The Determinants of Corporate Yield Spreads:

Before and After the Global Financial Crisis

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ABSTRACT

We study the impact of the recent global financial crisis on the determinants of corporate bond spreads, in particular, focusing on the impact of liquidity and credit risk on yield spreads using data regarding financial and non-financial bond issuers listed on the Korean Exchange. Our findings reveal that the credit risk component is a more influential determinant of yield spreads than liquidity, especially after the onset of the crisis. While not sufficient in linear regression specifications, the average trading volume of corporate bonds and the equity volatility of bond issuers are significantly correlated to yield spreads in a quadratic mode during the post-crisis period.

Keywords: Determinants of corporate bond spreads; Global financial crisis; Credit risk; Liquidity risk.

JEL classification: G01; G12; G32

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1. Introduction

The recent global financial crisis affected financial investors' risk perception and their ensuing behavior. Thus, it is worthwhile to explore the key determinants of risk premium by examining the most powerful influences on the market prices of risky assets *before* and *after* the onset of the crisis.

There is considerable academic research regarding the risk factors of corporate bonds to elucidate the determinants of yield spreads.[1] In line with many other studies, Delianedis and Geske (2001) argue that credit risk and spread are driven by recovery, tax, liquidity, and market risk factors. Collin-Dufresne, Goldstein, and Martin (2001) find that the changes in credit spreads are attributable to the supply/demand shock, which is independent of the proxies for both credit and liquidity risk. Huang and Huang (2012) demonstrate that credit risk explains a small portion of the yield spread for investment-grade bonds. Longstaff, Mithal, and Neis (2005) discover that credit risk is the main determinant of corporate yield spreads. Covits and Downing (2007) report similar findings with Longstaff, Mithal, and Neis (2005) regarding very short-term commercial paper issued by non-financial U.S. corporations. By proposing a new illiquidity measure, Dick-Nielsen, Feldhütter, and Lando (2011) report a dramatic increment with the onset of the subprime crisis in the spread contribution from liquidity factors in the corporate bond market.

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[1]On the analysis of sovereign yield behaviors, Ejsing, Grothe, and Grothe (2012) classify the related literature into two major streams: The first employs proxies for liquidity and credit risk to explain the variations in the time-series behavior of yield spreads. For example, using CDS spreads as a proxy for credit quality and effective bid-ask spreads as a measure of liquidity, Beber, Brandt, and Kavajecz (2009) discover that bond investors usually take both credit and liquidity risk into consideration; yet, their attention shifts toward the latter when the market is under stress. The second stream analyzes credit and liquidity risk by directly controlling either of the two factors. For example, Longstaff (2004) uses the difference in yields between Treasury and Refcorp bonds to examine whether a flight-to-liquidity premium exists in bond prices. Refcorp bonds have the same credit quality as sovereign bonds since they are fully guaranteed by the U.S. government.

The present study analyzes corporate bond yield spreads to shed additional light on the yield contribution from liquidity and credit components to the non-U.S. bond market following the recent global financial crisis. For this purpose, our data set incorporates both financial and non-financial corporate bond issuers listed on the Korean Exchange (KRX). It is noteworthy that despite the significant role the financial sector plays in the economy, prior academic research has devoted little attention to financial firms with regard to the topics analyzed in our study. Typically, this tendency is closely related to the estimation of firm-specific leverage or distance-to-default, a measure of the volatility-adjusted leverage of a firm, in a consistent and universal manner.[2] The problem arises when the leverage statistic is calculated; in this regard, Moody's KMV method suggests that the standard level of distance-to-default is solely determined by the firm's current liabilities and its long-term debts, even though financial firms in general possess a large amount of liabilities that cannot be simply categorized as such. Hence, this conventional approach for estimating the distance-to-default tends to neglect a substantial part of a financial firm's debts, producing unreliable estimates for their likelihood of default. To overcome this challenge, we obtain distance-to-default estimates from the website of the Risk Management Institute at the National University of Singapore (NUS–RMI), which provides such estimates of listed firms worldwide, including both financial and non-financial firms listed on the KRX, by adopting the methodology proposed by Duan and Wang (2012).

For evaluating the role of liquidity and credit risk in determining corporate yield spreads, we run regressions of average corporate yield spreads on the proxies for liquidity (*Average Trade Volume*, *Cash over Asset*, and *Maturity*) and credit risk (*Rating*, *Coupon*, *Equity*

[2]Bharath and Shumway (2008) show that Merton's (1974) distance-to-default probability is useful for predicting default, but is seemingly insufficient to represent the statistics of default.

Volatility, and *Distance-to-Default*) with data comprising 283 issues from 66 firms (financial and non-financial) between 2007–08 (before the crisis) and 567 bond issues from 124 firms between 2009–11 (after the crisis). Overall, the results demonstrate that credit risk plays a significant role in determining corporate yield spreads for Korean investment-grade bonds. In contrast to Delianedis and Geske (2001) and Huang and Huang (2003), such findings are robust to the alternative proxies for credit risk and various other model specifications.

Moreover, we find that participants in the Korean corporate bond market are more conscious of credit quality in the post-crisis era. However, we note that credit risk alone does not explain the entire yield-spread behavior. This observation provides evidence regarding the significant impact of liquidity on spread as well. Specifically, the empirical results show that *Maturity* is significantly related to spreads in our regression specifications even after controlling for credit risk factors. Furthermore, we explore the nonlinear properties of *Average Trade Volume* and *Equity Volatility* on average corporate yield spreads. While *Average Trade Volume* and *Equity Volatility* are not significant in linear specifications, non-trivial quadratic dimensions in such variables may account for yield spreads on their squared terms in the presence of other control variables.

The rest of this paper is organized as follows: Section 2 describes our methodology and selected variables; Section 3 provides the data selection criteria; Section 4 elaborates on the empirical results; and Section 5 presents our conclusions. In addition, we have included several appendices.

2. Methodology

2. 1 Model Specification

The basic unit of analysis is corporate bond transactions. For estimating the impact of credit and liquidity risk on yield spread pricing, we run a cross-sectional regression of bond spreads on the proxies for liquidity and credit risk. The basic model specification is given by

$$\text{(Yield Spread)} = \beta_0 + \beta_1^T * \text{(Liquidity risk factors)} + \beta_2^T * \text{(Credit risk factors)} + \varepsilon.$$

The term "Liquidity risk factors" represents a set of possible proxies for liquidity risk. Similarly, the term "Credit risk factors" represents a set of possible proxies for the default risk of a bond issuer. Note that Covitz and Downing (2007) take log functions of each variable to reduce the impact of outliers, arguing that their basic conclusion does not change in the form of log-level regression. In our data set, however, such a log-transformation tends to weaken the accuracy of empirical analysis, even though the major results are seemingly intact.

2. 2 Selected Variables

This study defines the *Yield Spread* on a corporate bond as the yield differential between a corporate bond and a comparable-maturity, risk-free rate instrument such as a government bond. Our analysis employs the average yield spread as a dependent variable in the regression model.

The liquidity proxies used in this analysis include *Average Trade Volume*, *Cash over Asset*, and *Maturity*.[3] The first measure, *Average Trade Volume*, is the average of the total trading volume during which a specific issue is outstanding. It is obtained by dividing the total trading volume with the number of (corresponding) months during which the issue is traded.[4]

The second liquidity measure, *Cash over Asset*, is specific to each bond issuer and is defined as the ratio of the sum of cash and marketable short-term securities such as trading securities to the amount of total assets, indicating the issuer's ability to meet its short-term obligations. A higher level of cash over total assets indicates a higher funding liquidity profile of the bond issuer. In general, therefore, this variable is expected to be negatively related to yield spreads assuming that a lower liquidity profile represents higher liquidity demand from the bond issuer's perspective. However, an excessively high level of cash ratio might represent higher inventory costs, meaning that after a threshold, a higher cash ratio drives up the yield spread.

Maturity is the time left until maturity from the issuance date of a security. As mentioned in Longstaff, Mithal, and Neis (2005), the rationale for using this variable is that there might be maturity-sensitive clientele for corporate bonds. Accordingly, it is expected that the shorter the maturity, the more liquid the bond. This study expects the coefficient of maturity to be positive in the analysis.[5]

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[3]We considered including *Average Trading Number* as another liquidity proxy measure in our analysis, but decided against it because of its possible multicollinearity with the *Average Trade Volume* variable. Note that Covitz and Downing (2007) included both variables in their study.

[4]Brunnermeier and Pederson (2009) argue that liquidity risk can be classified into market liquidity and funding liquidity. Market liquidity can be considered "good" when a security is easily traded in the market, measuring the ease of asset trade with a limited or no price impact. On the other hand, funding liquidity refers to the ability to settle obligations immediately. In this paper, we focus on market liquidity whose proxy is the *Average Trade Volume* variable.

[5]Longstaff, Mithal, and Neis (2005) demonstrate that the time to maturity is a significant factor for explaining the non-default component of spreads, arguing that the result is consistent with intuition—shorter-maturity

This study considers four credit risk variables as explanatory variables. The first proxy, *Rating*, is the credit rating assigned to each security that a firm issues. As in the case of yield-to-maturity, the rating offered by CheckExpert[6] is the average of the credit ratings given by three major Korean credit rating agencies: the National Information and Credit Evaluation Inc., Korea Asset Pricing (or Korea Ratings), an affiliate of Fitch Ratings, and Korea Investors Service, a Moody's affiliate. Our study utilizes the coding method of Covitz and Downing (2007) for credit ratings: AAA = 1, AA+ = 2, …, and BBB- = 10. Of course, a positive relationship is expected between yield spreads and credit ratings. Some might say that dummy variables could be used for coding credit ratings. However, that is unlikely, at least in this analysis, since only investment-grade firms are included in our data set.[7]

Coupon refers to the coupon rate of bonds. In the Korean corporate bond market, firms typically issue their bonds at par value.[8] As expected, bonds issued by firms with higher default risk are significantly discounted upon issuance, other things being constant. Our assumption is that firms raise the coupon rate in order to adjust the bonds to their face value. We expect the coefficient of the coupon rate to be positive.[9]

The *Distance-to-Default* (DtD) measure is based on Merton's (1974) bond pricing

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bonds are more liquid than longer ones. However, Covits and Downing (2007) maintain that a classification as to whether the time to maturity is a liquidity or credit factor is somewhat ambiguous. However, they prefer treating it as a liquidity measure.

[6] CheckExpert is a database, which provides useful information including financial statements, financial ratios, and security prices in the Korean financial market.

[7]Covitz and Downing (2007) mention that whether credit ratings are coded by using dummy or numeric variables, there are little or no changes in their results.

