ESSAYS IN THE ECONOMICS OF
FIXED INCOME SECURITIES

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and approved by

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ABSTRACT OF THE THESIS

Essays in the Economics of Fixed Income Securities

By Ronald Sverdlove

Thesis directors: Professors Ren-raw Chen and S. Abraham Ravid

1. Corporate Credit Default Swap Liquidity and Its Implications for Corporate Bond Spreads

   In a Credit Default Swap (CDS), the credit protection buyer pays a premium that has been viewed as the price of credit risk. Therefore, researchers have used CDS premiums to study the liquidity component of corporate bond spreads. Using a transaction dataset, we find very large bid-ask spreads in CDS quotes. With a two-factor model, we show that such spreads affect the estimation of credit risk, and therefore the estimation of the liquidity spread for corporate bonds. While the bond and CDS markets appear to have two different values for the credit spread, once liquidity is accounted for, the difference disappears.

2. The Effect of APR Violations on the Seniority and Timing of Debt Issuance

   We model the interactions between creditor groups in bankruptcy and their effects on the debt issuance decisions of firms. We show that firms may tend to keep issuing debt at one seniority level to avoid the costs of conflict in bankruptcy. Empirically, most firms do this, and many cluster at the senior subordinated level. Our model predicts what types of firms may change seniority level in sequential issues. As costs of conflict
increase, firms tend to issue more junior debt. Companies that issue subordinated debt are much smaller than senior issuers, while those issuing at both levels are intermediate on most financial measures. Our model is also supported by the fact that companies that issue only senior debt pay lower spreads than companies that issue at both levels.

3. Mergers and Debt Seniority

We study the seniority structure of debt for corporations undergoing mergers. We find that acquiring firms do not try to maintain their previous seniority structures after the merger, or to return to them quickly, in spite of the advantages that can be obtained by maintaining an optimal seniority structure of debt. This is consistent with evidence from recent studies that find that changes in capital structure tend to persist, and that firms are slow to revert to previous structures after shocks, such as those that may result from mergers.
ACKNOWLEDGEMENTS

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Finally, I must thank my family for their support during the long period from start to finish of my degree: my wife, Melissa, my children, Rachel and Madeline, and my parents, Freddy and Harry.
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CHAPTER 1. CORPORATE CREDIT DEFAULT SWAP LIQUIDITY AND ITS IMPLICATIONS FOR CORPORATE BOND SPREADS

1. INTRODUCTION

Corporate bond markets are much less liquid than equity markets. Consequently, prices of corporate bonds include large discounts that compensate investors for assuming liquidity risk. Using structural credit models, Huang and Huang (2003), for example, show that less than 30% of corporate bond yield spreads represent compensation to investors for accepting default risk. The balance of the yield spread is related either to liquidity or to the different tax treatments for corporate and Treasury bonds. However, such results have been criticized because they are model-implied, and it is well known that structural credit models tend to underestimate true credit risk. The introduction of the credit default swap (CDS) contract solves this problem since a CDS is a natural hedge for the default risk of a corporate bond. Roughly speaking, buying a corporate bond and the corresponding CDS as default protection is equivalent to buying a default-free corporate bond. Using CDS premiums as a measure of pure credit risk, researchers have studied corporate bond spreads (known also as “credit spreads” or “yield spreads”)

1 The tax effect results from the fact that interest payments on U. S. Treasury securities are not subject to state income taxes, while corporate bond coupon payments are.

2 While there are some questions about whether a CDS is a perfect hedge for a fixed coupon corporate bond, because of different accrued bases, researchers from both academia and industry believe the biases are small.

3 We use the term “premium” for the amount paid by a protection buyer to avoid confusion with “spread” which in the context of CDSs we use for bid-ask spreads. Bond prices can be said to have an (il)liquidity discount, while bond yields have an (il)liquidity premium.
which are corporate bond yields minus the corresponding risk-free rate. For example, Longstaff, Mithal, and Neis (2005) use CDS premiums as a reflection of pure credit risk in order to measure the default risk in corporate bond spreads. However, in a proprietary dataset we obtained from Creditex, we found very large bid-ask spreads in CDS quotes: the average bid-ask spread of the entire sample is 30% of the mid price between bid and ask. By contrast, bid-ask spreads in the equity markets are typically well under five percent.4

Motivated by this discovery, in this paper we investigate (1) how significant the implication of such large bid-ask spreads in CDS quotes is on a company’s true credit risk and (2) how the credit spread estimates in turn affect estimates of the liquidity premiums in corporate bonds. We study the dynamics of the liquidity factor for all firms in the dataset and estimate the liquidity premium in CDS quotes using a two-factor model. We find not only that the liquidity factor is economically and statistically significant, but also that the liquidity risk premium explains a substantial portion of the bid-ask spreads. Furthermore, we find that although the magnitude of liquidity is positively related to credit risk, the liquidity risk premium seems uncorrelated with credit risk.

Because of the swap nature of the CDS contract, a CDS premium provides a much purer quantification of credit risk5 and a small bid-ask spread in a CDS quote can

\[ \text{bid-ask spread} = 0.3 \times \text{mid price} \]

4 For example, Lin, Sanger, and Booth (1995) find that relative bid-ask-spreads on a representative sample of New York Stock Exchange stocks range from about 0.6% to 2.1%, depending on average volume.

5 A swap contract is not a purchase contract but rather an agreement between counterparties to exchange one good for the other. Hence, there is no price associated with the contract (no cash changes hands) and the values of the two legs, in the expected sense, must be equal. Given that the premium leg
translate into a substantial bid-ask spread in the corresponding corporate bond. Our simulation results show that the liquidity penalty in the corporate bond yield is 13 times the discount in the CDS premium quote. To our knowledge, there are only a few studies of corporate CDS liquidity, all done since 2005: Chen, Cheng, and Wu (2005), Tang and Yan (2007), Buhler and Trapp (2006), and Bongaerts, de Jong, and Driessen (2007).

As an important note on terminology, since we study bid-ask spreads in this paper and do not want to confuse these spreads with CDS quotes that are often named CDS spreads, we shall refer to the CDS spread quotes as CDS premiums. We shall retain the use of “spread” strictly for bid-ask spreads.

The paper is organized as follows. In Section 2, we provide a short, but thorough review of literature that is directly related to our study. In Section 3, we describe our data from Creditex and the interpolation algorithm necessary to calculate the bid-ask spreads. A series of sample statistics that demonstrate the liquidity issues associated with CDS quotes is provided in Section 4, followed by a description of a simple factor model and the results of its estimation in Section 5. Section 6 reexamines corporate bond spreads with the factor model. Finally, Section 7 concludes.

2. RELATED LITERATURE

The literature on corporate bond spreads is voluminous. In this section, we only refer to those papers that are directly related to our study. Huang and Huang (2003) and

\[^{6}\text{See Longstaff, Mithal, and Neis (2005) for a detailed review.}\]
Eom, Helwege, and Huang (2004) find significant differences between equity-market implied credit spreads (that represent only default risk) and observed corporate bond credit spreads. These differences represent the prices of other important factors, such as liquidity, embedded in the corporate bond credit spread.

As the CDS market has grown, researchers have often assumed that CDS premiums should represent the price of pure credit risk and that they should provide a more accurate measure of that price than can be derived from structural models of credit risk. Papers comparing corporate bond credit spreads and CDS premiums include Longstaff, Mithal, and Neis (2005), Hull, Predescu, and White (2004), Blanco, Brennan, and March (2005), Zhu (2004), Ericsson-Reneby-Wang (2005), and Saita (2006).  

