	(0.84)	(0.71)
Adjusted R^2	41.8	36.5	46.1	Adjusted R^2	49.6	52.4	52.4
SER	230.8	148.4	297.3	SER	247.6	264.6	214.5
# of observations	8077	4825	3252	# of observations	57147	26028	31119
# of bonds	1009	631	378	# of bonds	4929	2160	2769

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

7.4 Financial measures applied From Blume et al. (1998)

Financial measures from Blume et al. (1998)

	Bonds issued by private firms			Bonds issued by listed firms			
	All	Non-financial	Financial		All	Non-financial	Financial
Intercept	-238**	-284.72***	88.05	Intercept	-83.26	-128.42	71.27
	(117.37)	(94.8)	(210.56)		(76)	(132.72)	(54.6)
Time to Maturity (Years)	-5.12	-0.16	-9.32*	Time to Maturity (Years)	-2.45***	-3.39***	-2.01
	(3.5)	(2.35)	(4.87)		(0.85)	(1.08)	(1.82)
Bond Age (Years)	4.96	15.5***	-4.73	Bond Age (Years)	-0.74	-1.26	2.53
	(4.52)	(2.72)	(6.01)		(1.96)	(2.73)	(1.82)
Coupon (%)	20.34**	0.81	39.12***	Coupon (%)	37.49***	29.19***	21.86***
	(10)	(4.65)	(15.14)		(8.65)	(11.28)	(5.96)
Log(Issuesize)	4.44	4.38	-0.34	Log(Issuesize)	-22.62***	-8.58	-18.01**
	(5.88)	(3.73)	(11.37)		(5.97)	(5.92)	(7.81)
Senior	-4.96	47.25	12.58	Senior	31.55**	21.41	6.61
	(36.3)	(47.1)	(74.64)		(14.58)	(28.47)	(12.13)
10Y Swap Rate (%)	-15.60	2.54	-49.81**	10Y Swap Rate (%)	-12.55*	-19.12*	-15.57**
	(11.16)	(7.91)	(24.14)		(6.55)	(10.38)	(7.03)
10Y-1Y Swap Rate (%)	-53.72***	-34.19***	-85.1***	10Y-1Y Swap Rate (%)	-41.5***	-51.18***	-41.01***
	(17.23)	(8.95)	(18.24)		(5.6)	(8.9)	(5.39)
Implicit Bid-ask Spread (bp)	1.16***	0.58***	1.67***	Implicit Bid-ask Spread (bp)	0.68***	0.58***	0.68***
	(0.25)	(0.11)	(0.3)		(0.1)	(0.12)	(0.15)
Sector Volatility (%)	6.73**	4.68***	7.11**	Equity Volatility (%)	5.92***	8.91***	4.83***
	(2.7)	(1.26)	(3.02)		(0.95)	(0.99)	(1.32)
Estimated Market Value Leverage (%)	1.38	1.76	-3.38	Market Value Leverage (%)	0.40	2.96***	-0.81***
	(1.2)	(1.32)	(2.93)		(0.41)	(0.83)	(0.35)
Operating Income to Sales (%)	-1.14	-2.19*	-3.20	Operating Income to Sales (%)	-1.52**	-1.69	-1.29*
	(2.68)	(1.13)	(5.28)		(0.75)	(1.55)	(0.7)
Long-term Debt to Total Assets (%)	2.07***	2.02***	3.2**	Long-term Debt to Total Assets (%)	2.68***	-0.03	3.12***
	(0.8)	(0.57)	(1.45)		(0.73)	(1.18)	(1.04)
C1	10.26	14.68	145.00	C1	-8.96	-20.87***	6.41
	(19.75)	(22.55)	(98.58)		(5.48)	(7.66)	(7.41)
C2	44.03	65.47	-50.94	C2	-2.00	13.55**	-19.00**
	(36.6)	(44.93)	(83.49)		(4.58)	(5.66)	(7.95)
C3	-38.69	-46.31*	-156.51	C3	2.64	1.89	3.32
	(31.29)	(25.4)	(126.8)		(1.74)	(2.45)	(3.08)
C4	3.77	3.24		C4	-0.32	0.14	-1.44
	(2.68)	(2.27)			(0.48)	(0.53)	(1.7)
Adjusted R^2	42.3	38.3	47.8	Adjusted R^2	46.6	52.0	49.7
SER	230.4	143.2	295.3	SER	245.7	264.1	202.6
# of observations	7973	4819	3154	# of observations	56876	25999	30877
# of bonds	1005	631	374	# of bonds	4921	2158	2763