[8]This convention is verifiable from the Bonds tab or Information Center (Publication) tab on the KRX website: http://eng.krx.co.kr/. [Accessed on August 3, 2012]

[9]Longstaff, Mithal, and Neis (2005) use the coupon rate of bonds as a determinant of the non-default component of bond spreads, (specifically, tax effects), showing that the coupon rate of bonds is significant, at least at the 90% level, in any model specifications employed in this study.

formula.[10] DtD represents how far a firm is from default; a smaller DtD value means a higher probability of default. The default probabilities of every listed firm on the KRX are available at the website of the NUS–RMI, free of charge. The Credit Rating Initiative (CRI) database of this institute provides monthly frequency data on default probabilities. This study takes the average of the distance-to-default estimates of the period while a specific issue is outstanding within the sample period. Obviously, the distance-to-default variable is expected to have a negative relationship with bond spreads.

The last credit risk proxy we consider is *Equity Volatility*, estimated from historical stock price data.[11] Assuming there are 252 trading days per year (equivalently, 21 days per month), we obtain a monthly standard deviation by multiplying the square root of 21 and the standard deviation calculated using daily-frequency stock returns. The rationale behind this is that other liquidity or credit risk proxies such as average trading volume or the distance-to-default are computed on a monthly basis. It is well known that as a firm approaches default, the risk associated with its debt also increases, and such risk is correlated to the risk associated with equity. Thus, we expect the calculated equity return volatility to have a positive correlation with bond spreads.

3. Data and Sample

3. 1 Sample Period

We employ a set of data including the transactions of Korean bonds issued by both financial and non-financial firms. As for the sample period, we employ the difference between 3-year BBB- corporate bond yields and the corresponding risk-free interest rate as a

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[10] Source: *National University of Singapore, Risk Management Institute, CRI database.* Available at: http://rmicri.org [Accessed on August 3, 2012].

[11] For details of the estimation procedure, see Hull (page 286-288, 6th edition), for example.

proxy for financial market liquidity or a global change in credit risk. The data are obtained from the Bloomberg terminal. As illustrated in the following graph, the time series of these proxies were stable until the 2008 financial crisis when their values soared rapidly.

(Figure 1 here)

In fact, the post-crisis period—especially, the Korean market's post-crisis reaction to liquidity and credit risk—is of particular interest to us. Furthermore, despite looking slightly unstable compared to the data before 2008, the proxies during the post-crisis period seem to maintain relatively high values. The assumption behind this finding is that the 2008 financial crisis brought about a structural break and changed the whole context by putting the Korean economy into a new regime.

3.2 Data Description

The daily time-series data for Korean corporate bond spreads per issue were obtained from the CheckExpert. The database also provides data for the average of the yield-to-maturity estimates of three Korean credit rating agencies.[12] For refined data collection, our sample uses straight bonds by excluding the issues with embedded options such as calls or puts, whose prices are, in many cases, determined by the option's premium rather than fundamental risk factors specific to the issuer.

It is noteworthy that our data set includes financial bond issuers, whereas numerous academic papers exclude such issuers, dismissing the financial sector's significant role in the economy. The CRI Technical Report of NUS–RMI provides estimates of the distance-to-default for financial firms as well as for non-financial ones.

In addition, individual bond issues with face values of less than 1 billion KRW (also

[12]Korean regulations require issuers of non-guaranteed bonds to obtain ratings from at least two such agencies.

called "baby bonds") are excluded to avoid random sampling and to minimize the impact of extreme statistical figures on empirical results. Won and Lee (2007) maintain that baby bonds are mainly traded among individuals. In such cases, securities companies, the other party to a transaction, charge and garner huge commissions, as reflected in the interest rate, which, in turn, might distort the true level of interest rates.

Furthermore, our analysis considers the fixed coupon, exchange-listing, and Korean-denominated issues. It is possible to obtain reliable stock data such as stock return volatility or market capitalization only when exchange-listed issues are used. In particular, the most critical inputs in the distance-to-default calculation, which is employed as a proxy for credit risk, obviously include the market values of equity and the volatility of equity. Later in the paper, we provide a detailed explanation regarding Merton's (1974) model and his distance-to-default computation. Owing to the aforementioned reasons, our sample excludes unlisted companies.

Similarly, we exclude guaranteed bonds and subordinated bonds. The prices of guaranteed bonds are usually determined by the credibility of the assurers, rather than that of the corresponding company itself. Meanwhile, the prices of subordinated bonds vary depending on the priority precedence of the debt issues even though the business entity's credit qualities are identical. In addition, the issues with at least 6 months remaining to maturity come within the boundary of the sample. According to a 2011 report of Korea Ratings, bonds with less than 1 year remaining to maturity are usually accompanied by a rapid decline in liquidity. This is mainly attributable to the need for securing funding liquidity rather than the desire for higher investment returns. In this regard, Jung and Kook (2002) exclude issues with less than 6 months remaining to maturity when calculating the implied default rate per issue. Therefore, we solely employ and analyze bond issues with at least 6 months remaining to maturity to avoid facing the distortion of yield spreads by liquidity factors.

Lastly, our data set contains bond issues outstanding for at least 1 year throughout the sample period, both from March 1, 2007 to December 31, 2008 and from January 1, 2009 to December 31, 2011. For example, bond A, issued at the beginning of 2008 and expired at the end of 2011, is included in the sample, while bond B, issued at the end of November 2011 and still outstanding, is excluded. Unlike sovereign bonds that have abundant liquidity, corporate bonds are traded less frequently in the market, implying that more reliable empirical results can be obtained by including only the issues that provide data for a long-term period; here, "long-term period" refers to one year or more. Tables 1-1 and 1-2 summarizes the composition of our data set before and after the crisis, respectively.

(Table 1 here)

As a result, a total of 66 firms rated as follows are used in the analysis for the pre-financial crisis period: AAA (5), AA+ (7), AA (5), AA- (14), A+ (9), A (10), A- (7), BBB+ (4), BBB (4), and BBB- (1). Similarly, we included 124 firms in the post-crisis sample as follows: AAA (7), AA+ (11), AA (11), AA- (28), A+ (17), A (22), A- (15), BBB+ (6), BBB (6), and BBB- (1). Speculative-grade bonds (also known as junk bonds) are not actively traded in the market, making it hard to calculate their fair value, which renders them less useful for the analysis of credit and liquidity risk. Therefore, this study includes only investment-grade firms (i.e., those rated BBB- or higher). Sometimes, for instance, bonds such as A-1 and A-2 can be rated differently during a certain sample period even if they are issued by the same firm. One possible (seemingly obvious) explanation for this could be that A-1 and A-2 were issued on different dates. To adjust for such a difference, firms are treated the same in this study even if their credit rating is altered during the analysis period. Issues before the crisis number 283, and they are specified as follows: AAA (64), AA+ (34), AA (17), AA- (49), A+

(30), A (42), A- (21), BBB+ (11), BBB (12), and BBB- (3). The number of issues after the crisis for all ratings totals 567 as follows: AAA (122), AA+ (55), AA (36), AA- (97), A+ (70), A (92), A- (48), BBB+ (20), BBB (26), and BBB- (1).

3.3 Summary Statistics

Tables 2-1 and 2-2 provide the summary statistics for the variables used in the analysis before and after the financial crisis, respectively.

(Table 2-1 here)

During the pre-crisis period, as seen from Table 2-1, the average of the dependent variables is about 1.239%, with a standard deviation of 0.577%. As seen from the median, the distribution of the average spreads has a long right tail, indicating that some of the very wide yield spreads skew the distribution to the right. *Average Trade Volume* registers a value of about 53 ($x10^8$ Korean won) every month per issue, reflecting some large values in the right tail of the distribution, while *Cash over Asset* averages about 0.215, again with a long right tail. *Maturity* as of issuance is 3.982 years, and the median is 3 years. The mean value of *Coupon* is around 5.5, with a standard deviation 0.91, while *Equity Volatility* averages 17.39% per month, with a standard deviation of approximately 4.01, where the lowest value is 8.752 and the highest is 25.91. As mentioned above, this study includes bonds with an investment-grade or higher rating, since speculative-grade bonds are not actively traded. Thus, the size of Korean corporate bond issuers tends to be large and they are well capitalized. The average credit rating score is about 4.46 (between AA- and A+), with a standard deviation of 2.613. The range of credit ratings is from 1 (AAA) to 10 (BBB-). Finally, *Distance-to-Default* averages about 2.14 per issue, with a standard deviation of about 1.4%.

(Table 2-2 here)

After the onset of the crisis, as shown in Table 2-2, the average of the dependent variables is about 1.466%, with a standard deviation of 1.161, indicating that the average value of yield spreads increased by 0.226% after the crisis. *Average Trade Volume* shows a value of about 108 (x10^8 Korean won) every month per issue, while *Cash over Asset* averages about 0.232, again with a long right tail. We can find that the *Average Trade Volume* has considerably increased from 53 to 108 (x10^8 Korean won) since the onset of the global financial crisis. *Maturity* as of issuance is 3.552 years (and the median is exactly 3 years), implying that the distribution is fairly balanced. The mean *Coupon* rate is about 5.9, with a standard deviation 1.41 and maximum of 10, while *Equity Volatility* averages about 12.322% per month, with a standard deviation of about 2.697. One noticeable observation is that both the average and standard deviation of *Equity Volatility* significantly decreased after the crisis. The average *Rating* is about 4.266 (between AA- and A+), with a standard deviation of 2.395 (about 2 notches). Finally, *Distance-to-Default* averages 2.284 per issue, with a standard deviation of about 1.2%.

Tables 3-1 and 3-2 show the pair-wise correlation coefficients among the independent variables before and after the global financial crisis, respectively.

(Table 3-1 here)

(Table 3-2 here)

As confirmed from Table 3-1, *Average Trade Volume* is negatively correlated with *Cash over Asset*, with a correlation coefficient of about -0.17 before the crisis. *Coupon*, *Equity Volatility*, and *Rating* are positively correlated with one another; the correlation coefficient between *Rating* and *Equity Volatility* is relatively high, while *Coupon* and *Equity Volatility* exhibit a weaker correlation. On the other hand, *Distance-to-Default* is negatively correlated with the other three credit risk measures; *Distance-to-Default* and *Equity Volatility* are highly correlated relatively, with a correlation coefficient of about -0.5, while *Distance-to-Default* exhibits a relatively weak correlation with *Rating*, with a coefficient of -0.144. Among the correlation coefficients between variables in Table 3-1, the coefficient between *Rating* and *Equity Volatility* is the highest with a value of 0.558, while that between *Maturity* and *Average Trade Volume* is the weakest, with a value of -0.004.