2.1. **Bond Credit Spreads and CDS Premiums**

Longstaff, Mithal, and Neis (2005) study the non-default component in corporate bond credit spreads. They attribute this component to illiquidity since they find the tax effect in their data to be insignificant. Using CDS data from Citigroup between March 2001 and October 2002 for 68 firms, they find the non-default component in corporate bonds to be significant, time varying, and fast mean-reverting. All but three of the corporations in their sample were investment-grade rated issuers. The three corporations that were not investment grade were rated double B. Their CDS dataset is a transaction dataset that includes bids, asks, and actual trade quotes. Yet, Longstaff, Mithal, and Neis only use the mid quotes of the CDS premiums to represent corporate credit risk.

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7 Some of these papers and others indicate that CDS spreads seem to be too high for the default risk they represent. For example, see Berndt, Douglas, Duffie, Ferguson, and Schranz (2005), Blanco, Brennan, and Marsh (2005), Pan and Singleton (2005), and Saita (2006).
Ericsson, Reneby, and Wang (2005) use CDS premiums to measure corporate bond credit spreads via three structural models using CDS data from CreditTrade, a credit derivatives broker, for 71 firms in the period from June 1997 to April 2003. Calibrating their models to CDS premiums and then using them to price bonds, they conclude that corporate bond credit spreads are significantly higher than the CDS premiums.

As in Longstaff, Mithal, and Neis (2005), Saita (2006) uses CDS premiums as the benchmark for default risk and studies the returns on bonds. Saita says that the risk-return tradeoff for bond portfolios is puzzling because he finds that measuring bond performance by the Sharpe ratio and more general risk-return measures gives values ten times larger than those of the S&P500 index. The CDS data used by Saita are intraday transaction prices obtained from GFI (a credit derivatives broker) for the period from June 1998 to June 2004 and from Lombard Risk from July 1999 to June 2005. Hull, Predescu, and White (2004) find similar evidence that on average corporate bond credit spreads exceed the corresponding CDS premiums by 17%. However, their interpretation of this result is different from that of Longstaff, Mithal, and Neis (2005). They interpret the disparity as the difference between the Treasury rate and the “implied risk-free rate”. Hull, Predescu, and White use CDS data provided by GFI for the period between January 5, 1998 and May 24, 2002. GFI’s dataset also includes bids, asks, and actual trade quotes, but they only use mid quotes.

In their study of the relationship between corporate bond credit spreads and CDS premiums, Blanco, Brennan, and Marsh (2005) report results similar to Hull, Predescu, and White (2004), but contrary to Longstaff, Mithal, and Neis (2005). That is, they conclude that the theoretical relation holds quite well in practice. In cases where the
corporate bond credit spreads and the CDS premiums are not identical, they attribute the difference to the tendency of CDS premiums to lead corporate bond credit spreads in price discovery. Their dataset includes a daily time series of indicative prices\(^8\) from CreditTrade and mid-market prices from J.P.Morgan for 33 investment-grade companies from January 2, 2001 to June 20, 2002. Blanco, Brennan, and Marsh select the CDS in their dataset for maximum liquidity in order to eliminate that factor from their spreads.

Zhu (2004) studies the causality relationship between corporate bond credit spreads and CDS premiums, selecting CDS data for 24 entities from CreditTrade between January 1, 1999 and December 31, 2002. He asserts that CDS premiums and bond credit spreads are identical in theory, but he does find differences in the data. Zhu confirms the findings of Blanco, Brennan, and Marsh (2005) that the CDS market tends to lead the corporate bond market. As in other studies, while his dataset is transactional, Zhu uses midpoints for his calculations.

\section*{2.2. CDS and Structural Models}

In addition to comparing CDS premiums and corporate bond credit spreads, some researchers employ structural credit risk models to explain CDS premiums. Since it is believed that CDS premiums represent corporate credit risk better than corporate bond credit spreads, they are perfect candidates for testing structural models.

\footnote{Indicative prices are defined by the American Stock Exchange Dictionary of Financial Risk Management (http://www.amex.com/servlet/AmexFnDictionary?pageid=display&titleid=3352) as follows: "Bid and offer price provided by a market maker for the purpose of evaluation or information, not as the firm bid or offer price at which she is willing to trade. Also called Nominal Quotation. (2) A preliminary estimate of the price at which a financial instrument might be created. Indicative prices are quoted to customers for planning or valuation purposes, but they do not form the basis for an actual transaction without further discussion." Thus, they are intermediate between firm quotes and matrix prices.}
Berndt, Douglas, Duffie, Ferguson, and Schranz (2005) study the difference between (risk-neural) CDS-implied credit risk and the actual credit risk that Moody’s KMV\(^9\) claims to measure: Expected Default Frequency (EDF). They conclude that the difference between the two is quite large and time varying. Their dataset includes intraday CDS transaction quotes for 39 bank names between June 2000 and December 2004 that they obtained from CIBC.

Zhang, Zhou, and Zhu (2005) derive a structural model with volatility and jump risks and apply it to a dataset consisting of monthly average spreads on 307 entities for the years 2001–2003. They conclude that their model is significantly better than the existing models in explaining the time-series variability of CDS prices.

Finally, we note that Chen, Fabozzi, Pan, and Sverdlove (2006) study factors that impact CDS values by comparing pair-wise nested models. Using the same data as this paper does, they conclude that random recovery is an important model assumption for explaining a large portion of the credit risk, while random interest rates are not an important assumption.

### 2.3. CDS Liquidity

In contrast to the studies that use CDS premiums as pure credit risk to gauge corporate bond credit spreads, other researchers have discovered that CDS premiums themselves are not necessarily a good measure of pure default risk. Since CDSs are marketable instruments, they carry some of the same risks as any other marketable instrument.

\(^9\) Moody's KMV is a leading provider of credit measures for public companies. See Crosbie and Bohn (2002) for a description of their methodology.
One of the first papers to investigate the factors determining CDS premiums is Cossin, Hricko, Aunon-Nerin, and Huang (2002). The authors point out that CDS premiums are not subject to the direct effects of changes in interest rates, nor to the influence of the embedded options that may be found in corporate bond indentures. Cossin et al. perform regressions of CDS premiums on credit ratings, various factors related to market interest rates in the United States and other countries, and corporate factors such as size, leverage, and stock price changes. Their dataset includes 392 transaction prices on different CDS from 1998 to 2000. While credit rating remains the most important predictor of CDS prices, most of the other factors they consider contribute to explaining the spreads. The regression approach is also employed by Ericsson, Jacobs, and Oviedo (2004), who employ a much larger dataset from CreditTrade that includes almost 50,000 quotes covering the years 1999-2002. They also find that leverage, volatility, and interest rates can explain a significant amount of the variability in CDS premiums.

Chen, Cheng, and Wu (2005) conduct the first evaluation of CDS liquidity. Following the reduced-form model defined by Longstaff, Mithal, and Neis (2005), they use J.P. Morgan’s matrix data to study the term structure of liquidity premiums. They discover a significant liquidity factor in CDS quotes and further find that liquidity risk is priced in the market. Because there is no bid-ask information in their dataset, Chen, Cheng, and Wu have to approximate liquidity by the frequency of price changes.

Tang and Yan (2007) use CreditTrade CDS data from June 1997 to March 2006 to examine liquidity problems in the CDS market. They present a systematic study of the liquidity effect on CDS premiums and show that this effect is significant, with an
estimated liquidity premium on a par with those of Treasury bonds and corporate bonds. Tang and Yan find that systematic liquidity risk is particularly important for more actively traded CDS contracts, while individual liquidity characteristics dominate the liquidity effect for infrequently traded CDS contracts. Their evidence suggests that search costs are the prevalent consideration for the liquidity of infrequently traded contracts, while demand pressure, inventory constraint, and adverse selection contribute to the liquidity premium for actively traded contracts. They also document significant effects of liquidity spillover from the corporate bond, stock, and stock option markets to the CDS market on both CDS liquidity and CDS premiums.