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

7.5 Inputs to approach inspired by Moody's RiskCalc™

Inputs to approach inspired by Moody's RiskCalc™

Bonds issued by private firms				Bonds issued by listed firms			
Non-financial firms		Financial firms		Non-financial firms		Financial firms	
Intercept	-17.91	Intercept	921.53	Intercept	-24.16	Intercept	281.27***
	(73.35)		(846)		(151.47)		(85.52)
Time to Maturity (Years)	-3.71	Time to Maturity (Years)	-5.15**	Time to Maturity (Years)	-3.3***	Time to Maturity (Years)	-2.70
	(3.18)		(2.57)		(1.12)		(1.84)
Bond Age (Years)	6.89***	Bond Age (Years)	0.67	Bond Age (Years)	0.45	Bond Age (Years)	2.19
	(2.64)		(8.98)		(2.87)		(2.08)
Coupon (%)	5.35	Coupon (%)	21.87	Coupon (%)	20.28**	Coupon (%)	22.16***
	(4.32)		(20.28)		(9.55)		(6.9)
Log(Issuesize)	-1.58	Log(Issuesize)	-8.51	Log(Issuesize)	-2.98	Log(Issuesize)	-18.9**
	(4.02)		(9.36)		(6.22)		(9.03)
Senior	50.06	Senior	14.52	Senior	30.80	Senior	10.12
	(38.03)		(60.37)		(28.83)		(12.19)
10Y Swap Rate (%)	-1.94	10Y Swap Rate (%)	-76.72***	10Y Swap Rate (%)	-17.3*	10Y Swap Rate (%)	-16.1**
	(6.3)		(15.74)		(10.28)		(7.23)
10Y-1Y Swap Rate (%)	-25.64***	10Y-1Y Swap Rate (%)	-71.53***	10Y-1Y Swap Rate (%)	-47.33***	10Y-1Y Swap Rate (%)	-43.93***
	(9.08)		(27.05)		(7.65)		(6.55)
Implicit Bid-ask Spread (bp)	0.54***	Implicit Bid-ask Spread (bp)	1.58***	Implicit Bid-ask Spread (bp)	0.58***	Implicit Bid-ask Spread (bp)	0.67***
	(0.1)		(0.27)		(0.11)		(0.13)
Sector Volatility (%)	3.84***	Sector Volatility (%)	5.95**	Equity Volatility (%)	8.87***	Equity Volatility (%)	4.76***
	(0.87)		(2.79)		(0.99)		(1.24)
Estimated Market Value Leverage (%)	0.21	Estimated Market Value Leverage (%)	-1.22	Market Value Leverage (%)	2.27***	Market Value Leverage (%)	-0.78*
	(0.8)		(1.88)		(0.71)		(0.47)
Sales ($USm)	0.0030**	1 to Sales ('000)	-30.10	Log(Sales ($USm)	-19.73**	Log(Total Assets $USm)	-14.9***
(Size)	(0.0014)	(Size)	(85.45)	(Size)	(9.24)	(Size)	(5.43)
Log(Operating Income to Sales)	98.02**	Log(Sales to Total Assets)	209.46*	Net Income to Total Assets (%)	-0.36	Net Income to Total Assets (%)	-25.56***
(Profitability)	(38.89)	(Profitability)	(84.74)	(Profitability)	(1.69)	(Profitability)	(7.86)
Sales to Total Assets (%)	4.21***	1/(Cash to Total Assets (bp))	0.00	Log(Cash to Total Assets)	5.50	Cash to Total Assets (%)	0.01
(Profitability)	(1.3)	(Liquidity)	(0)	(Liquidity)	(5.76)	(Liquidity)	(0.97)
Log(Cash to Total Assets)	-3.82	1 to Sales Growth in %	-24.77	Sales Growth (%)	0.38	Sales Growth (%)	-0.14
(Liquidity)	(5.33)	(Growth)	(19.8)	(Growth)	(0.42)	(Growth)	(0.35)
Sales Growth (%)	-0.59	Log(Interest Coverage)	26.79	Positive Interest Coverage	179.61**	Positive Interest Coverage	58.05
(Growth)	(0.56)	(Debt coverage)	(31.65)	(Debt coverage)	(83.51)	(Debt coverage)	(42.14)
1 to Interest Coverage	42.37***	1 to (Total Liabilities to Assets)	25.30	Long-term Debt to Networth	0.93	Long Term Debt to Total Assets (%)	2.92***
(Debt coverage)	(15.99)	(Leverage)	(568.05)	(Leverage)	(1.19)	(Leverage)	(1.11)
Retained Earnings to Total Assets (%)	-7.29***						
(Solvency)	(2.2)						
Adjusted R^2	48.5		51.24		53.33		53.96
SER	130.6		285.82		262.53		210.5
# of observations	4730		3139		25815		31000
# of bonds	620		375		2154		2758