Table 3-2 indicates that between 2009 and 2011, *Average Trade Volume* and *Cash over Asset* seem to be quite weakly correlated, with a correlation coefficient of about -0.033. Liquidity proxies are negatively correlated with each other after the crisis. On the other hand, *Coupon*, *Equity Volatility*, and *Rating* are positively correlated with one another in this period. That is, the correlation coefficient between *Rating* and *Coupon* is relatively high, while *Coupon* and *Equity Volatility* exhibit a weaker correlation. We also find that the correlation coefficients among these three variables, *Coupon*, *Equity Volatility*, and *Rating*, decrease after the onset of the global financial crisis. On the other hand, *Distance-to-Default*, as before the crisis, is negatively correlated with the other three credit risk measures; *Distance-to-Default* and *Rating* are relatively highly correlated, with their correlation coefficient reaching -0.365, while *Distance-to-Default* exhibits a relatively weak correlation with *Coupon*, with a coefficient of -0.213. The coefficient between *Rating* and *Maturity* is the highest with a value of -0.443, and that between *Equity Volatility* and *Cash over Asset* is the weakest, with a coefficient of -0.01 during the post-crisis period.

4. Empirical Analysis

4. 1 Determinants of Corporate Yield Spreads

The regression results for each sample are presented in Table 4-1 (before the crisis) and Table 4-2 (after the crisis). Model 1 includes three of the liquidity proxies—*Average Trade*

Volume, *Cash over Asset*, and *Maturity*, whereas Models 2 to 5 consider four different combinations of the proxies for credit risk—*Coupon, Equity Volatility, Rating*, and *Distance-to-Default.* To compare the performance of Models 2 to 5 with that of Model 1, the number of variables to be included in each model is matched with the four possible combinations. Model 6 employs all the variables.[13]

(Table 4-1 here)

(Table 4-2 here)

During the pre-crisis period, as indicated by Table 4-1, the estimated coefficient of the *Financial* dummy variable is not significantly different from zero except in Model 3. On the other hand, after the crisis, all the coefficients have positive signs except in Model 1 and 3; and all are significant at the 99% level as reported by Table 4-2. Note that the signs of *Financial* change from negative to positive when *Rating* is controlled for, which is fairly consistent among model specifications in both Table 4-1 and Table 4-2, and indicates a non-trivial credit-quality gap between non-financial and financial bond issuers.[14] We infer that *Financial* became more significant after the crisis, since the recent crisis originated from the vulnerability in the U.S. financial system. Thus, ceteris paribus, Korean bond market participants require more compensation for their investment in corporate bonds issued by

[13]As a robustness check, we also conducted similar analyses by restricting the number of trades to be at least (i) multiple and (ii) five, respectively. The motivation behind these additional tests was to check whether the extremely low value of the variable might distort the results and whether the basic conclusion is robust to other specifications. However, we could not observe any meaningful difference in the results. In the scenario with a restriction that the number of trades be equal to 10 or more, the sample size — particularly for financial firms — is not large enough to draw a significant conclusion. Details are available upon request.

[14]Longstaff et al. (2005) use a dummy variable for bonds issued by financial firms as a proxy for liquidity risk, explaining that financial firms presumably have better access to capital markets and that their bonds enjoy more liquidity in the market than those issued by other types of firms. The dummy variable was also significant in their findings, with the argument that the result is inconsistent with the hypothesis that securities issued by financial firms are easier to trade in the market with limited price impact.

financial firms after the onset of the recent global financial crisis, controlling for credit and liquidity factors.[15]

Table 4-1 indicates that the coefficient of *Average Trade Volume* shows a negative sign as expected before the crisis, but is positive in the presence of other variables, remaining statistically insignificant in both cases. After the crisis, on the other hand, it becomes significant at the 99% level in Model 1 of Table 4-2 without any of the credit proxies. However, when credit variables are included in the regression (Model 6), its significance declines with t-statistic of -0.22, indicating that *Average Trade Volume* cannot be a sufficient explanatory variable for yield spreads in general. With respect to the full model specification (Model 6) in Tables 4-1 and 4-2, *Average Trade Volume* is the only explanatory variable whose sign varies before and after the crisis. We posit that this observation is seemingly related to flight-to-liquidity behavior with the onset of the crisis, even though the signs are not statistically significant.

The coefficient of *Cash over Asset* exhibits positive signs in both pre- and post-crisis periods, and the sign is inconsistent with univariate reasoning. As seen from Tables 4-1 and 4-2, combining both liquidity and credit variables in one spreads regression (Model 6) results in the coefficient of *Cash over Asset* losing some of its significance, but it still remains statistically distinguishable from zero, indicating that higher *Cash over Asset* drives up the

[15]Financial institutions' assets are mostly liquid, which might bring about more severe conflicts between managers and shareholders, according to the free cash flow hypothesis. Specifically, appropriation of such assets by insiders is relatively easy to undertake. In addition, it is well known that the corporate governance of financial institutions is substantially different from that of non-financial firms. Financial institutions are monopolistic in nature and implicitly benefit from governmental protection from exit; thus, financial firms might face a more serious agency problem than non-financial firms. Moreover, compared to non-financial firms, financial firms have a stronger capacity to react to illiquidity owing to rich, liquid assets even in the case of earning deterioration emanating from lax management. Thus, market surveillance over incompetent corporate management is known to be weaker in the case of financial firms.

Yield Spread to a higher level. When it comes to our interpretation of the positive direction of the estimated coefficient, we refer to Jensen (1986) who defines free cash flow as cash flow in excess of that required to fund all positive net present value projects when discounted at the appropriate cost of capital. According to Jensen (1986), free cash flow in a corporation makes managers as agents for shareholders waste available resources by choosing suboptimal investment portfolios and making decisions against the growth of firm value for their own benefit. Therefore, the market seems to expect that the corporation's free cash flow might be used in a direction against the maximization of shareholders wealth rather than for enhancing the firm's funding capacity, for example, by reducing rollover risks.[16]

Maturity has a negative sign and remains statistically distinguishable from zero (with a t-statistic of -4.27) before the crisis. However, its sign reverses in the full model (Model 6) with its statistical significance. The same pattern appears after the crisis in that the coefficients of *Maturity* have a negative sign and are significant, whereas the sign reverses in the specification that also includes credit variables. Although their significance also declines in Model 6, the coefficients are still significantly different from zero at the level of 99% of confidence. This result is consistent with Helwege and Turner (1999) who noted that the yield curve for high-yield firms appears upward-sloping, holding credit quality constant.[17] Overall, *Maturity* has all positive signs and remains statistically distinguishable from zero in both periods in the full model specification (Model 6). We also observe that the t-statistic increased from 2.41 to 4.39 after the crisis, indicating that the explanatory power of flight-to-

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[16]The NUS–RMI CRI Technical Report (2011) states that the ratio of the sum of cash and short-term investments over total assets has a significantly negative relationship with the firm's default risk across different countries.

[17]Helwege and Turner (1999) claim that related prior works, including the study by Jarrow, Lando, and Turnbull (1997) who argue that the yield curve for high-grade corporate issuers looks upward-sloping and that for speculative-grade firms is downward-sloping or hump-shaped, are subject to the potential selection bias issue.

liquidity behavior increased during the post-crisis period.

We can see from Tables 4-1 and 4-2 that the coefficients on *Coupon* show positive signs in all specifications and are statistically distinguishable from zero. This is presumably consistent with the hypothesis that the price of securities issued by firms with high default risk is highly discounted other things being constant, and that firms raise coupon rates to bring the bond price as of issuance to par value. Note that this interpretation differs from that of Longstaff, Mithal, and Neis (2005) who use the coupon rate of bonds as a non-default component in the spread.[18] Specifically, the t-statistic of *Coupon* markedly increased from 5.57 to 12.10 during the financial crisis, suggesting that the market became more sensitive to the perception of credit risk after the crisis.

Before the crisis, the coefficients of *Equity Volatility* are positive and statistically significant at the 95% level across all model specifications, as expected. During the post-crisis period, however, its coefficients have positive signs in all specifications except for Model 5, and are statistically insignificant in the presence of other variables.[19]

Next, *Rating* demonstrates a significantly positive relationship with the yield spread in each regression in both pre- and post-crisis periods. These results are supportive of a common expectation in that the lower the rating, the higher the spread. The t-statistic of *Rating* represents its stronger explanatory power after the crisis than before as it changed from 6.20 before the crisis to 19.08 after the crisis. This result perhaps describes the presence of the flight-to-quality behavior in the corporate bond market.

The estimated coefficient of *Distance-to-Default* (*DtD*) shows negative signs, as expected, and is statistically insignificant in almost all the models before the crisis. Similarly, the

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[18]According to our understanding, all Korean corporate bonds are issued at face value.

[19]In contrast, other empirical results such as Covits and Downing (2007) indicate that the coefficient on *Equity Volatility* is significantly different from zero.

coefficients on *DtD* have negative signs after the crisis, but are significantly different from zero in all the specifications between 2009 and 2011, where the statistical significance on *DtD* appears with a t-value of -4.69 after the financial crisis. From this result, we can infer that *DtD*, like the *Financial* dummy, seems to reflect the credit risk premium, which was formed in the market after the crisis. This observation is also related to the flight-to-quality behavior among investors.

While the selected liquidity variables explain a relatively smaller portion of the variation in yield spreads, credit factors seem to be more influential determinants of corporate bond spreads. All the adjusted R-square statistics in Models 2 to 5, which only include credit factors as an explanatory variable, are higher than those in Model 1, which only reflects the proxies for the liquidity risk components. This phenomenon supports our hypothesis that a significant portion of corporate bond spreads emanates from the default component before and after the crisis, in general. Among the specifications that consider only credit variables, Model 2, which considers *Coupon, Equity Volatility*, and *Rating* shows the best performance, with an adjusted R-square of 0.5227 before the crisis. Model 4, which includes *Coupon, Rating, and Distance-to-Default* shows the highest performance, whereas Model 3, which considers *Coupon, Equity Volatility, and Distance-to-Default* exhibits the lowest adjusted R-square after crisis. Tables 4-1 and 4-2 also suggest that market participants react more sensitively to *Coupon*, *Rating*, and *Distance-to-Default*—which can be regarded as proxies for credit risk—after, rather than before, the crisis.