Buhler and Trapp (2006) is the paper which is most similar to ours. The authors use a reduced-form model of credit risk with added liquidity factors for the corporate bond and CDS markets. They find that credit spreads are almost the same in the corporate bond and CDS markets, but that liquidity premiums are significantly different. In particular, at times of high credit risk, the corporate bond market becomes less liquid, while the CDS market becomes more liquid. They test their model using four years of data (2001-2005) for 37 telecommunications companies issuing Euro-denominated bonds.

Bongaerts, de Jong, and Driessen (2007) use an asset pricing model for CDS that includes the effects of expected liquidity and liquidity risk. They convert CDS premium data into a time series of expected returns on CDS investments. This allows them to estimate risk premiums and liquidity exposures. They find evidence of priced systematic factors for credit and liquidity risks with the effect of expected liquidity stronger than the effect of liquidity risk. The model is tested using CDS bid and ask quotes from
CreditTrade for the period from 2000 to 2006. As we do in our dataset, Bongaerts, de Jong, and Driessen limit their analysis to five-year senior CDS with modified restructuring. After computing daily average quotes, they have approximately 100,000 observations.

Despite the differences in datasets and methodologies, all of these papers agree that there is a significant liquidity factor in CDS premiums and therefore that these premiums cannot be used as a pure measure of credit risk for analyzing corporate bond credit spreads.

2.4. Other Empirical Studies of CDS Premiums

The empirical literature on CDS is large and growing rapidly, making it impossible for us to provide a comprehensive review here. As a few examples, we note that Skinner and Diaz (2003) and Houweling and Vorst (2005) implement a reduced-form credit risk model and use it to predict CDS premiums, Townend (2002) points out that CDS contracts are similar to American put options on the underlying bonds and Chan-Lau and Kim (2004) and Pan and Singleton (2006) study CDS contracts for sovereign rather than corporate reference entities.

3. DATA

Our dataset includes the following information: (1) transactional CDS quotes from Creditex, (2) rating data from the Fixed Investment Securities Database (FISD)

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10 Modified restructuring is one of the choices that a participant in a CDS trade has in the selection of how restructuring is treated for purposes of defining a credit event for the reference entity.
from Mergent, Inc., (3) bond data from Trade Reporting and Compliance Engine (TRACE), and (4) risk-free interest rates from the Federal Reserve Bank of St. Louis.

3.1. CDS Quotes from Creditex

The CDS prices were obtained from Creditex, which collected them from two or more dealers. The data cover the period from February 15, 2000 to April 8, 2003. The CDS prices are written on reference entities worldwide in five currencies with the U. S. dollar being the dominant currency (76.5%) followed by the Euro (19.1%). Maturities range from 0.5 to 30 years, but for the majority (84.7%) are five years. The dataset contains 87.2% senior (unsecured) debt and 12.7% junior debt and 23.9% financial companies, 4.4% sovereign names, and 71.6% industrial firms.11

The most important feature of this dataset is that it contains bid, ask, and actual trade quotes, which allows us to study the liquidity in the market. At the beginning of the period, there are very few trades. Active trading started around the middle of 2001. The time of day of the quote or trade is also included.

The dataset contains 217,480 observations (102,874 bids, 101,351 asks, and 13,255 trades) across 1,372 reference entities. However, there are 1,217 repeating entries (467 bids, 304 asks, and 446 trades). There are also 64 bad data points (14 bids, 16 asks, and 34 trades).12 Correcting for those we end up with 216,199 observations which are composed of 102,393 bids, 101,031 asks, and 12,775 trades. The breakdown

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11 The dataset further divides the industrial group into corporate and telecommunications groups.

12 Bad data points are mostly those with values that are clearly inconsistent with surrounding values in the time series. In other cases, it appears that a bid quote has been recorded as an ask or vice versa.
by year through the first quarter of 2003 is given below to show the growth of the market (which suggests liquidity improvement):

<table>
<thead>
<tr>
<th>Entire period</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>216,199</td>
<td>25,516</td>
<td>38,146</td>
<td>105,967</td>
</tr>
<tr>
<td>Bid</td>
<td>102,393</td>
<td>12,007</td>
<td>16,623</td>
<td>51,558</td>
</tr>
<tr>
<td>Ask</td>
<td>101,031</td>
<td>13,398</td>
<td>18,774</td>
<td>47,104</td>
</tr>
<tr>
<td>Trade</td>
<td>12,775</td>
<td>111</td>
<td>2,749</td>
<td>7,305</td>
</tr>
</tbody>
</table>

For the purpose of this study, we limited the data to U. S. entities, five-year maturity, modified restructuring settlement,\(^{13}\) and senior debt. We end up with 63,123 observations including 28,347 bids, 28,532 asks, and 6,244 trades across 584 reference entities. We note that modified restructuring (MR) only started after January 15, 2001 in the dataset. Before that date, most U.S. names had full restructuring (R). Since then, the U.S. market has been standardized on MR. This change is evident in the following breakdown of restructuring in our filtered dataset.\(^{14}\)

<table>
<thead>
<tr>
<th>Restructuring Types for U. S., 5-year, Senior CDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>Bid</td>
</tr>
<tr>
<td>Ask</td>
</tr>
<tr>
<td>Trade</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

\(^{13}\) Modified restructuring is standard in the U. S., while full restructuring is standard in Europe. Modified restructuring reduces the set of credit events which require payment by the protection seller under the CDS contract.

\(^{14}\) In the Appendix, there is further discussion of restructuring, including a table of restructuring types for the full data set.
As an example, consider the data for Enron. In the full dataset, there are 180 observations for Enron that include 92 bids, 55 asks, and 33 trades. These numbers are similar to those in the study by Longstaff, Mithal, and Neis (2005), Yet after filtering (for senior, MR, and 5-year) only 6 bids, 7 asks, and 2 trades remained. The observations eliminated are mostly those with full restructuring from before 2001.

Since we plan to interpolate values for the bid and ask prices, we also eliminate observations for which the time of day appears to be incorrect: those for which the time is given as 0:00 or 17:00. Finally, we only study 5-year CDS quotes and hence we retrieve 5-year constant maturity Treasury (CMT) rates from the web site of the St. Louis Federal Reserve Bank.

3.2. Linear Interpolation and Modified Interpolation

The data for each company is irregularly distributed in time. The distribution of times reflects market conditions and liquidity of the individual securities, so we want to preserve this distribution. We interpolate from the filtered data so that we will have both a bid and an ask premium, and therefore a bid-ask spread, at each time in the dataset, whether the original data item was a bid, an ask, or a trade. For each company, we begin by linearly interpolating between given values to all the times with data for that company.

The problem that can occur with this procedure is that when there are large time gaps, the resulting values can have bid prices that are higher than the corresponding asks. We correct this problem by interpolating the bid-ask spreads. For each time where the

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15 They have 31 observations for Enron. Note that their data is from the period 2000-2001, while ours is from 2000-2003.
bid is greater than the ask, we move forward and backward in time until we find the first points in each direction where the bid is less than the ask. We then linearly interpolate the spread between those two points. For each point in that time interval, we preserve the bid or ask price that was in the original data and use the interpolated spread to calculate the other one. If the original data item was a trade, we assume that the premium is at the midpoint between the bid and ask premiums. Then we set the interpolated bid and ask to be on either side of the trade by half of the interpolated spread. A detailed graphical presentation of the interpolation scheme is given in the appendix. The resulting data we use in our analysis include 52,289 total observations of which 27,928 are for industrial names and 24,361 are for financial names.