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

8 Appendix 8: Effect of adding 125 month dummy variables

8.1 Altman's z"-score

Altman's z''-score				
		Listed firms		
	Private non-financial	All	Non-financial	Financial
Intercept	541.60	169.50	330,29**	288,9**
	(519,2)	(143,7)	(166,1)	(114,6)
Time to Maturity (Years)	-3.70	-3,59***	-4,05***	1,7**
	(3,9)	(1,3)	(1,3)	(0,8)
Bond Age (Years)	1.50	-3.20	-7,9**	-1.00
	(13,1)	(3,8)	(3,9)	(1,7)
Coupon (%)	11.60	29,67**	36,4**	7,5***
	(23,3)	(14,2)	(15)	(2,6)
Log(Issuesize)	12.60	-7.60	-17,8**	-8,2***
	(14,2)	(8)	(7,9)	(1,1)
Senior	91,83*	58.20	73,5*	-51,3***
	(49,8)	(35,5)	(38,3)	(22)
10Y Swap Rate (%)	85.70	-60.89	-88,5*	18.80
	(169,2)	(47)	(51,6)	(30,5)
10Y-1Y Swap Rate (%)	-277.20	44.80	77.00	-93,2***
	(252,2)	(71,1)	(82)	(38,1)
Implicit Bid-ask Spread (bp)	0,70***	1,17***	1,3***	0,09***
	(0,2)	(0,2)	0.21	(0)
Altman's z''-score	-135,24**	-44,76***	-48,79***	-2.60
	(56,4)	(12,7)	(13,6)	(8,4)
Rating dummy variables''	Yes	Yes	Yes	Yes
Month dummy variables'''	Yes	Yes	Yes	Yes
Adjusted R^2	52.6	36.5	36.8	54.4
SER	270.8	323.7	340.1	90.1
# of observations	718	30023	26242	3781
# of bonds	98	2629	2152	447

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

''' Dummy variables for all months between August 2002 to December 2012. July 2002 is the intercep

* Significant at a 1% significance level, ** Significant at a 5% significance level,

*** Significant at a 10% significance level

8.2 Financial Measures applied in Kovner and Wei (2012)

Financial measures applied in Kovner and Wei (2012)