4. 2 Incremental Importance of Each Variable

Tables 5-1 and 5-2 provide the regression results for nine specifications and show the incremental importance of each variable. Specifically, the first four models include all credit variables. Model 1 omits all the liquidity variables, while Models 2 to 4 in turn consider each of the liquidity proxies. The next four models include all liquidity variables. That is, Model 5 leaves out all the proxies for credit risk, Models 6 to 8 employ each of the credit variables in turn, and Model 9 employs all the variables we consider.

(Table 5-1 here)

(Table 5-2 here)

We see that the *Financial* variable shows very different patterns before and after the crisis. Specifically, it takes negative signs in all models except Model 7 in Table 5-1 and does not seem to be significant in a statistical sense. As seen from Table 5-2,[20] the coefficients of *Financial* after the crisis have positive signs in nearly all specifications and are statistically distinguishable from zero.

As seen from Table 5-1, the coefficients of *Average Trade Volume* have positive signs in all the models, except in Models 5 and 6, and are not statistically distinguishable from zero. However, *Average Trade Volume* has negative signs in all the specifications, and is significant in Models 5 to 8 as shown in Table 5-2. From this data, it might be tempting to say that there is a strong negative relationship between *Yield Spread* and *Average Trade Volume*, to make it consistent with a common liquidity interpretation. However, in Model 9 (Table 5-2), which controls for the relevant variables, the significance of *Average Trade Volume* declines, with a t-value of -0.18. One possible explanation for this, as specified above, is that Korean corporate bonds are not traded as frequently as other securities such as stocks or sovereign bonds; thus, trading liquidity measures might not fully reflect all the relevant information in bond prices. Another explanation is that there might be a non-linear component to the effect

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[20] Among the four credit variables, *Coupon*, *Rating*, and *Distance-to-Default* are compared with three liquidity variables to be included in the regression. In addition, the three credit variables are consistently significant in all specifications from the previous table.

of *Average Trade Volume* on *Yield Spread*.[21]

The coefficients of *Cash over Asset* are consistently positive in all specifications and are significantly distinguishable from zero in both periods. This result is consistent with the observations from Tables 4-1 and 4-2.

Interestingly, the beta-coefficients on *Maturity* have positive signs, holding credit quality constant. However, they show the opposite sign when a specific issue's credit is not controlled for. This finding corresponds to that of Helwege and Turner (1999). In addition, it is consistent with the hypothesis that shorter-maturity bonds are more liquid than longer ones. The above-mentioned patterns regarding the coefficients of *Maturity* are coherent in both Tables 5-1 and 5-2.

We can see from Table 5-1 that Model 3, which considers *Cash over Asset,* shows the highest performance with an adjusted R-square of 0.5224 between 2007 and 2008. During the post-crisis period, the incremental importance of *Maturity*, among all three liquidity proxies, is the highest; the adjusted R-square rises just by 0.93% with the addition of the *Maturity* term.

The regression coefficients for *Coupon* are consistently significant and positive in all specifications, both before and after the crisis. The coefficient values, signs, and t-statistics for *Coupon* in Table 5-1 exhibit similar patterns with the results in Table 5-2. However, we note that the significance of *Coupon*, a proxy for credit risk, increased remarkably after the crisis. From this finding, we might infer that markets are more sensitive to credit risk during a financial crisis.

Rating also shows a significantly positive relationship with *Yield Spread* in all the regressions, clearly demonstrating the inverse relationship between spreads and credit

[21]Tables 7-1 and 7-2 show a quadratic relationship between spreads and some explanatory variables.

qualities in both Tables 5-1 and 5-2. We also find that the statistical significance of *Rating* increases more than that of *Coupon* between 2009 and 2011.

The coefficients on *Distance-to-Default* have negative signs and are significant at the 99% level in both periods. As is well known, *Distance-to-Default* is a measure of a firm's leverage, which is scaled by volatility. A low value of *Distance-to-Default* represents high leverage, and vice versa. Accordingly, increasing *Distance-to-Default* should decrease the probability of default, leading to lower yield spreads. *Distance-to-Default* shows the highest performance with a t-value of -8.14 in Model 8 (Table 5-1) when the *Rating* variable is not included; yet, its significance declines considerably if controlling for *Rating*. However, the coefficients are still significantly different from zero in this case. The same pattern can be also found in Table 5-2. This is likely owing to a high correlation between *Rating* and *Distance-to-Default*. Thus, perhaps the two terms seem to reduce each other's significance when they are considered in a regression at the same time.

As seen from Models 5 to 8, the incremental significance of *Rating*, among all three credit proxies, is the highest in both periods; the adjusted R-square rises by 25.04% with the addition of the *Rating* term in the pre-crisis period, and by 34.6% after the crisis. Model 6, which considers the *Coupon* variable, exhibits the second-highest increase in the statistical significance before the crisis, and Model 8, which includes the *Distance-to-Default* term, shows the second-highest increase in t-value after the crisis. Moreover, as Tables 5-1 and 5-2 suggest, credit risk appears to be a more important determinant of corporate spreads in the Korean bond markets before and after the global financial crisis. One interesting finding is that Model 9 in Table 5-2 explains 72.69% of the variation in spreads, while Model 6 in Table 4-2, which includes all the relevant variables, explains 72.66% of the variation in yield spreads. Perhaps, the addition of *Equity Volatility* weakens the model's persuasiveness somewhat during the post-crisis period; *Equity Volatility* is seemingly insufficient for explaining the variations in spreads at least in a linear regression model between 2009 and 2011.[22]

4. 3 Quadratic Terms

This section investigates the role of *Average Trade Volume* and *Equity Volatility* to elucidate the variations in spreads by including the square terms of these two variables in the presence of other variables. We show, especially in Table 4-2, that both *Average Trade Volume* and *Equity Volatility* are not significant in a linear regression model. Viewed in this light, it is worthwhile exploring whether there is a quadratic component in *Average Trade Volume* or *Equity Volatility*. Moreover, this section tests whether there is a non-linear relationship between yield spreads and *Cash over Asset*. Previously, *Cash over Asset* was expected to show a negative relationship with yield spreads up to a certain point after which a higher cash ratio should have a positive relationship with yield spread, as excessively high *Cash over Asset* might indicate more opportunity costs such as inventory costs, possibly making investors demand higher compensation.

Specifically, Model 1 of Table 7-1 and 7-2 shows the empirical results of a specification that includes all liquidity and credit variables—the same results as in Model 6 in Table 4-1 and Table 4-2. Model 2 adds the square terms of both *Average Trade Volume* and *Equity*

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[22]Tables 6-1 and 6-2 show similar results by dropping one variable, *Rating,* which is replaced by *Equity Volatility*. As mentioned above, the specification that considers *Coupon*, *Equity Volatility*, and *Distance-to-Default* as proxies for credit risk presents the least persuasive explanation among the four models that consider three credit variables. See Models 2 to 5 in Tables 4-1 and 4-2. However, the basic conclusion regarding the relative significance of credit and liquidity risk is unchanged.

Volatility to Model 1. Model 3 includes an additional square term of *Cash over Asset* in Model 2.

(Table 7-1 here)

As seen from Table 7-1, the quadratic terms add little to the quality of fit: the adjusted R-square rises by 0.94% with inclusion of the square terms of *Average Trade Volume* and *Equity Volatility*, compared to the adjusted R-square of Model 1. We also see that the coefficient on *Average Trade Volume* is positive but statistically insignificant. The coefficient on its square term is negative and not statistically significant from zero.

On the other hand, the coefficient on *Equity Volatility* is negative and statistically significant at the 95% level. The coefficient on its square term is positive and statistically distinguishable from zero in both Models 2 and 3. Thus, one can see that the marginal effect of *Equity Volatility* on *Yield Spread* is given by

$$\frac{\partial(Spread)}{\partial(Equity\ Voltility)} = -0.102 + 0.0072 * Equity\ Volatility \qquad (1)$$

Equation (1) shows that, holding other things constant, a higher level of *Equity Volatility* lowers spreads; yet, the marginal effect reverses and an increase in volatility boosts spreads at a high value of equity return volatility.

However, the quadratic term of *Cash over Asset* does not seem to add to the quality of fit: the adjusted R-square decreases by 0.04% with inclusion of the square term, compared to the adjusted R-square of Model 2. Moreover, *Cash over Asset* is statistically insignificant, and the coefficient on its square term is statistically distinguishable at the 90% level.

(Table 7-2 here)

As seen from Table 7-2, the quadratic terms also make little contribution to the quality of fit during the post-crisis period: the adjusted R-square rises by 0.83% with inclusion of the square terms, compared to the adjusted R-square of Model 1. Surprisingly, unlike the previous results in Table 7-1, the coefficient on *Average Trade Volume* is negative and statistically significant. The coefficient on its square term is positive and statistically distinguishable from zero as both coefficients appear in Models 2 and 3. From the full model (Model 3), the marginal effect of *Average Trade Volume* on *Yield Spread* is given by

$$\frac{\partial(Spread)}{\partial(Trade\ Volume)} = -0.001 + 0.00001 * Trade\ Volume \quad (2)$$

Equation (2) suggests that, other things being constant, a higher level of *Average Trade Volume* depresses spreads; yet, at a high value of *Average Trade Volume*, the marginal effect reverses and, rather, an increase in *Average Trade Volume* boosts spreads. Thus, higher yield should be compensated for in order to move a large volume of trades, indicating a non-linear equation for corporate bonds.

In addition, interestingly, the coefficient on *Equity Volatility* is negative and statistically significant. The coefficient on its square term is positive and statistically distinguishable from zero in both models. From the full model (Model 3), one can see that the marginal effect of *Equity Volatility* on *Yield Spread* is given by

$$\frac{\partial(Spread)}{\partial(Equity\ Voltility)} = -0.984 + 0.018 * Equity\ Volatility \qquad (3)$$

From this equation (3), ceteris paribus, a higher level of *Equity Volatility* depresses spreads; yet, at a high level of *Equity Volatility*, an increase in volatility boosts spreads. This pattern can be also observed from Table 7-1. One possible interpretation is that when *Equity Volatility* is low, an increase in volatility hikes expected profits, attracting more investors and outweighing the compensation for increased risk that investors bear. Above a certain level of risk, however, as the probability of default increases sharply, investors might ratchet up their demands for compensation for the risk they undertake.

As seen from Table 7-2, the quadratic term of *Cash over Asset* also adds little to the quality of fit: the adjusted R-square rises by 0.09% with inclusion of the square term, compared to the adjusted R-square of Model 2. The coefficient on *Cash over Asset* is negative but statistically insignificant, and the coefficient on its square term is positive and statistically distinguishable from zero at the 90% level. This result is the similar to that observed in Table 7-1 except for the sign of the squared *Cash over Asset* term. The marginal effect of *Cash over Asset* increases with *Cash over Asset*; yet, the direction of marginal effect does not reverse. Thus, whether the relationship between *Yield Spread* and *Cash over Asset* is linear or not, an increase in *Cash over Asset* tends to boost spreads.