3.3. FISD Dataset

For fitting the data to pricing models, we need additional information about the companies, including credit rating and industry. Since the CDS are written on names rather than specific bond issues, the credit ratings should be at the company level. This type of data is available from several sources. We first tried the Compustat database, but we were not able to find a majority of the reference companies in Compustat. Therefore, we switched to using the Fixed Investment Securities Database (FISD) from Mergent, Inc. This database has complete at-issue information on 162,593 bonds issued by 10,177 entities. Roughly 90% of the bonds have issue dates in 1986 or later (and for another 5%, the issue date is not available.). Current and historical ratings from the three agencies are included in FISD: Moody’s, and Standard and Poor’s, and, Fitch. Historical ratings are

16 There are also ratings from Duff and Phelps. In March 2000, just at the beginning of our dataset, Fitch IBCA acquired Duff and Phelps.
not given at regular intervals, but only when changes (i.e., upgrades or downgrades) occur. “Current” ratings are simply the most recent ones: some of them are ten or more years old. We decided to use only Standard and Poor's ratings for consistency. Ratings in FISD are given on a per-issue basis, not on an issuer basis. One could take an average rating for all the issues of a company, but we found that this does not provide much additional information. For a sample of companies that we checked, in most cases all bond issues had the same current rating. In a few cases, there was one bond with a rating one notch different from the rest. Therefore, we used the rating of a company’s first issue in the list as a company’s rating.\(^\text{17}\)

In order to combine the CDS data with the ratings, we need to match the companies in the CDS dataset to the FISD. In the CDS data, companies are identified only by name and dealer-specific proprietary identifiers. There are no standard identifiers such as CUSIPs. Therefore, it is necessary to match names between the two data sources. The matching process we used is described in the Appendix. In the end, we were able to match 1,135 of the 1,372 CDS names in the FISD. We then extracted from FISD a company-level credit rating as described above, as well as a 2-digit SIC code. These data were used to classify the names into a two-dimensional array of categories.

3.4. TRACE Dataset

We retrieve bond data from the TRACE dataset. By matching the CUSIPs between TRACE and FISD, we obtain 1,480,441 bond prices and yields from 2,308

\(^\text{17}\) The FISD is provided as relational database tables, both as plain text files and as a Microsoft Access database. As a result, many tools are available for extracting desired data.
bonds and 273 names for the period of study. A casual inspection of the data shows that the liquidity of the bonds varies. Some bonds are very liquid (multiple transactions per day) and others are illiquid (one transaction in many days). There appear to be some errors in the TRACE yield and price data.\textsuperscript{18} We recalculated the yields from the bond parameters and eliminated all data points where the yield reported by TRACE differed from our calculated yield by more than 5%. We then reduced the data to have just one bond price (yield) per company per day. For each company on each date when there are trades, we picked the one bond with maturity closest to five years. If a selected bond has more than one trade on a day, we used its median yield on that day.\textsuperscript{19} Sometimes the maturities are not close, since there may have been only one bond of the company traded on the day to begin with. In 228 cases, the maturity of the selected bond is less than one year, going as low as 1 day. In contrast, there were some cases where the only bond is long term and the time to maturity can be close to 30 years. The final dataset includes 9,316 company-day data points: price, yield, volume, and maturity.

4. SOME PRELIMINARY RESULTS

The filtered dataset under study contains 63,123 observations including 28,347 bids, 28,532 asks, and 6,244 trades across 584 entities. But the liquidity across these entities varies dramatically. There are 191 entities (32.7\%) for which there are no trades,

\textsuperscript{18} Some of these are obvious typographic errors, such as entering the time of day in the yield field.

\textsuperscript{19} If there are an even number of trades on the day, we randomly elect one of the yields on either side of the median, so that we always have an actual transaction yield.
only bid and ask quotes, and half of the entities have fewer than 20 observations (bid, ask, and trade). The top 40 entities account for nearly half (49.2%) of the sample points.

The bid-ask spreads for many names are wide. To make a reasonable comparison of the data for different names, we use the normalized bid-ask spread, defined as the bid-ask spread divided by the bid-ask midpoint. We use the mid point to normalize the bid-ask spread because there is a significantly positive relationship between the mid CDS quotes and the bid-ask spread. Figure 1.1 shows the distribution of the normalized bid-ask spreads for the entire sample. The mean value is 29.16% and the median value is 24.87%. The distribution is skewed to the right. There are a few cases where the bid-ask spread exceeds 100%.

We illustrate differences in liquidity with two names: Procter & Gamble (PG) and Disney (DIS). As shown in Figure 1.2, in the filtered dataset P&G, rated AA-, has 66 bids, 79 asks, and 11 trades, so it is not a very liquid name. It is ranked 107th based on the number of observations. There is one trade that falls outside of the bid-ask band when we use ordinary linear interpolation. Disney, rated A-, ranks 17th based on the number of observations, having 344 bids, 325 asks, and 95 trades. There are no violations of the bid-ask band. These observations are plotted in Figure 1.3. For Disney, the average ask is 107.93 basis points and the average bid is 91.97, so the normalized bid-ask spread is 15.96%. On the other hand, for P&G, the average ask is 27.06 basis points and the average bid is 15.02, so the normalized bid-ask spread is 57.31%. The quotes are lower for P&G because of its higher rating (lower risk), but the spread is much higher because of lower liquidity.

20 The correlation between the mid quotes and the bid-ask spreads is 67.2% in our sample.
In order to look at the data more deeply, we compare the number of trades and the bid-ask spread across names. By comparing these two measures of liquidity, we check for the robustness of the liquidity effects we observe in the CDS market. We use the interpolation algorithm described in the previous section to provide a bid and ask for every observation. Figure 1.4 plots the normalized bid-ask spread against the number of trades per company per day. For each number of trades on a day, the plot shows the mean and one standard deviation on each side of it. There is a clear pattern of normalized bid-ask spreads and their dispersion both decreasing as the number of trades on a day increases.\(^{21}\) We compute the simple Pearson correlation between the bid-ask spread and the number of trades to be \(-12.49\%\), although it is clear that the relationship is non-linear. When we run a regression of bid-ask spread against trades per day, the slope of the linear fit indicates that there is a 3.34% drop for every additional trade in the market.

The sub-samples we investigated behave similarly. Table 1.1 demonstrates the sub-sample statistics of the relationship between the normalized bid-ask spread and the number of trades. Note that for each correlation calculation, we need to recompute daily averages in that particular cohort and then compute the correlation. Negative correlations are observed throughout all cohorts, ranging from the lowest \(-6\%\) (AA, Industrial) to the highest \(-21\%\) (B, Industrial). The overall correlations for the financial and industrial sectors are \(-15\%\) and \(-12\%\), respectively. In most of the ratings-industry groups, the correlation is between \(-10\%\) and \(-20\%).\(^{22}\)

\(^{21}\) Note that for each of the groups with 9, 10, or 11 trades on a day, there is only one data point (only one company that had that many trades on one day), so no standard deviation can be calculated.

\(^{22}\) The relationship is similar when we measure the normalized bid-ask spreads against the total number of observations.
The liquidity improves over time, as expected. Figure 1.5 shows that normalized bid-ask spreads decrease over time. In a regression, the R-squared is 20.14%. The slope is \(-0.016\%\) per calendar day, which translates to 3.47\% a year. In other words, on average, the bid-ask spread improves 347 basis points per year.