	Bonds issued by private firms			Bonds issued by listed firms		
	All	Non-financial	Financial	All	Non-financial	Financial
Intercept	-98.67	198.15	100.41	394,03***	466,95**	305.27
	(250,7)	(214,3)	(325,5)	(138)	(216,4)	(215,1)
Time to Maturity (Years)	-4.23	-3.10	-0.15	-4,23***	-4,50***	-4.44
	(3,6)	(3,7)	(1,8)	(1,4)	(1,4)	(3,1)
Bond Age (Years)	4.09	15,22***	6.03	-1.49	-5.32	-0.85
	(4,7)	(5,5)	(5,5)	(2,9)	(3,6)	(3,7)
Coupon (%)	-0.66	0.33	-9.08	21,61***	34,30**	15,95**
	(5,7)	(5,6)	(9,4)	(8)	(14,7)	(6,5)
Log(Issuesize)	-0.98	3.58	-7.23	-7.70	-0.37	-18,81*
	(4,1)	(4,9)	(6,3)	(8,5)	(7,2)	(9,7)
Senior	-19.09	17.24	13.37	38.84	67,54*	16.05
	(31,6)	(30,2)	(54,7)	(15)	(37,3)	(13,5)
10Y Swap Rate (%)	-50.95	-67.24	-64.34	-17.80	-80.01	39.81
	(60,8)	(56,6)	(98,4)	(40,1)	(54)	(50,3)
10Y-1Y Swap Rate (%)	-40.96	-7.36	-12.24	-22.63	55.28	-75.70
	(107,6)	(76,6)	(177,4)	(53,6)	(83)	(76,9)
Implicit Bid-ask Spread (bp)	0,94***	0,52***	0,74***	1,13***	1,21***	0,82***
	(0,2)	(0,1)	(0,3)	(0,2)	(0,2)	(0,3)
Log(Total Assets ($USm))	45,62***	3.38	22,54**	-22,10***	-16,93*	-20,71***
(Size)	(13,5)	(20,9)	(9,1)	(5,8)	(9,5)	(7,6)
Operating Income to Total Assets	2.79	2.38	7.35	-13,90***	-14,97***	-30,91***
Profitability	(4,9)	(3,1)	(5,5)	(3,2)	(3,9)	(8,6)
Total Debt to Total Assets (%)	0.82	2,19*	0.23	1,46**	1.94	1.49
(Leverage)	(0,6)	(1,2)	(0,8)	(0,7)	(1,4)	(0,9)
Rating dummy variables''	Yes	Yes	Yes	Yes	Yes	Yes
Month dummy variables'''	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	51.1	47.3	69.8	40.9	38.3	48.0
SER	219.0	157.3	222.1	286.8	334.5	225.5
# of observations	8130	4866	3264	58035	26883	31152
# of bonds	1012	631	381	4943	2172	2771

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

''' Dummy variables for all months between August 2002 to December 2012. July 2002 is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significanc