5. Summary and Concluding Remarks

This study employs Korean corporate bond data to analyze the relative importance of credit and liquidity proxies as the determinants of yield spread. The data set includes the transactions of corporate bonds issued by both financial and non-financial firms listed on the Korean Exchange from March 1, 2007 to December 31, 2011.

Although results of prior works suggest a significant non-default component in corporate spreads, our study's regression results indicate that credit risk is the dominant determinant of corporate bond spreads. This result is robust to alternative proxies for credit risk with various specifications. Empirical results for the pre- and post- financial crisis periods indicate that Korean corporate bond market participants seem to care more about default risk after the crisis than in the pre-crisis period.

This study also examines the incremental importance of each credit and liquidity variable.

Our analysis results indicate that the *Maturity* variable demonstrates the highest contribution to the quality of fit among liquidity proxies during the post-crisis period, controlling for three credit proxies—*Coupon, Rating, and Distance-to-Default*. Among the credit proxies, *Rating* exhibits the highest marginal contribution when controlling for liquidity proxies—*Average Trade Volume, Cash over Asset*, and *Maturity*.

Moreover, this study explores whether there was a quadratic component in *Average Trade Volume* or *Equity Volatility* since they are not significant determinants of spreads in a linear regression model. Empirical analysis indicates that the squared terms of both *Average Trade Volume* and *Equity Volatility* are statistically significant, suggesting a quadratic element to the effect of *Average Trade Volume* and *Equity Volatility* on *Yield Spread*.

However, ours is a preliminary study and has several limitations. One possible limitation is related to the imbalance between credit and liquidity measures analyzed. As noted, corporate bonds are not traded as frequently as stocks or government bonds; thus, the trading-based measures, in particular, might not contain sufficient information on corporate bond pricing. Furthermore, our study cannot rule out the possibility that the empirical results might depend on the choices of proxies for the risk components. To alleviate this problem of possibly omitted liquidity risk variables, future analysis could incorporate more liquidity proxies such as Amihud's measure, Roll's measure, the turnover of bonds, and so forth. In addition, we need to perform a series of robustness checks. For example, a test for a potential endogeneity bias would be ideal to ensure that endogeneity is not a major concern in our analysis. For this purpose, the Durbin–Wu–Hausman test seems appropriate. We leave these issues for our future research.

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Figure 1
Time-Series Plot of the Proxies for Credit Premium in the Market

The plot shows the time series of the difference between 3-year corporate bond yields with a BBB- credit rating and the corresponding risk-free interest rate as a proxy for financial market liquidity or a global change in credit risk. (Source: Bank of Korea)

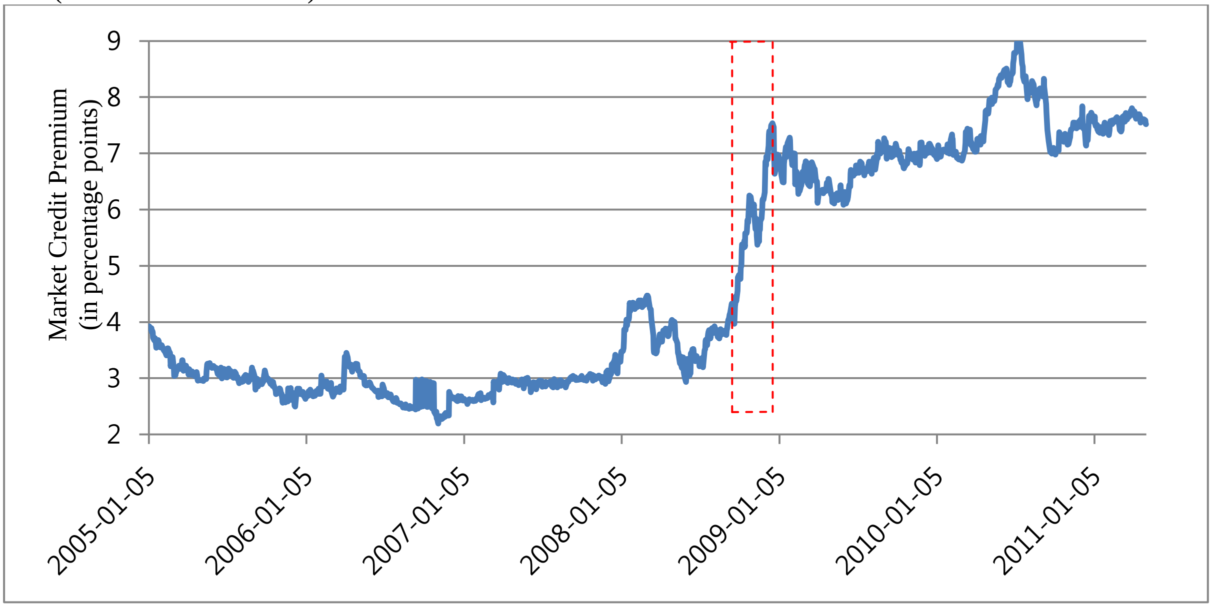

Table 1-1
Summary of Sample Composition (Before the Crisis)

This study considers only investment-grade firms (rated BBB- or higher). The total firms in the sample number 66 and total bond issues, 283. The sub-sample period is March 1, 2007 to December 31, 2008.

	AAA	**AA+**	**AA**	**AA-**	**A+**	**A**	**A-**	**BBB+**	**BBB**	**BBB-**	**Total**
Number of Firms	5	7	5	14	9	10	7	4	4	1	66
Number of Issues	64	34	17	49	30	42	21	11	12	3	283

Table 1-2
Summary of Sample Composition (After the Crisis)

This study considers only investment-grade firms (rated BBB- or higher). The total firms in the sample number 124 and total bond issues, 567. The sub-sample period is January 1, 2009 to December 31, 2011

	AAA	**AA+**	**AA**	**AA-**	**A+**	**A**	**A-**	**BBB+**	**BBB**	**BBB-**	**Total**
Number of Firms	**7**	**11**	**11**	**28**	**17**	**22**	**15**	**6**	**6**	**1**	**124**
Number of Issues	**122**	**55**	**36**	**97**	**70**	**92**	**48**	**20**	**26**	**1**	**567**

Table 2-1
Summary Statistics (Before the Crisis)

The table shows the summary statistics for variables used in the regression analysis. The variable "Yield Spread" is the difference between the yield-to-maturity on a corporate bonds and the corresponding risk-free rate; "Average Trade Volume" is the average of the total trading volume during which a specific issue is outstanding; "Cash over Asset" is the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; "Maturity" is the years to maturity of the bonds; "Coupon" is the annual coupon interest; "Equity Volatility" is the volatility of the firm's daily equity returns during which a specific issue is outstanding; "Rating" is the credit rating assigned to each security, coded so that AAA=1; and "Distance-to-Default" is the probability of default based on Merton (1974). The sub-sample period is March 1, 2007 to December 31, 2008; the sample includes 283 bond issues.

Variable	Mean	Std. Dev.	Min	Med	Max
Yield Spread	1.2392	0.5768	0.3221	1.1191	3.2732
Trade Volume	52.991	68.956	0.4546	28.571	733.50
Cash over Asset	0.2151	0.1665	0.0106	0.1792	0.7976
Maturity	3.9824	1.5137	2.0000	3.0000	10.000
Coupon	5.4638	0.9127	1.5000	5.3300	9.0000
Equity Volatility	17.394	4.0067	8.7521	17.994	25.907
Rating	4.4578	2.6132	1.0000	5.0000	10.000
Distance-to-Default	2.1406	1.3603	-0.0910	2.0572	6.0906

Table 2-2
Summary Statistics (After the Crisis)

The sub-sample period is January 1, 2009 to December 31, 2011; the sample includes 567 bond issues. For more details, see the notes for Table 2-1.

Variable	Mean	Std. Dev.	Min	Med	Max
Yield Spread	1.4656	1.1609	0.3631	1.0227	5.9820
Trade Volume	107.76	107.56	1.6667	75.167	807.78
Cash over Asset	0.2319	0.1674	0.0076	0.2102	0.8314
Maturity	3.5523	1.4902	1.5000	3.0000	10.000
Coupon	5.9049	1.4125	0.0000	5.6350	10.700
Equity Volatility	12.322	2.6966	5.7174	12.270	21.293
Rating	4.2660	2.3953	1.0000	4.0000	10.000
Distance-to-Default	2.2843	1.2146	-0.3538	2.1988	7.2941

Table 3-1

Pair-wise Correlations between Independent Variables (Before the Crisis)

The table shows the pair-wise correlation coefficients for the variables used in the regression analysis. The variable "Average Trade Volume" is the average of the total trading volume during which a specific issue is outstanding; "Cash over Asset" is the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; "Maturity" is the years to maturity of the bonds; "Coupon" is the annual coupon interest; "Equity Volatility" is the volatility of the firm's daily equity returns during which a specific issue is outstanding; "Rating" is the credit rating assigned to each security, coded so that AAA=1; and "Distance-to-Default" is the probability of default based on Merton (1974). The sample period is March 1, 2007 to December 31, 2008; the sample includes 283 bond issues.

	Trade Volume	Cash over Asset	Maturity	Coupon	Equity Volatility	Rating
Cash over Asset	-0.1697					
Maturity	-0.0037	-0.2341				
Coupon	-0.0492	0.2867	-0.2927			
Equity Volatility	-0.0650	0.2156	-0.3893	0.3692		
Rating	-0.2716	0.4641	-0.5161	0.4279	0.5577	
Distance-to-Default	0.0287	0.2857	0.1801	-0.2555	-0.5003	-0.1439

Table 3-2

Pair-wise Correlations between Independent Variables (After the Crisis)

The sample period is January 1, 2009 to December 31, 2011; the sample includes 567 bond issues. For more details, see the notes for Table 3-1.