Subsample results are summarized in Table 1.2. The numbers reported in the first column of each sector are basis points per annum. The numbers in the second column are the numbers of observations. As can be seen, the subsamples behave similarly. All but AAA industrial cohorts show improved liquidity over time. However the AAA industrial cohort has very few observations and the result is not reliable. Two other groups whose results are biased because of small sample size are NA industrial and B industrial. The former has a positive slope (liquidity deterioration) of 139 basis points per annum and the latter has nearly 2000 basis points liquidity improvement.

Except for the above cohorts, the largest improvement of liquidity is for BB rated names in the industrial sector where the reduction of the normalized bid-ask spread is near 700 basis points per annum, for both financial and industrial sectors. The improvement of liquidity is similar for the financial and the industrial sectors in general, 301 basis points and 386 basis points per annum, respectively. The improvement of liquidity over the different ratings seems to vary and does not exhibit any particular pattern.\(^{23}\)

\(^{23}\) Bongaerts, de Jong, and Driessen (2007) find that in their data set, market activity actually decreases after 2003. They have several possible explanations for this change in the CDS market. Tang and Yan (2007) also find a decrease in trading activity after 2003, but they attribute it to increased competition from dealers whose transactions are not included in their data set.
Finally, we look at the relationship between CDS premiums and the number of trades. Tang and Yan (2007) discover a positive relationship; that is, more trades seem to occur with higher CDS premiums. We identify a similar result in our dataset as shown in Figure 1.6. Tang and Yan attribute this to the affects of informed trading and adverse selection. We suspect that this is related to firm-specific characteristics, and yet without proper data we cannot test such a hypothesis.

4.1. Event Time

Looking at the market from the perspective of calendar days is sometimes misleading. The increasing number of quotes and trades reported in Figure 1.7 show the improvement in liquidity over time. However, this improvement does not necessarily come from more transactions for each firm. Rather, it may come from the fact that there are more firms for which CDS are being traded in the market. To test this hypothesis, we redo every analysis in this section by “event date”. We line up all contracts by when they were first introduced to the market, and we refer to that day as day zero. By doing this, we will be able to determine if there are more transactions for a firm over time.

By definition, there are a large number of contracts on day zero, since we will have at least one observation from each firm in the dataset. Hence, if the number of contracts of a given firm does not increase, the number of observations will not increase over (event) time. We plot the number of contracts by event date in Figure 1.8.

From this graph, we can see that the improved market liquidity is related to the increasing number of firms in the market. We see also from the event date plot that firms start to drop out since not very many earlier firms survived the entire period.
While the number of observations is not increasing for each firm, interestingly the liquidity does improve. Compared with Figure 1.5, where the normalized bid-ask spread is improving by 0.64% per year, in event time, the normalized bid-ask spread is improving by 4.58% per year (see Figure 1.9).

Lastly, we examine the phenomenon in Figure 1.6 that CDS premiums seem to increase with the number of observations. The result using event time is qualitatively similar to the result shown in Figure 1.6, while the quantitative magnitude is much reduced. While the slope drops quite dramatically from 1.7897 to 0.0093, it is still highly significant ($t$ value of 3.06) using event time.

5. AN ESTIMATION OF LIQUIDITY

In this section, we formally model liquidity with a factor-based reduced-form model as in Longstaff, Mithal, and Neis (2005), and estimate the parameters associated with the factor model. In this section, we first demonstrate a bootstrapped liquidity factor and its basic characteristics and then empirically estimate a square-root process for the factor.

5.1. A Simple Bootstrapped Result

There is a one-to-one correspondence between a CDS premium and its underlying hazard rate under the assumption that interest rate, hazard rate, and recovery rate are all independent of one another. For a particular credit obligor, CDS premiums of various tenors imply a forward hazard curve; or equivalently, the survival probability curve that can be used to estimate a model. We shall define a two-factor model in the next subsection.
Define $w$ to be the expected recovery rate, $P$ to be the risk-free discount factor between today and time $t$, and $Q$ to be the survival probability between now and time $t$. Then we can write the correspondence between the CDS premium and its survival probability curve as:

$$s_T = \frac{(1 - w) \int_0^T P_t(-dQ_t)}{\sum_{j=1}^T P_j Q_j}$$

where $s_T$ represents the CDS premium to be paid periodically (unannualized) until time $T$ or default, whichever is earlier. The numerator is known as the protection value (or protection leg value) of the CDS and the denominator is equal to the value of a default-risky $1$ annuity with no recovery. It is important to note that equation (1) imposes no assumption about the dynamic processes followed by the default and risk-free rates, but it does assume independence among recovery rate, risk-free rate, and hazard rate.

In bootstrapping, the recovery rate is set to the industry standard value of 40%, the risk-free discount factor is computed from the CMT rates, and the survival probability is computed from the assumption of a constant hazard rate:

$$Q_t = e^{-Ht}$$

Hence, we can compute the hazard rate for each quoted CDS premium. Recall that all CDS premiums included in this study are trades with a 5-year tenor.

With the presence of liquidity, the numerator is modified to include an additional factor, $L$, which represents the liquidity adjustment to the default value.

---

24 The product of this annuity value and the quoted CDS premium yields the premium leg value.
where \( L_t \) is a penalty for illiquidity. We should note that the denominator cannot be adjusted by liquidity since it is nothing more than a risky annuity factor.

We model the premium of a CDS trade in a not perfectly liquid market with equation (3). Since we assume that illiquidity always reduces the price, we postulate that the CDS premium in a real market should be less than a hypothetically perfectly liquid CDS premium. While the perfectly liquid premiums are unobservable, we know that they cannot be more than the ask quotes. During the days when there are no actual trades, we know that they cannot be less than the bid quotes. Hence, the bid-ask spread should serve as an upper bound of the liquidity premium when there are no actual trades and the trade-ask difference should be the upper bound when there are actual trades.

Ideally, we would like to fit equation (1) through ask premiums and equation (3) through bid or actual premiums. Since our interpolation algorithm guarantees that the actual premiums are always equal to the mid premiums by construction, we shall fit equation (3) through the interpolated mid quotes.\(^{25}\) Note that this maximizes the penalty for illiquidity. Our empirical results, to be shown later, are consistent with this observation. As we take this maximum quantity for measuring illiquidity to estimate our model, we indeed find that the model “over-corrects” the liquidity discount and produces CDS premiums that are too low.

\(^{25}\) There are a few exceptions of this rule. If there are simultaneous actual bids and asks surrounding the trades, then actual trades will differ from the mid prices. In this case, we still use the mid prices for the estimation.
Corporate bonds must be priced consistently with our previous assumptions. Hence, the value of a fixed-rate corporate bond that pays a periodic cash flow \( c \) can be written as

\[
V = c \sum_{j=1}^{\infty} P_j Q_j + P_n Q_n + w \int_0^T P_t (-dQ_t)
\]

if it is perfectly liquid and

\[
V^* = c \sum_{j=1}^{\infty} P_j Q_j L_j + P_n Q_n L_n + w \int_0^T P_t (-dQ_t) L_t
\]

if there is a liquidity impact. The yields to maturity for these prices can consequently be computed as follows:

\[
V = \sum_{j=1}^{\infty} \frac{c}{(1 + y)^j} + \frac{1}{(1 + y)^n}
\]

and

\[
V^* = \sum_{j=1}^{\infty} \frac{c}{(1 + y')^j} + \frac{1}{(1 + y')^n}
\]

respectively. Note that \( V^* < V \) and \( y' - y \) is the yield spread that is positively correlated with illiquidity.