8.3 Financial measures applied in Blume et al. (1998)

Financial measures applied in Blume et al. (1998)						
	Bonds issued by private firms			Bonds issued by listed firms		
	All	Non-financial	Financial	All	Non-financial	Financial
Intercept	421,68**	361,91***	264.87	228*	484,5***	38.72
	(198,23)	(121,44)	(372,26)	(118,91)	(179,14)	(148,37)
Time to Maturity (Years)	-5.26	-2.90	-1.84	-3,7***	-4,92***	-3.91
	(3,94)	(3,01)	(3,25)	(1,26)	(1,37)	(2,65)
Bond Age (Years)	5.32	13,51***	4.34	-2.09	-4.76	0.02
	(4,25)	(4,27)	(3,32)	(2,42)	(3,42)	(2,64)
Coupon (%)	-1.67	-8.21	-4.89	19,73***	30,56**	12,73**
	(6,08)	(6,55)	(7,64)	(7,54)	(14,05)	(5,47)
Log(Issuesize)	5.92	7.00	-6.81	-12,77*	-7.27	-17,68**
	(5,78)	(4,64)	(7,06)	(6,79)	(7,56)	(8,14)
Senior	-69.72	47.19	-54.82	11.72	40.81	-6.85
	(51,03)	(34,72)	(53,19)	(13,95)	(35,54)	(15,32)
10Y Swap Rate (%)	-43.49	-54.01	-38.65	-16.64	-89,17*	37.09
	(60,32)	(47,21)	(96,76)	(37,81)	(51,66)	(46,42)
10Y-1Y Swap Rate (%)	-54.11	-17.80	-43.43	-20.76	68.39	-78.89
	(105,93)	(63,43)	(184,28)	(51,91)	(81,49)	(72,64)
Implicit Bid-ask Spread (bp)	1,03***	0,52***	0,78***	1,03***	1,16***	0,68***
	(0,19)	(0,09)	(0,27)	(0,16)	(0,19)	(0,22)
Operating Income to Sales (%)	-2.52	-3,53***	-2.36	-3,43***	-4,09**	-3,32***
	(1,68)	(1,15)	(2,96)	(0,97)	(1,97)	(1,18)
Long-term Debt to Total Assets (%)	2,44**	2,3*	1,82**	2,58**	0.90	3,34**
	(1,01)	(1,23)	(0,74)	(1,12)	(1,75)	(1,65)
C1	-6.76	-0.26	104,11*	-30,47***	-61,37***	3.01
	(14,6)	(13)	(45,89)	(6,31)	(10,38)	(5,98)
C2	49,07*	23.97	-32.92	3.05	15,29**	-28,68**
	(25,24)	(28,44)	(35,73)	(5,98)	(6,81)	(13,03)
C3	-33.55	-24.80	-87.37	7,05*	1.11	20,86***
	(23,58)	(18,92)	(65,29)	(4,16)	(3,43)	(6,95)
C4	-3.10	1.68		-0.39	0.01	-1.15
	(4,15)	(2,36)		(0,8)	(0,67)	(1,31)
Rating dummy variables''	Yes	Yes	Yes	Yes	Yes	Yes
Month dummy variables'''	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	51	49.23	70.17	41.39	39.21	49.57
SER	219.82	154.36	222.79	276.2	330.29	202.61
# of observations	8026	4860	3166	57740	26834	30906
# of bonds	1008	631	377	4935	2170	2765

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

''' Dummy variables for all months between August 2002 to December 2012. July 2002 is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significanc