	Trade Volume	Cash over Asset	Maturity	Coupon	Equity Volatility	Rating
Cash over Asset	-0.0332					
Maturity	-0.1064	-0.1769				
Coupon	-0.1722	0.1141	-0.3826			
Equity Volatility	0.0133	-0.0102	-0.2207	0.0767		
Rating	-0.2359	0.3772	-0.4432	0.3730	0.2655	
Distance-to-Default	0.1309	-0.0285	0.2665	-0.2125	-0.2922	-0.3650

Table 4-1

The Determinants of Corporate Yield Spreads (Before the Crisis)

The table shows the regression results for the sample of 283 bond issues from March 1, 2007 to December 31, 2008. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are: “Financial,” a dummy variable indicating whether a firm is a financial institution, coded so that a financial firm=1; “Average Trade Volume,” the average of the total trading volume during which a specific issue is outstanding; “Cash over Asset,” the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; “Maturity,” the years to maturity of the bonds; “Coupon,” the annual coupon interest; “Equity Volatility,” the volatility of the firm’s daily equity returns during which a specific issue is outstanding; “Rating,” the credit rating assigned to each security, coded so that AAA=1; and “Distance-to-Default,” the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and ‘*,’ ‘**,’ and ‘***’ indicate significance at the 10%, 5%, and 1% levels, respectively. There are 66 firms in the sample.

	Model					
	1	2	3	4	5	6
Intercept	1.4462***	-0.6770***	-0.7075***	-0.1700	0.1953	-0.7696***
	(12.36)	(-4.14)	(-2.99)	(-0.98)	(0.98)	(-2.83)
Financial	-0.1826*	0.0210	-0.3818***	-0.0822	0.1087	0.0594
	(-1.90)	(0.26)	(-4.36)	(-0.84)	(1.05)	(0.56)
Trade Volume	-0.0004					0.0004
	(-0.80)					(1.15)
Cash over Asset	0.9164***					0.4704***
	(4.29)					(2.60)
Maturity	-0.0896***					0.0475**
	(-4.27)					(2.41)
Coupon		0.1890***	0.2609***	0.1990***		0.1701***
		(6.26)	(8.70)	(6.55)		(5.57)
Equity Volatility		0.0269***	0.0395***		0.0297***	0.1007**
		(3.69)	(4.54)		(3.30)	(2.53)
Rating		0.0926***		0.1021***	0.1236***	0.1033***
		(6.64)		(7.45)	(8.81)	(6.20)
Distance-to-Default			-0.0488*	-0.0560**	-0.0192	-0.0393
			(-1.82)	(-2.54)	(-0.71)	(-1.42)
Adj.-R Square	0.1935	0.5227	0.4537	0.5107	0.4566	0.5357

Table 4-2
The Determinants of Corporate Yield Spreads (After the Crisis)

The table shows the regression results for the sample of 567 bond issues from January 1, 2009 to December 31, 2011. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are:"Financial," a dummy variable indicating whether a firm is a financial institution, coded so that a financial firm=1; "Average Trade Volume," the average of the total trading volume during which a specific issue is outstanding; "Cash over Asset," the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; "Maturity," the years to maturity of the bonds; "Coupon," the annual coupon interest; "Equity Volatility," the volatility of the firm's daily equity returns during which a specific issue is outstanding; "Rating," the credit rating assigned to each security, coded so that AAA=1; and "Distance-to-Default," the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and '*,' '**,' and '***' indicate significance at the 10%, 5%, and 1% levels, respectively. There are 124 firms in the sample.

	Model					
	1	2	3	4	5	6
Intercept	2.4809***	-1.6034***	-0.1518	-1.0831***	0.1566	-1.7982***
	(16.98)	(-9.81)	(-0.58)	(-6.85)	(0.82)	(-6.92)
Financial	-0.5758***	0.5011***	-0.9065***	0.3240***	0.3985***	0.4319***
	(-4.90)	(5.72)	(-9.38)	(3.45)	(3.82)	(4.53)
Trade Volume	-0.0028***					-0.0007
	(-7.29)					(-0.22)
Cash over Asset	1.3909***					0.5401***
	(5.30)					(3.20)
Maturity	-0.2640***					0.0944***
	(-9.34)					(4.39)
Coupon		0.2307***	0.3473***	0.2256***		0.2498***
		(11.29)	(13.64)	(11.23)		(12.10)
Equity Volatility		0.0204	0.1963***		-0.0413	0.0217
		(0.43)	(3.18)		(-0.79)	(0.46)
Rating		0.3683***		0.3349***	0.3898***	0.3472***
		(24.74)		(20.96)	(22.55)	(19.08)
Distance-to-Default			-0.3568***	-0.1156***	-0.1344***	-0.1207***
			(-11.50)	(-4.47)	(-4.65)	(-4.69)
Adj.-R Square	0.2959	0.7036	0.4979	0.7138	0.6496	0.7266

Table 5-1

The Incremental Importance of Each Variable (Before the Crisis)

The table shows the regression results for the full sample of 283 bond issues from March 1, 2007 to December 31, 2008. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are: “Financial,” a dummy variable indicating whether a firm is a financial institution, coded so that a financial firm=1; “Average Trade Volume,” the average of the total trading volume during which a specific issue is outstanding; “Cash over Asset,” the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; “Maturity,” the years to maturity of the bonds; “Coupon,” the annual coupon interest; “Equity Volatility,” the volatility of the firm’s daily equity returns during which a specific issue is outstanding; “Rating,” the credit rating assigned to each security, coded so that AAA=1; and “Distance-to-Default,” the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and ‘*,’ ‘**,’ and ‘***’ indicate significance at the 10%, 5%, and 1% levels, respectively.

	Model								
	1	2	3	4	5	6	7	8	9
Intercept	-0.1700	-0.1855	-0.0718	-0.3793	1.4462***	-0.2197	0.0921	1.6345***	-0.3468
	(-0.98)	(-1.06)	(-0.41)	(-1.76)	(12.36)	(-1.05)	(0.59)	(15.16)	(-1.61)
Financial	-0.0822	-0.0951	-0.0620	-0.0263	-0.1826*	-0.2730***	0.3340***	-0.4464***	-0.0094
	(0.4027)	(-0.96)	(-0.64)	(-0.25)	(-1.90)	(-3.22)	(3.63)	(-4.84)	(-0.09)
Trade Volume		0.0004			-0.0004	-0.0002	0.0006	0.0002	0.0005
		(1.03)			(-0.80)	(-0.59)	(1.42)	(0.52)	(1.50)
Cash over Asset			0.5042***		0.9164***	0.4675**	0.5522***	1.2451***	0.5462***
			(2.79)		(4.29)	(2.41)	(3.06)	(6.34)	(3.03)
Maturity				0.0324	-0.0896***	-0.0489***	0.0477**	-0.0482**	0.0402**
				(1.64)	(-4.27)	(-2.58)	(2.24)	(-2.46)	(2.04)
Coupon	0.1989***	0.1976***	0.1790***	0.1991***		0.2944***			0.1757***
	(6.55)	(6.49)	(5.81)	(6.58)		(9.17)			(5.71)
Rating	0.1021***	0.1042***	0.0901***	0.1163***			0.1696***		0.1096***
	(7.45)	(7.51)	(6.33)	(7.20)			(11.23)		(6.59)
Distance-to-Default	-0.0560**	-0.0578***	-0.0781***	-0.0523**				-0.1928***	-0.0780***
	(-2.54)	(-2.60)	(-3.37)	(-2.36)				(-8.14)	(-3.36)
Adj.-R Square	0.5107	0.5086	0.5224	0.5136	0.1935	0.3791	0.4439	0.3469	0.5266

Table 5-2
The Incremental Importance of Each Variable (After the Crisis)

The table shows the regression results for the sample of 567 bond issues from January 1, 2009 to December 31, 2011. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are: “Financial,” a dummy variable indicating whether a firm is a financial institution, coded so that a financial firm=1; “Average Trade Volume,” the average of the total trading volume during which a specific issue is outstanding; “Cash over Asset,” the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; “Maturity,” the years to maturity of the bonds; “Coupon,” the annual coupon interest; “Equity Volatility,” the volatility of the firm’s daily equity returns during which a specific issue is outstanding; “Rating,” the credit rating assigned to each security, coded so that AAA=1; and “Distance-to-Default,” the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and ‘*,’ ‘**,’ and ‘***’ indicate significance at the 10%, 5%, and 1% levels, respectively.

	Model								
	1	2	3	4	5	6	7	8	9
Intercept	-1.0831***	-1.0202***	-1.1397***	-1.6665***	2.4809***	-0.0484	-0.5178***	3.0056***	-1.7369***
	(-6.85)	(-6.19)	(-7.17)	(-8.19)	(16.98)	(-0.19)	(-3.12)	(21.68)	(-7.80)
Financial	0.3240***	0.3205***	0.3454***	0.4102***	-0.5758***	-0.4667***	0.6340***	-0.8174***	0.4360***
	(3.45)	(3.41)	(3.68)	(4.35)	(-4.90)	(-4.38)	(6.42)	(-7.60)	(4.60)
Trade Volume		-0.0003			-0.0028***	-0.0019***	-0.0006**	-0.0021***	-0.0001
		(-1.35)			(-7.29)	(-5.35)	(-2.05)	(-5.84)	(-0.18)
Cash over Asset			0.4906***		1.3909***	1.3598***	0.4199**	1.3097***	0.5323***
			(2.88)		(5.30)	(5.75)	(2.19)	(5.56)	(3.17)
Maturity				0.0912***	-0.2640***	-0.1379***	0.0177	-0.1743***	0.0937***
				(4.45)	(-9.34)	(-4.96)	(0.75)	(-6.58)	(4.38)
Coupon	0.2256***	0.2232***	0.2265***	0.2477***		0.3339***			0.2492***
	(11.23)	(11.07)	(11.31)	(12.15)		(11.36)			(12.1)
Rating	0.3349***	0.3317***	0.3224***	0.3621***			0.4187***		0.3489***
	(20.96)	(20.55)	(19.55)	(21.47)			(23.20)		(19.58)
Distance-to-Default	-0.1156***	-0.1147***	-0.1214***	-0.1162***				-0.3801***	-0.1224***
	(-4.47)	(-4.44)	(-4.70)	(-4.56)				(-11.65)	(-4.82)
Adj.-R Square	0.7138	0.7142	0.7173	0.7231	0.2959	0.4277	0.6419	0.4332	0.7269

Table 6-1

The Incremental Importance of Each Variable (Before the Crisis)

The table shows the regression results for the sample of 283 bond issues from March 1, 2007 to December 31, 2008. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are: "Financial," a dummy variable indicating whether a firm is a financial institution, coded so that a financial firm=1; "Average Trade Volume," the average of the total trading volume during which a specific issue is outstanding; "Cash over Asset," the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; "Maturity," the years to maturity of the bonds; "Coupon," the annual coupon interest; "Equity Volatility," the volatility of the firm's daily equity returns during which a specific issue is outstanding; and "Distance-to-Default," the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and '*,' '**,' and '***' indicate significance at the 10%, 5%, and 1% levels, respectively.