To investigate the magnitude of misusing the CDS premium as the true credit risk, we calculate a numerical example. We set the risk-free yield curve to be flat at 3%, the flat hazard rate at \( h = 1\% \) (and the survival probability \( Q_t = e^{-ht} \) for \( t = \frac{1}{4}, \frac{1}{2}, \ldots, 5 \)), and the flat liquidity rate at \( \ell = 1\% \) (and the liquidity discount \( L_t = e^{-\ell t} \) for \( t = \frac{1}{4}, \frac{1}{2}, \ldots, 5 \)). Later, we shall relax the flat curve assumption and assume a mean reverting square-root process for each factor. The maturities of the bond and CDS are both 5 years. We also assume quarterly coupons for the bond to match the quarterly CDS premiums, and use these to calculate the yield. We set the coupon to be such that the perfectly liquid (\( \ell = 0 \)) bond is
priced at par (i.e. $1), hence the bond with a liquidity discount will be sold at a discount to par. We find that the risk-free bond price is $1.0281 with a yield of 3.01%. The perfectly liquid but default risky bond price is $1 by construction with a coupon of $0.0362 per annum (hence the yield is 3.62%). The illiquid bond price is $0.9556 with a yield of 4.62%. From this result, we can compute the credit spread of the bond to be 61 basis points and the liquidity spread to be 100 basis points. The total bond credit spread is 161 basis points. On the CDS side, the perfectly liquid CDS premium is 60.3 basis points and the illiquid premium is 58.8 basis points, which leads to a bid-ask spread of 1.5 basis points (if we double the liquidity spread for the bid-ask spread then it would be 3 basis points).

There is a large difference between the 1.5 basis point liquidity spread for the CDS and the 100 basis point liquidity spread for the bond. 1.5 basis points is 2.5% of its premium and 100 basis points is 33% of its yield; hence the liquidity premium is magnified by 13 times! This indicates that large liquidity spreads in bonds only permit small liquidity spreads in CDS quotes.

To obtain a more complete picture, we run simulations for both hazard and liquidity rates from a low of 1% to a high of 10% at intervals of 1% and plot the ratio of the percentage bond liquidity spread to the percentage CDS liquidity spread. The results are shown in Figure 1.10.

Different parameter combinations change the magnitudes, but not the relation. We observe that the smaller the hazard rate (high-grade companies), the larger the ratio of the bond liquidity spread to the CDS liquidity spread. The disparity decreases as the default risk increases.
We also observe that the liquidity impact is more pronounced for low hazard rates than for high hazard rates. As the liquidity factor increases (from 1% to 10%) the ratio of bond liquidity spread to CDS liquidity spread increases more than when the hazard rates are high.

The limiting case of the above analysis also demonstrates that as the liquidity factor approaches zero (i.e., perfect liquidity), both the bond liquidity spread and the CDS liquidity spread go to zero, but the CDS liquidity spread approaches zero at a faster rate than the bond liquidity spread.

Our next exercise is to examine the magnitude of the errors in bond yields resulting from using the CDS premium as a pure measure of the credit risk spread. Assume that the market prices the liquidity correctly. The CDS premium quote should contain the liquidity discount and be 58.8 basis points and the bond price and yield should be $0.9556 and 4.620%, respectively. Note that the true credit risk should be 60.3 basis points for the CDS. If we erroneously take 58.8 basis points as the pure credit risk, it implies 0.976% for the hazard rate, as opposed to the true hazard rate of 1%. The wrong hazard rate is then used to compute the bond price to be $0.9562 and the yield to be 4.605%. Hence the error is 1.5 basis points, or 0.33% of the yield, for the misuse of the CDS quote.

If we now use 10% for both the hazard rate and the liquidity rate, the bond yield is 18.49% and the bond credit spread is 15.48%. The CDS premiums are 6.096% with perfect liquidity and 4.920% with illiquidity. The hazard rate implied by using 4.920% as a pure measure of credit risk is 0.0891 and results in $0.7235 for the illiquid bond price or a 17.57% bond yield. The error is 92 basis points, or 5.24% of the yield.
In Figure 1.11, we plot the bond yield errors as a percentages of the true yield for various combinations of hazard rate and liquidity rate. The simple theoretical result contradicts the common understanding that since CDS are more liquidly traded, their quotes should be regarded as pure credit risk. The simulation above demonstrates the opposite.

5.2. Estimation of a Two-Factor Model for Liquidity and Credit

In this section, we study the dynamics of the liquidity factor. We use a two-factor affine model for the credit and liquidity dynamics that underlie the CDS premiums. There are three principal reasons for choosing the two-factor affine model. First, the model has closed-form solutions for the discount factor that can be computed very efficiently. Many studies empirically test only a small sample of firms (e.g. Longstaff, Mithal, and Neis (2005) tested 68 firms) due to computational difficulties. With the closed-form solutions from the model, we are able to test all 584 firms in our dataset. However, there have been criticisms of affine models, the most noteworthy being that by Dai and Singleton (2003) who concluded that affine models are not rich enough to explain term structure dynamics. Fortunately, using affine models in our study is free from these problems. The reason is that our CDS premiums all have a rolling 5-year maturity and therefore do not contain information on the term structure of credit spreads. Thus, in our study, we benefit from the computational efficiency of an affine model without being subject to its drawbacks.

The second reason for using affine models is that they seem to fit credit spreads rather well. Chen, Cheng, and Wu (2006)) compare the performances of the quadratic models and the affine models in fitting term structure dynamics of credit spreads. They
find that the two factor affine model is equivalent to the one factor quadratic model and the estimation time is also comparable.\textsuperscript{26} Duffie, Pan, and Singleton (2000) propose a set of jump diffusion, random volatility affine models for the term structure dynamics for both risk-free and default-risky rates. Their models are flexible enough to account for any form of dynamics in credit spreads.

Finally, recently there have been several proposals for modeling the hazard rate using the change of time method. For example, Joshi and Stacey (2006) proposed an intensity gamma model where they use the gamma time change process. Ding, Giesecke, and Tomecek (2006) proposed a time-changed jump process. We do not choose to use this new methodology because there are no econometric tools (e.g. maximum likelihood estimation) for managing historical data. These models are mainly employed for cross-sectional fitting.

Following Longstaff, Mithal, and Neis (1995) and Chen, Cheng, and Wu (2006), we assume that the risk-free term structure is independent of the hazard and liquidity factors and that the hazard rate \( h \), and the liquidity rate \( \ell \) each follows a square-root process as follows:

\begin{equation}
\begin{aligned}
    dh &= (\alpha_i \mu_i - (\alpha_i + \lambda_i)h)dt + \sigma_i \sqrt{\ell}dW_i \\
    d\ell &= (\alpha_2 \mu_2 - (\alpha_2 + \lambda_2)\ell)dt + \sigma_2 \sqrt{\ell}dW_2
\end{aligned}
\end{equation}

where \( \alpha_i \) (mean reversion speed), \( \mu_i \) (mean reversion level), \( \sigma_i \) (volatility), and \( \lambda_i \) (market price of risk) for \( i = 1, 2 \) are constants and \( dW_i dW_2 = 0 \) in the risk-neutral world. Cox, Ingersoll, and Ross (CIR) (1985) derive a closed-form solution for the following expected values:

\textsuperscript{26} This is because the affine model has closed-form solutions.
\[
\begin{align*}
Q_t &= E\left[ \exp\left(-\int_0^t h_s \, ds \right) \right] \\
L_t &= E\left[ \exp\left(-\int_0^t \ell_s \, ds \right) \right]
\end{align*}
\]

as:

\[
\begin{align*}
Q_t &= A_t(t)e^{-\lambda_1 B_1(t)} \\
L_t &= A_t(t)e^{-\lambda_2 B_2(t)}
\end{align*}
\]

where

\[
A_t(t) = \left[ \frac{2\xi e^{(\alpha + \xi)t/2}}{(\alpha + \xi)(e^{\xi t} - 1) + 2\xi} \right]^{\beta_{t,\mu}}
\]

\[
B_i(t) = \frac{2(e^{\xi t} - 1)}{(\alpha_i + \xi)(e^{\xi t} - 1) + 2\xi}
\]

\[
\xi_i = \sqrt{(\alpha_i + \lambda_i)^2 + 2\sigma_i^2}
\]

for \( i = 1,2 \).