8.4 Inputs to approach inspired by Moody's RiskCalcTM

Inputs to approach inspired by Moody's RiskCalc™

Bonds issued by private firms				Bonds issued by listed firms			
Non-financial firms		Financial firms		Non-financial firms		Financial firms	
Intercept	421,74**	Intercept	708.77	Intercept	308,16*	Intercept	105.32
	(171,9)		(823,58)		(177,28)		(187,45)
Time to Maturity (Years)	-1.60	Time to Maturity (Years)	-0.38	Time to Maturity (Years)	-4,14***	Time to Maturity (Years)	-4.70
	(2,16)		(1,56)		(1,36)		(2,89)
Bond Age (Years)	7,47**	Bond Age (Years)	5.99	Bond Age (Years)	-4.30	Bond Age (Years)	-1.22
	(2,35)		(6,07)		(3,24)		(3,33)
Coupon (%)	-4.07	Coupon (%)	-8.05	Coupon (%)	28,24**	Coupon (%)	19,19**
	(3,55)		(9,96)		(11,35)		(7,62)
Log(Issuesize)	-4,7*	Log(Issuesize)	-8,34*	Log(Issuesize)	-15,15**	Log(Issuesize)	-20,3**
	(2,46)		(4,56)		(6,88)		(9,75)
Senior	37.53	Senior	-15.37	Senior	34.71	Senior	3.55
	(31,74)		(38,06)		(32,57)		(14,27)
10Y Swap Rate (%)	-87,11*	10Y Swap Rate (%)	-23.41	10Y Swap Rate (%)	-57.06	10Y Swap Rate (%)	55.20
	(51,46)		(94,6)		(50,48)		(51,87)
10Y-1Y Swap Rate (%)	28.28	10Y-1Y Swap Rate (%)	-58.77	10Y-1Y Swap Rate (%)	27.01	10Y-1Y Swap Rate (%)	-94.03
	(58,29)		(180,33)		(69,78)		(77,09)
Implicit Bid-ask Spread (bp)	0,40***	Implicit Bid-ask Spread (bp)	0,71***	Implicit Bid-ask Spread (bp)	0,93***	Implicit Bid-ask Spread (bp)	0,73***
	(0,09)		(0,23)		(0,16)		(0,2)
Sales ($USm)	0,0058***	1 to Sales ('000)	-32.30	Log(Sales ($USm)	-7.20	Log(Total Assets $USm)	-7.84
(Size)	(0,0013)	(Size)	(45,72)	(Size)	(7,46)	(Size)	(4,83)
Log(Operating Income to Sales)	45.87	Log(Sales to Total Assets)	96.11	Net Income to Total Assets (%)	-5,3***	Net Income to Total Assets (%)	-41,04***
(Profitability)	(35,52)	(Profitability)	(87,05)	(Profitability)	(1,96)	(Profitability)	(13,45)
Sales to Total Assets (%)	2,17**	1/(Cash to Total Assets (bp))	0.00	Log(Cash to Total Assets)	6.07	Cash to Total Assets (%)	0.45
(Profitability)	(0.89)	(Liquidity)	(0,0008)	(Liquidity)	(5,99)	(Liquidity)	(1,07)
Log(Cash to Total Assets)	-7.75	1 to Sales Growth in %	-5.59	Sales Growth (%)	-1,05*	Sales Growth (%)	-0.09
(Liquidity)	(6,99)	(Growth)	(7,85)	(Growth)	(0,63)	(Growth)	(0,38)
Sales Growth (%)	-0.90	Log(Interest Coverage)	27.68	Positive Interest Coverage	307,93***	Positive Interest Coverage	122,41***
(Growth)	(0,56)	(Debt coverage)	(24,98)	(Debt coverage)	(100,11)	(Debt coverage)	(44,22)
1 to Interest Coverage	25.86	1 to (Total Liabilities to Assets)	-164.26	Long-term Debt to Networth	2,25*	Long Term Debt to Total Assets (%)	3,30*
(Debt coverage)	(15,86)	(Leverage)	(359,13)	(Leverage)	(1,28)	(Leverage)	(1,72)
Retained Earnings to Total Assets (%)	-7,77***						
(Solvency)	(1.85)						
Control variables	Yes	Control variables	Yes	Control variables	Yes	Control variables	Yes
Rating dummy variables''	Yes	Rating dummy variables''	Yes	Rating dummy variables''	Yes	Rating dummy variables''	Yes
Month dummy variables'''	Yes	Month dummy variables'''	Yes	Month dummy variables'''	Yes	Month dummy variables'''	Yes
Adjusted R^2	58.3	Adjusted R^2	71.6	Adjusted R^2	42.21	Adjusted R^2	52.27
SER	138.0	SER	217.83	SER	311.83	SER	215.46
# of observations	4770	# of observations	3151	# of observations	26455	# of observations	31019
# of bonds	630	# of bonds	378	# of bonds	2165	# of bonds	2760

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

''' Dummy variables for all months between August 2002 to December 2012. July 2002 is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

8.5 Sector inputs to a structural credit risk measure – private firms

Sector inputs to a structural credit risk measure for yield spreads			
	Bonds issued by private firms		
	All	Non-financial	Financial
Intercept	-132.52	-53.79	-1049.57
	(184,17)	(113,78)	(652,2)
Time to Maturity (Years)	-4.59	-3.62	-0.48
	(3,07)	(2,51)	(2,22)
Bond Age (Years)	4.36	10,77***	6.93
	(2,99)	(3,28)	(5,64)
Coupon (%)	4.93	3.83	-9.99
	(5,87)	(4,16)	(10,07)
Log(Issuesize)	1.54	2.83	-5.31
	(4,16)	(3,28)	(6,96)
Senior	-11.50	8.39	6.27
	(28,22)	(30,88)	(44,97)
10Y Swap Rate (%)	-60.93	-68.43	-62.77
	(70,99)	(61,78)	(101,74)
10Y-1Y Swap Rate (%)	2.56	30.81	-12.49
	(112,22)	(77,97)	(183,68)
Implicit Bid-ask Spread (bp)	0,79***	0,46***	0,77***
	(0,15)	(0,09)	(0,27)
Sector Volatility (%)	6,89**	4,57**	38.57
	(2,99)	(2,07)	(24,63)
Estimated Market Value Leverage (%)	2,6***	2,71***	0.36
	(0,78)	(1)	(2,32)
Rating dummy variables''	Yes	Yes	Yes
Month dummy variables'''	Yes	Yes	Yes
Adjusted R^2	57.0	49.9	69.7
SER	198.4	133.0	223.5
# of Observations	8077	4825	3252
# of Bonds	1009	631	378