	Model								
	1	2	3	4	5	6	7	8	9
Intercept	-0.7075***	-0.7074***	-0.4614*	-0.5273*	1.4462***	-0.2197	0.1157	1.6345***	-0.3714
	(-2.99)	(-2.98)	(-1.92)	(-1.87)	(12.36)	(-1.05)	(0.60)	(15.16)	(-1.32)
Financial	-0.3818***	-0.3714***	-0.3122***	-0.3889***	-0.1826*	-0.2730***	-0.0872	-0.4464***	-0.3192***
	(-4.36)	(-4.04)	(-3.56)	(-4.43)	(-1.90)	(-3.22)	(-1.00)	(-4.84)	(-3.48)
Trade Volume		-0.0001			-0.0004	-0.0002	-0.0003	0.0002	0.00002
		(-0.38)			(-0.80)	(-0.59)	(-0.70)	(0.52)	(0.06)
Cash over Asset			0.6922***		0.9164***	0.4675**	0.8255***	1.2451***	0.6759***
			(3.74)		(4.29)	(2.41)	(4.29)	(6.34)	(3.56)
Maturity				-0.0216	-0.0896***	-0.0489***	-0.0285	-0.0482**	-0.0115
				(-1.16)	(-4.27)	(-2.58)	(-1.40)	(-2.46)	(-0.62)
Coupon	0.2609***	0.2603***	0.2247***	0.2546***		0.2944***			0.2224***
	(8.70)	(8.63)	(7.28)	(8.36)		(9.17)			(7.11)
Equity Volatility	0.0395***	0.0398***	0.0317***	0.0363***			0.0626***		0.0301***
	(4.54)	(4.53)	(3.62)	(3.99)			(8.16)		(3.29)
Distance-to-Default	-0.0488*	-0.0470*	-0.0829***	-0.0509*				-0.1928***	-0.0835***
	(-1.82)	(-1.72)	(-2.99)	(-1.90)				(-8.14)	(-2.93)
Adj.-R Square	0.4537	0.4495	0.4780	0.4543	0.1935	0.3791	0.3475	0.3469	0.4725

Table 6-2

The Incremental Importance of Each Variable (After the Crisis)

The table shows the regression results for the sample of 567 bond issues from January 1, 2009 to December 31, 2011. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are: "Financial," a dummy variable indicating whether or not a firm is a financial institution, coded so that a financial firm=1; "Average Trade Volume," the average of the total trading volume during which a specific issue is outstanding; "Cash over Asset," the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; "Maturity," the years to maturity of the bonds; "Coupon," the annual coupon interest; "Equity Volatility," the volatility of the firm's daily equity returns during which a specific issue is outstanding; and "Distance-to-Default," the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and '*,' '**,' and '***' indicate significance at the 10%, 5%, and 1% levels, respectively.

	Model								
	1	2	3	4	5	6	7	8	9
Intercept	-0.1518	-0.0247	-0.5074**	0.1999	2.4809***	-0.0484	1.3953***	3.0056***	0.0024
	(-0.58)	(-0.09)	(-1.96)	(0.65)	(16.98)	(-0.19)	(5.41)	(21.68)	(0.01)
Financial	-0.9065***	-0.8772***	-0.7165***	-0.8984***	-0.5758***	-0.4670***	-0.5847***	-0.8174***	-0.6832***
	(-9.38)	(-9.14)	(-7.32)	(-9.32)	(-4.90)	(-4.38)	(-5.08)	(-7.60)	(-7.06)
Trade Volume		-0.0012***			-0.0028***	-0.0019***	-0.0028***	-0.0021***	-0.0014***
		(-3.56)			(-7.29)	(-5.35)	(-7.38)	(-5.84)	(-4.18)
Cash over Asset			1.3864***		1.3909***	1.3598***	1.4496***	1.3097***	1.3284***
			(6.55)		(5.30)	(5.75)	(5.64)	(5.56)	(6.30)
Maturity				-0.0568**	-0.2640***	-0.1379***	-0.2315***	-0.1743***	-0.0563**
				(-2.18)	(-9.34)	(-4.96)	(-8.16)	(-6.58)	(-2.19)
Coupon	0.3473***	0.3351***	0.3368***	0.3274***		0.3339***			0.3032***
	(13.64)	(13.17)	(13.64)	(12.14)		(11.36)			(11.52)
Equity Volatility	0.1963***	0.2092***	0.2093***	0.1745***			0.3555***		0.2026***
	(3.18)	(3.42)	(3.50)	(2.80)			(5.05)		(3.40)
Distance-to-Default	-0.3568***	-0.3431***	-0.3429***	-0.3459***				-0.3801***	-0.3168***
	(-11.50)	(-11.09)	(-11.40)	(-11.05)				(-11.65)	(-10.44)
Adj.-R Square	0.4979	0.5082	0.5329	0.5013	0.2959	0.4277	0.3257	0.4332	0.5470

Table 7-1
Quadratic Terms (Before the Crisis)

The table shows the regression results for specifications that include quadratic terms of "Average Trade Volume," "Cash over Asset," and "Equity Volatility" from March 1, 2007 to December 31, 2008, represented as "Average Trade Volume Sq," Cash over Asset Sq," and "Equity Volatility Sq," respectively. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are: "Financial," a dummy variable indicating whether a firm is a financial institution, coded so that a financial firm=1; "Average Trade Volume," the average of the total trading volume during which a specific issue is outstanding; "Cash over Asset," the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; "Maturity," the years to maturity of the bonds; "Coupon," the annual coupon interest; "Equity Volatility," the volatility of the firm's daily equity returns during which a specific issue is outstanding; "Rating," the credit rating assigned to each security, coded so that AAA=1; and "Distance-to-Default," the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and '*,' '**,' and '***' indicate significance at the 10%, 5%, and 1% levels, respectively.

	Model		
	1	2	3
Intercept	-0.7696***	0.3623	0.2890
	(-2.83)	(0.72)	(0.56)
Financial	0.0594	0.0580	0.1065
	(0.56)	(0.55)	(0.89)
Trade Volume	0.0004	0.0007	0.0007
	(1.15)	(1.02)	(0.98)
Trade Volume Sq		-4.65533E-7	-4.36373E-7
		(-0.36)	(-0.34)
Cash over Asset	0.4704***	0.3831**	0.9612
	(2.60)	(2.10)	(1.36)
Cash over Asset Sq			-0.820*
			(-0.85)
Maturity	0.0475***	0.0401**	0.0417**
	(2.41)	(2.02)	(2.09)
Coupon	0.1701***	0.15647***	0.1572***
	(5.57)	(5.09)	(5.11)
Equity Volatility	0.1007**	-0.1020**	-0.1019**
	(2.53)	(-2.20)	(-2.19)
Equity Volatility Sq		0.0036***	0.0036***
		(2.72)	(2.73)
Rating	0.1033***	0.1067***	0.1059***
	(6.20)	(6.45)	(6.38)
Distance-to-Default	-0.0393***	-0.050*	-0.0560**
	(-1.42)	(-1.80)	(-1.95)
Adj.-R Square	0.5357	0.5451	0.5447

Table 7-2
Quadratic Terms (After the Crisis)

The table shows the regression results for specifications that include quadratic terms of “Average Trade Volume,” “Cash over Asset,” and “Equity Volatility” from January 1, 2009 to December 31, 2011, represented as “Average Trade Volume Sq,” Cash over Asset Sq,” and “Equity Volatility Sq,” respectively. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are: “Financial,” a dummy variable indicating whether a firm is a financial institution, coded so that a financial firm=1; “Average Trade Volume,” the average of the total trading volume during which a specific issue is outstanding; “Cash over Asset,” the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; “Maturity,” the years to maturity of the bonds; “Coupon,” the annual coupon interest; “Equity Volatility,” the volatility of the firm’s daily equity returns during which a specific issue is outstanding; “Rating,” the credit rating assigned to each security, coded so that AAA=1; and “Distance-to-Default,” the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and ‘*,’ ‘**,’ and ‘***’ indicate significance at the 10%, 5%, and 1% levels, respectively.

	Model		
	1	2	3
Intercept	-1.7982***	-0.3385	-0.1563
	(-6.92)	(-0.72)	(-0.32)
Financial	0.4319***	0.4545***	0.3823***
	(4.53)	(4.78)	(3.66)
Trade Volume	-0.0001	-0.0016***	-0.0014**
	(-0.22)	(-2.65)	(-2.41)
Trade Volume Sq		0.000003***	0.000003***
		(2.90)	(2.72)
Cash over Asset	0.5401***	0.5325***	-0.3493
	(3.20)	(3.20)	(-0.63)
Cash over Asset Sq			1.2938*
			(1.66)
Maturity	0.0944***	0.0776***	0.0766***
	(4.39)	(3.61)	(3.57)
Coupon	0.2498***	0.2408***	0.2411***
	(12.10)	(11.78)	(11.81)
Equity Volatility	0.0217	-0.9165***	-0.9839***
	(0.46)	(-3.10)	(-3.30)
Equity Volatility Sq		0.0082***	0.0087***
		(3.23)	(3.43)
Rating	0.3472***	0.3441***	0.3435***
	(19.08)	(18.86)	(18.85)
Distance-to-Default	-0.1207***	-0.1315***	-0.1258***
	(-4.69)	(-5.17)	(-4.91)
Adj.-R Square	0.7266	0.7349	0.7358

Table 8-1
Maturity Interaction (Before the Crisis)

The table shows the regression results for the sample of 283 bond issues from March 1, 2007 to December 31, 2008. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are: "Financial," a dummy variable indicating whether a firm is a financial institution, coded so that a financial firm=1; "Average Trade Volume," the average of the total trading volume during which a specific issue is outstanding; "Cash over Asset," the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; "Maturity," the years to maturity of the bonds; "Coupon," the annual coupon interest; "Equity Volatility," the volatility of the firm's daily equity returns during which a specific issue is outstanding; "Rating," the credit rating assigned to each security, coded so that AAA=1; and "Distance-to-Default," the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and '*,' '**,' and '***' indicate significance at the 10%, 5%, and 1% levels, respectively.