By assuming independence between the risk-free term structure and the hazard and liquidity factors, we can separate the risk-free discount rate from the rest of the modeling. This conveniently permits us to use the market-given term structure of risk-free rates to perform risk-free discounting.

We use the method of maximum likelihood derived in Chen and Scott (1993, p. 16) to estimate the parameters of the model. In particular, we use Chen and Scott’s one-factor model for both the hazard rate and the liquidity factor. Since the factors are independent of one another, we can estimate each one separately. In particular, we use Chen and Scott’s equations where four pure discount bonds are used. In the context of the hazard rate factor, we have:
where the four such survival probabilities are 1-year, 2-year, 3-year, and 5-year.

The transition density function of the hazard rate is a non-central chi-squared distribution:

\[
\phi(h_{u} \mid h_{u-\Delta u}) = c_{i} e^{-\alpha_{u} h_{u} \mu u} \left( \frac{h_{u}}{e^{-\alpha_{u} \Delta u} h_{u-\Delta u}} \right) \sqrt{\pi \alpha_{u}} \ I_{q_{i}} \left( 2c_{i} \sqrt{e^{-\alpha_{u} \Delta u} h_{u-\Delta u}} \right)
\]

where

\[
c_{i} = \frac{2\alpha_{i}}{\sigma_{i}^{2} (1 - e^{-\alpha_{i} \Delta u})}
\]

\[
q_{i} = \frac{2\alpha_{i} \mu_{i}}{\sigma_{i}^{2}} - 1
\]

\( I_{q_{i}} \) is the modified Bessel function of the first kind of order \( q_{i} \) and the error terms \( \varepsilon_{i} \) are assumed to be independent Gaussian random variables with mean 0 and variance-covariance matrix \( \Omega \). The resulting log-likelihood function is:

\[
\ln L(h_{1}, \ldots, h_{T}) = -T \ln |B| - \frac{3T}{2} \ln [2\pi] - \frac{T}{2} \ln |\Omega| - \frac{1}{2} \sum_{t=2}^{T} \varepsilon_{i}^{T} \Omega^{-1} \varepsilon_{i}
\]

where, with a slight abuse of notation, \( t \cdots T \) are time points where data are collected, \( B \) is a matrix whose elements are functions \( B_{i}(t_{j}) \) for \( j = 1 \cdots 4 \), and \( \varepsilon_{i} \) represents a vector of time series of \( \varepsilon_{i} \).

The same setup is applied to the liquidity factor with proper substitutions of the functions and variables. While our intention was to perform the estimation on every firm in the dataset, this could not be accomplished because there were many firms that did not have enough data points for estimation of the model. After excluding these firms, our
final sample for the estimation contains only 274 companies, which is about half of the total number of companies in the filtered dataset.

We estimate the hazard rate factor, $h$, with mid CDS quotes, and the liquidity factor, $\ell$, with ask CDS quotes. Then, we compute the survival probability value, $Q_t$, and the liquidity discount value, $L_t$, respectively. Finally, the risk-free discount factor, $P_t$, is computed from the 5-year CMT rate.

We estimate these parameters for each firm in our sample. Because of the large number of estimates, we choose to report summarized results in an aggregate manner to conserve space. Note that our main interest is not in those individual estimates but in the aggregate behavior of liquidity in the CDS market and consistent pricing between a CDS and its reference corporate bond.

While all the estimation results for individual firms are available upon request, we choose to simply summarize our results. Figure 1.12 and Figure 1.13 show the plot of the average value for all of the estimated parameters for both the hazard rate and the liquidity factor, broken down by rating, sector, and market size. The market size is divided into 10 deciles represented by the numerals 1 through 10 where “1” represents the lowest market capitalization and “10” represents the highest market capitalization. There are four estimated parameters: $\alpha$ (risk-neutral mean reversion rate), $\mu$ (risk-neutral mean reversion level), $\sigma$ (volatility), and the $\lambda$ (market price of risk). The liquidity factor is estimated on the right-hand side of each figure and the hazard rate factor is estimated on the left hand side. The breakdown by ratings and market capitalization is in Figure 1.12 and Figure 1.13, respectively. In each of the graphlets of Figure 1.12 and Figure 1.13, diamonds represent financial firms and squares represent industrial firms.
In Figure 1.12, we observe some unambiguous results. The mean-reversion level parameter for the hazard rate $\mu_i$ is an increasing function of rating for both the financial and industrial sectors. This is naturally expected as the parameter reflects the long-term mean level of the hazard rate which is a direct function of the credit quality. Interestingly, this is not the case for the liquidity factor. The mean-reversion parameter for the liquidity factor ($\mu_L$) presents a flat pattern for the financial sector and a “U” shape for the industrial sector. We note that at the bottom of the U shape are A and BBB rated entities which are also those that have the most data points. As the parameter represents the long-term mean of the liquidity factor, it is consistent with our previous observation that liquidity is negatively related to market activity (which is reflected in the number of points in the dataset.)

Another result worth pointing out is the result for the volatility parameter. In Figure 1.12, we find that the estimates of the volatility parameter $\sigma_i$ present a flat pattern across ratings for both the financial and industrial sectors. Note that the true volatility in the CIR square-root model is the volatility parameter multiplied by the level of the hazard rate. Hence, the flat volatility parameter values translate to an increasing pattern across ratings as the hazard rates of lower ratings are higher, which is an intuitive finding. With respect to liquidity, we find similar results, although the dispersion of the volatility parameter estimates seems to be larger. The other two parameters – speed of mean reversion $\alpha$ and the market price of risk $\lambda$ – do not seem to present any particular pattern for either sector (in both hazard rate and liquidity factors).

In Figure 1.13, we present parameter values across different levels of market capitalization. The 10 deciles represent market capitalization from the smallest (1) to the
largest (10). Similar to the observation in Figure 1.12, the mean-reversion level
parameter for the hazard rate $\mu_1$ has a negative relationship with market capitalization.
This is obviously due to the fact that larger firms tend to have better credit ratings.
Interestingly, contrary to the observation in Figure 1.12, the parameter for the liquidity
factor $\mu_2$ suggests an inverse relationship with market capitalization. One possible
reason for this finding is that larger firms are more closely followed and more heavily
traded by investors.

In Figure 1.13, we find that the estimates of the volatility parameter $\sigma_2$ for the
hazard rate present a flat pattern across various levels of market capitalization for the
industrial sector and a decreasing pattern for the financial sector. While this may appear
strange at the first glance, there is a plausible explanation: since the volatility of the CIR
model is the volatility parameter multiplied by the square-root of the hazard rate value,
the true volatility actually presents a flat pattern for the financial sector and an increasing
pattern for the industrial sector. Hence, this finding is intuitive.

Finally, the remaining two parameters for the liquidity factor – speed of mean
reversion $\alpha$ and the market price of risk $\lambda$ – seem to present no particular pattern for
either sector (in both hazard rate and liquidity factors) when they are plotted against
market capitalization.