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

''' Dummy variables for all months between August 2002 to December 2012. July 2002 is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance level

8.6 Inputs to a structural credit risk measure – listed firms

Sector and publicly traded data inputs to a structural credit risk measure for yield spreads						
	Bonds issued by listed firms					
	All		Non-financial		Financial	
Intercept	-175.28	-205.92	-104.68	-339,79**	-201.93	-132.19
	(142,73)	(155,19)	(162,12)	(152,11)	(333,2)	(190)
Time to Maturity (Years)	-3,57***	-2,05**	-3,83***	-2,74***	-4.54	-2.98
	(1,36)	(0,84)	(1,35)	(1,02)	(3,11)	(1,98)
Bond Age (Years)	-1.80	1.05	-5.71	-2.67	-1.08	-0.08
	(2,38)	(1,71)	(3,6)	(2,76)	(3,92)	(2,44)
Coupon (%)	22,13***	22,58***	38,77***	24,79**	13,72**	16,23***
	(8,38)	(7,24)	(15,51)	(11,13)	(6,25)	(5,84)
Log(Issuesize)	-14,69*	-23,4***	-11,98*	-9,92*	-16,93*	-22,76***
	(8,29)	(6,83)	(6,68)	(5,94)	(9,8)	(8,67)
Senior	39,07**	32,56**	52.43	17.13	26,12**	18,16*
	(16,1)	(13,4)	(37,96)	(30,4)	(11,95)	(10,47)
10Y Swap Rate (%)	25.69	85,35*	-31.15	48.87	51.67	91.68
	(41,91)	(47,09)	(50,14)	(36,9)	(51,84)	(58,25)
10Y-1Y Swap Rate (%)	-72.56	-157,24**	-12.67	-88.87	-90.23	-168,28*
	(58,93)	(67,4)	(72,17)	(60,26)	(80)	(92,46)
Implicit Bid-ask Spread (bp)	0,97***	0,65***	1,00***	0,59***	0,86***	0,57***
	(0,17)	(0,1)	(0,2)	(0,13)	(0,28)	(0,14)
Sector Volatility (%)	3,86***		5,38***		1.83	
	(1,29)		(1,6)		(13,18)	
Estimated Market Value Leverage (%)	2,7***		3,43**		2,43*	
	(1)		(1,64)		(1,37)	
Equity Volatility (%)		7,18***		10,37***		6,46***
		(1,17)		(1,48)		(1,97)
Market Value Leverage (%)		1,13***		2,79***		0.00
		(0,35)		(0,61)		(0,26)
Rating dummy variables''	Yes	Yes	Yes	Yes	Yes	Yes
Month dummy variables'''	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	38.7	53.6	34.5	55.3	45.6	59.5
SER	273.2	237.8	310.6	256.5	229.5	197.9
# of Observations	57147	57147	26028	26028	31119	31119
# of Bonds	4929	4929	2160	2160	2769	2769

'' Dummy variables for AA, A, BBB, Speculative Grade and Not Rated. AAA is the intercept

''' Dummy variables for all months between August 2002 to December 2012. July 2002 is the intercept

* Significant at a 1% significance level, ** Significant at a 5% significance level, *** Significant at a 10% significance le

9 Appendix 9: Liquidity component in sub periods

The liquidity component in basis points for July 2002 to December 2007 and January 2008- December 2012