	Model			
	1	2	3	4
Intercept	1.4976***	-0.1864	-3.8163***	-3.8236***
	(5.03)	(-1.12)	(-6.33)	(-6.21)
Financial				0.0059
				(0.06)
Trade Volume	-0.0025		-0.0002	-0.00016
	(-1.52)		(-0.12)	(-0.12)
Trade Volume x Maturity	0.0005		0.00015	0.00015
	(1.31)		(0.54)	(0.54)
Cash over Asset	1.9040***		0.8665	0.8623
	(2.67)		(1.21)	(1.20)
Cash over Asset x Maturity	-0.2580		-0.1583	-0.1568
	(-1.30)		(-0.74)	(-0.73)
Maturity	-0.1440		0.9253***	0.9261***
	(-1.37)		(5.93)	(5.90)
Maturity x Maturity	0.0080		-0.0171*	-0.0171*
	(0.88)		(-1.90)	(-1.90)
Coupon		0.2681***	0.8043***	0.8045***
		(5.90)	(8.17)	(8.15)
Coupon x Maturity		-0.0188**	-0.1460***	-0.1462***
		(-2.25)	(-6.70)	(-6.67)
Rating		0.080**	0.0789*	0.0796*
		(2.35)	(1.80)	(1.76)
Rating x Maturity		0.0082	0.0055	0.0055
		(0.92)	(0.48)	(0.47)
Distance-to-Default		-0.197***	-0.1249**	-0.1238**
		(-4.21)	(-2.16)	(-2.03)
Distance-to-Default x Maturity		0.0337***	0.0171	0.0170
		(3.47)	(1.25)	(1.22)
Adj.-R Square	0.1888	0.5273	0.6013	0.5998

Table 8-2

Maturity Interaction (After the Crisis)

The table shows the regression results for the sample of 567 bond issues from January 1, 2009 to December 31, 2011. The dependent variable is the difference between the yield-to-maturity on a corporate bond and the corresponding risk-free rate. The independent variables are: "Financial," a dummy variable indicating whether a firm is a financial institution, coded so that a financial firm=1; "Average Trade Volume," the average of the total trading volume during which a specific issue is outstanding; "Cash over Asset," the ratio of the sum of cash and marketable securities such as trading securities to the amount of total assets; "Maturity," the years to maturity of the bonds; "Coupon," the annual coupon interest; "Equity Volatility," the volatility of the firm's daily equity returns during which a specific issue is outstanding; "Rating," the credit rating assigned to each security, coded so that AAA=1; and "Distance-to-Default," the probability of default based on Merton (1974). The t-statistics are shown in parentheses below each coefficient estimate, and '*,' '**,' and '***' indicate significance at the 10%, 5%, and 1% levels, respectively.

	Model			
	1	2	3	4
Intercept	3.6884***	-0.721***	-2.8952***	-3.2949***
	(12.81)	(-4.71)	(-5.57)	(-6.50)
Financial				0.4590***
				(4.91)
Trade Volume	-0.0102***		0.0003	0.0004
	(-7.09)		(0.27)	(0.50)
Trade Volume x Maturity	0.0014***		-0.0002	-0.0002
	(3.51)		(-0.77)	(-0.71)
Cash over Asset	0.7637***		0.0010	0.3837
	(3.29)		(0.01)	(0.78)
Cash over Asset x Maturity	-0.0691		0.0151	0.0336
	(-0.92)		(0.29)	(0.23)
Maturity	-0.7527***		0.7587***	0.7121***
	(-5.98)		(4.47)	(4.33)
Maturity x Maturity	0.0457***		-0.0231**	-0.0190*
	(3.88)		(-2.24)	(-1.88)
Coupon		0.2716***	0.4785***	0.4823***
		(7.17)	(8.16)	(8.51)
Coupon x Maturity		-0.0184*	-0.0877***	-0.0872***
		(-1.73)	(-4.78)	(-4.97)
Rating		0.3233***	0.3744***	0.4017***
		(8.60)	(8.73)	(9.33)
Rating x Maturity		-0.0052	-0.0214*	-0.0164
		(-0.50)	(-1.80)	(-1.39)
Distance-to-Default		-0.377***	-0.2439***	-0.2165***
		(-6.81)	(-3.42)	(-2.92)
Distance-to-Default x Maturity		0.0590***	0.0259	0.0293
		(4.30)	(1.40)	(1.45)
Adj.-R Square	0.3206	0.7221	0.7311	0.7447

Appendices

A. Estimation of Distance-to-Default

This appendix elaborates on the estimation of the distance-to-default provided by the Risk Management Institute at the National University of Singapore.[23] The distance-to-default computation begins with the framework of Merton (1974), which is a structural model that requires a number of assumptions. Among them, the two most important are as follows. The first is that the asset value of a firm follows a geometric Brownian motion:

$$dV = \mu V dt + \sigma_V V dW$$

where V is the asset value of the firm, μ is the drift based on V, σ_V is the volatility of the firm value, and dW is a standard Wiener process.

The second assumption of the Merton model is that firms are financed by a single discount bond maturing in T, besides equity. Meanwhile, equity holders receive the firm value, which is less than the face value of the firm's debt, represented as L. Thus, the payoff of equity holders at maturity is

$$E_{\mathrm{T}} = \max\ (V_{\mathrm{T}} - L, 0)$$

that is the same as the call option payoff on the underlying value of the firm with a strike price equal to the face value of the firm's debt and a time-to-maturity of T. Thus, according to the Black–Scholes option pricing formula, the equity value of a firm satisfies

$$E = V\mathcal{N}(d_1) - e^{-rT}F\mathcal{N}(d_2)$$

where E is the market value of the firm's equity, F is the face value of the firm's debt, r is the risk-free rate, $\mathcal{N}(\ )$ is standard cumulative normal distribution function, and

[23]For reference, the distance-to-default estimates offered by NUS–RMI include those for both non-financial and financial firms. We will briefly distinguish between those two.

$$d_1 = \frac{\ln\left(\frac{V}{F}\right) + \left(r + 0.5\sigma_V^2\right)T}{\sigma_V\sqrt{T}} \ \& \ d_2 = d_1 - \sigma_V\sqrt{T}.$$

The Merton model uses one more important equation, expressing that the volatility of the firm's value is closely related to the volatility of its equity. Under the second assumption, we can derive the following relationship using Ito's lemma:

$$\sigma_{\mathrm{E}} = \left(\frac{V}{E}\right)\mathcal{N}(d_1)\sigma_V.$$

In Merton's (1974) model, the distance-to-default can be calculated as follows. The first step is to estimate σ_E (the volatility of equity) from the market data such as historical return data. The second step is to choose a forecasting horizon and the face value of the firm's debt. Moody's KMV assumptions are to set the time to maturity at 1 year and the face value of the firm's debt to a value equal to the firm's current liabilities plus one half of its long-term debt.[24] The last step is to solve $E = V\mathcal{N}(d_1) - \mathrm{e}^{-rT}F\mathcal{N}(d_2)$ numerically to infer V and σ_V.

After this numerical procedure, the distance-to-default can be obtained from the following formula:

$$\mathrm{DtD} = \frac{\ln\left(\frac{V}{F}\right) + \left(\mu - 0.5\sigma_V^2\right)T}{\sigma_V\sqrt{T}}$$

However, financial firms usually have large amount of liabilities such as deposits that are categorized as neither current nor long-term liabilities. Thus, since the standard assumption of debt in traditional distance-to-default calculation, as described above, ignores a significant portion of a firm's liabilities, the standard distance-to-default calculation needs to be extended to give reasonable (acceptable) estimates for financial firms by accounting for debt other than current liabilities and long-term debt. For further details, see Duan and Wang (2012).

[24]NUS–RMI's technical report says that the current liabilities and long-term debt are taken from a firm's financial statements, compiled according to Generally Accepted Accounting Principles (GAAP) and not International Financial Reporting Standards (IFRS).

B. Maturity Interaction

Maturity might be regarded as either a liquidity or credit risk proxy; we treat it as a liquidity variable in this paper. Tables 8-1 and 8-2 explore the function of *Maturity* by interacting liquidity and credit proxies with the *Maturity* variable. In these tables, Model 1 includes the liquidity proxies and their interaction terms; Model 2 includes the credit variables and their interactions; and Models 3 and 4 include both set of variables.[25]

(Table 8-1 here)

As seen from the Table 8-1, the interaction terms, like some quadratic terms, add some quality of fit: the adjusted R-square increases by 7.32% with the addition of the interaction terms, compared with the adjusted R-square of Model 9 in Table 5-1. In addition, as consistent with previous empirical findings, the results in Table 8-1 also demonstrate that credit risk appears to be a more important determinant of *Yield Spread*.

Meanwhile, an investigation of the coefficients of individual variables sheds additional light on the effect of determinants on yield spreads. The coefficient for *Maturity* shows a significantly positive relationship with spreads. The coefficient on its interaction term with *Maturity* is negative and significant at the 90% level. Judging from Model 3, the derivative of *Yield Spread* with respect to *Maturity* is as follows:

$$\frac{\partial(Spread)}{\partial(Maturity)} = 0.925 - 0.034 * Maturity \qquad (4)$$

From this equation (4), ceteris paribus, a higher level of *Maturity* increases *Yield Spread*;

[25]Model 4 also includes the financial dummy variable.

yet, when it comes to *Maturity* over 27 years, the incremental effect reverses.[26]

Also, Model 4 gives the incremental effect of *Coupon* on *Yield Spread* as follows:

$$\frac{\partial(Spread)}{\partial(Coupon)} = 0.804 - 0.146 * Maturity \qquad (5)$$

The marginal effect of *Coupon* on *Yield Spread* declines with *Maturity*. Perhaps, this is related to the fact that issuers with lower default risk tend to have longer-term bonds.

(Table 8-2 here)

The interaction terms also play a role to improve the quality of fit for the period after the crisis: the adjusted R-square increases by 1.78% with the addition of the interaction terms, compared to the adjusted R-square of Model 9 in Table 5-2. In addition, as consistent with previous empirical findings, these results also demonstrate that credit risk appears to be a more important determinant of *Yield Spread*. From the differences in adjusted R-square between Models 1 and 3, and between Models 2 and 3, it is possible to confirm the conclusion regarding the relative importance between credit and liquidity risk.

The coefficient for *Maturity* shows a significantly positive relationship with spreads. The coefficient on its interaction term with *Maturity* is negative and significant. Judging from Model 4, the marginal effect of *Maturity* on *Yield Spread* is as follows:

$$\frac{\partial(Spread)}{\partial(Maturity)} = 0.712 - 0.038 * Maturity \qquad (6)$$

From equation (6), ceteris paribus, a higher level of *Maturity* increases *Yield Spread*; yet,

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[26]Note that the longest maturity of an issue in the sample is 10 years.

when it comes to *Maturity* over 18 years, the incremental effect reverses. This pattern can be observed in equation (4) as well.

In addition, Model 4 gives the incremental effect of *Coupon* on *Yield Spread* as follows:

$$\frac{\partial(Spread)}{\partial(Coupon)} = 0.482 - 0.087 * Maturity \qquad (7)$$

The pattern shown in equation (7) also appears in equation (5).