Bonds issued by private firms

Period	Rating	All				Non financial				Financial			
		All	0-2 years	2-5 years	5-30 years	All	0-2 years	2-5 years	5-30 years	All	0-2 years	2-5 years	5-30 years
July 2002 - December 2007	AAA	0.71	0.35	0.82	1.34	1.58	5.46	2.37	5.50	1.80		1.47	2.90
	Observations	428	160	139	129	244	123	85	36	184	37	54	93
	A	15.83	11.43	20.40	28.51	12.96	9.03	15.25	26.71	14.31	10.86	21.83	18.06
	Observations	3237	1651	1224	362	2004	974	803	227	1233	677	421	135
	BBB	25.51	12.98	41.61	41.05	16.81	8.50	27.16	30.97	29.53	17.14	40.83	
	Observations	391	177	157	57	333	147	129	57	58	30	28	0
	SPEC	18.27	15.97	23.40	15.81	8.74	7.68	10.73	7.40	7.04	5.92	9.26	
	Observations	229	110	85	34	158	65	59	34	71	45	26	0
January 2008 - December 2012	AAA	7.00	3.10	7.55	16.75	7.42	5.00	6.04		17.33	6.62	17.70	32.37
	Observations	736	213	305	218	141	78	63	0	595	135	242	218
	A	14.72	9.26	12.91	30.63	6.79	3.85	6.69	12.75	14.60	12.14	9.15	26.76
	Observations	2481	949	974	558	1837	732	732	373	644	217	242	185
	BBB	90.27	98.17	125.48	50.15	33.80	33.25	28.10	30.69	90.10	87.73	100.03	32.62
	Observations	233	94	84	55	91	30	13	48	142	64	71	7
	SPEC	43.65	62.94	46.32	31.01	23.11	16.08	9.25	20.38	15.43	23.43	16.97	9.25
	Observations	363	84	171	108	52	9	6	37	311	75	165	71

Bonds issued by listed firms

Period	Rating	All				Non financial				Financial			
		All	0-2 years	2-5 years	5-30 years	All	0-2 years	2-5 years	5-30 years	All	0-2 years	2-5 years	5-30 years
July 2002 - December 2007	AAA	0.53	0.26	0.66	1.23	2.73	1.15	3.58	6.02	-0.98	-0.48	-1.22	-2.18
	Observations	10855	4680	3618	2557	942	699	692	2333	8522	3738	2919	1865
	A	9.09	3.92	10.44	18.51	11.10	4.53	12.08	24.52	2.92	1.28	3.64	5.31
	Observations	15146	5745	4714	4687	2537	1915	2431	6883	8263	3208	2799	2256
	BBB	15.93	6.79	14.42	29.01	15.18	5.97	14.20	30.21	18.13	14.33	14.13	22.82
	Observations	8704	2644	2427	3633	2270	2037	2903	7210	1494	374	390	730
	SPEC	51.81	31.53	53.80	60.03	53.25	33.47	56.85	62.07	32.37	14.60	22.26	40.23
	Observations	5256	1456	1703	2097	1408	1651	1917	4976	280	48	52	180
January 2008 - December 2012	AAA	9.20	3.90	7.29	18.34	2.81	1.03	2.25	5.68	9.60	4.12	7.65	19.05
	Observations	6094	2218	2199	1677	241	149	298	688	5406	1977	2050	1379
	A	35.04	22.36	33.37	40.79	17.61	7.46	13.92	23.30	41.49	30.77	40.86	46.94
	Observations	6145	1904	1676	2565	484	226	875	1585	4560	1420	1450	1690
	BBB	24.24	12.37	20.56	30.08	3.99	1.74	3.09	5.00	41.79	31.39	36.65	50.75
	Observations	3671	849	1015	1807	370	289	1114	1773	1898	479	726	693
	SPEC	35.72	31.50	40.48	35.51	27.72	17.66	30.37	31.57	39.74	41.10	60.77	29.03
	Observations	2005	445	434	1126	261	278	833	1372	633	184	156	293