Ericsson, Jacobs, and Oviedo-Helfenberger (2004) find that market size explains a
significant portion of the liquidity premium. Later in this paper we investigate how the
liquidity risk premium behaves in relation to other variables. Those findings are not
consistent with theirs.
The majority of the liquidity factor estimates for the industrial sector are significant (70.8% of the $\mu_2$ estimates and 65.7% of the $\alpha_2$ estimates at the 5% level, and 76.5% and 73.0% respectively at the 10% level). Yet, on the contrary, the liquidity factor estimates for the financial sector are generally insignificant (only 7.1% of the $\mu_1$ estimates are significant at the 5% level). This suggests that the financial sector is generally more liquid than the industrial sector.

6. THE EFFECT OF CDS LIQUIDITY ON CORPORATE BOND SPREADS

The swap nature of the CDS contract allows a near perfect hedge of corporate default. As a result, in the past few years, researchers have used data on single name CDS where the reference entity is a corporation to study the liquidity component of corporate bond spreads. However, what has been ignored is that a small liquidity discount in CDS can translate into a large liquidity discount in the bond value.

To see this, we observe from equation (1) that the value of default protection (protection leg value), \[ V = (1 - w)\int_{0}^{T} P_t(-dQ_t), \] is equal to the value of the total premiums paid (premium leg value), \[ V = s_t \sum_{j=1}^{n} P_j Q_j. \] The liquidity discount observed in the protection value can be described as a percentage of the perfectly liquid value: \[ V^* \equiv \delta V \] where $\delta < 1$. As a result, we have: \[ s_t^* = \delta s_t. \] It is then clear that a small liquidity discount in the CDS premium, $(1 - \delta)s_t$, is translated into a large liquidity discount in protection value, $(1 - \delta)V$, which in turn results in a large liquidity discount in bond value.

---

27 It is a perfect hedge for corporate floaters.
To examine empirically the effect of CDS liquidity on actual corporate bond credit spreads, we use our TRACE bond data for the period July 1, 2002 to April 8, 2003, when the CDS data end. In this dataset, there are many bonds issued by the same company, which is different from the CDS dataset where CDS contracts are one per company. Hence, to make bonds comparable to CDSs, we limit ourselves to one bond per company. After matching with the CDS dataset, we are left with 273 names.

6.1. Preliminary Results

Longstaff, Mithal, and Neis (2005) reported sample statistics for the ratio of CDS premiums to bond credit spreads. They found the ratio to range from 49% to 68% for their 68 investment-grade names.\(^\text{28}\) For the firms in our data, we find comparable results. In Table 1.3, the percentages for the bid quotes range from 11% to 34% and for the ask quotes from 16% to 58%. The table also shows that lower rated bonds have a larger percentage of their spreads explained by credit risk and higher rated bonds have a smaller percentage.

6.2. Model Fit

One of the main objectives of this study is to investigate how the bid-ask spread in CDS quotes can affect the estimation of the liquidity spread in corporate bond yields. We estimate the parameters using CDS bid quotes and then price bonds accordingly. All the corporate bonds are assumed to have a 40% recovery rate. Equation (4) is used to estimate theoretical bond prices. We estimate the parameter values of the CIR model to

\(^{28}\) 65 names are investment grade and 3 are BB rated. See their Table II on page 2231.
compute the model-implied $Q_i$ in equation (4) and then compute the price of the corporate bond. Finally, we compute the liquidity spread defined in equations (6) and (7).

To see the effect of the bid-ask spread, we estimate again using the ask price. Then we repeat the calculation of the liquidity spread defined in equations (6) and (7). Hence we obtain two sets of parameters — one discussed in the previous section and the other discussed here.

These two sets of liquidity spreads allow us to compare bond mispricing attributable to the bid-ask spreads in the CDS quotes. Take Exxon-Mobil Corp. (ticker symbol XOM) as an example. There are two bonds in the database (CUSIPs: 607059AT9 and 302289AQ) and 76 observations over the period. The yields of these two issues are similar. The 607059AT9 issue matures 8/15/2021 and has a 8.62% coupon rate; the 302289AQ6 issue matures 7/1/2005 and has a 6% coupon rate. The former issue yields roughly 5-6% in the sample period and the latter yields roughly 2%. It is clear that for our study the longer maturity issue is the better choice. We plot the yields of the two issues in Figure 1.14.

The same principle is applied to all bonds. We select only one issue from each firm. We select those issues that have a maturity closest to 5 years in order to better match the CDS contracts in our dataset. We compute for each trade day the liquidity spread using the estimates from the hazard factor process (that uses the mid CDS quotes) and the estimates from the combination of hazard and liquidity factors (that uses the ask CDS quotes). The model-implied liquidity spreads from only the hazard factor will be larger than the liquidity spreads from further adjusting for the liquidity factor. We report
both liquidity spreads in Table 1.4. The left column of each sector reports the liquidity spreads under only the hazard factor. A priori we would expect this spread to reflect an unbiased estimation of the liquidity premium embedded in those bond prices. The right column of each sector reports the liquidity spreads under both the hazard and liquidity factors. Since the computed bond prices are already adjusted for illiquidity, we would expect these spreads to be near zero.

As we can see, the liquidity spreads implied by the model with only the hazard factor are on average 575 basis points with 421 basis points for the financial sector and 669 basis points for the industrial sector. In terms of ratings, except for the AAA group, we see the liquidity spreads gradually come down – from 866 basis points in AA to 104 basis points for BB.

If the model is correct, we would expect the adjustment to be perfect and the liquidity spreads to disappear. In fact what we find is that the model’s liquidity adjustment almost always overshoots. This could be caused by the bias resulting from our use of the maximum possible liquidity premium (the difference between ask and mid premiums) to estimate the liquidity factor. In all but one case, the liquidity spreads are negative after adjustment. The overall liquidity spread is –21 basis points, with the spread for financial firms being –7 basis points and for industrial firms being –29 basis points.

While the absolute magnitude of the liquidity correction is not completely satisfactory, we feel that the relative performance of using only one factor for liquidity is quite good. Overall, while the one-factor model overcorrects for the liquidity premium (the liquidity premium is 575 basis points but the model computes 596 basis points, an
overcorrection of 21 basis points), it explains 96% of the liquidity premium. There is similar performance for the financial and industrial sectors.

Finally, we investigate the liquidity risk premium from various perspectives. Under the CIR model, the instantaneous risk premium is $\lambda x$ where $\lambda$ is the market price of risk and $x$ is the factor value. We estimate the market price of risk for both the hazard rate factor and the liquidity factor ($\lambda_1, \lambda_2$) and compute the time-varying factor values $(h_t, \ell_t)$ for all $t$. As a result, we can compute the time-varying risk premiums for both the hazard rate and liquidity factors. We then compute the average risk premium for each firm.

We first find that the liquidity premiums are substantially larger than the credit risk premiums. On average, the liquidity premiums are 14 times greater than the credit risk premiums. Furthermore, the results of a linear regression of the liquidity risk premium on rating, number of quotes, sector (dummy), and credit risk premiums, suggests that the liquidity risk premium is only significant with respect to the number of quotes; it is not significant with respect to either rating or credit risk premium. This result holds for both the financial and industrial sectors (i.e., the sector dummy is insignificant). The regression results are presented in Table 1.5.

The number of quotes has a negative impact on the liquidity risk premium. That is, the higher is the number of quotes, the less is the liquidity risk premium. The computed $t$ value of this variable is 7.98. This is intuitive and consistent with the conventional wisdom. The regression result also suggests that the liquidity risk premium is not related to credit quality (the computed $t$ value for rating is only 0.15). It is interesting to note that although the liquidity factor is positively related to the hazard rate
as shown earlier, the liquidity risk premium is uncorrelated with the credit risk premium (the computed \( t \) value is 0.41). Finally, these results seem to be applicable to both the financial and industrial sectors, since the dummy sector variable is insignificant (a computed \( t \) value of 1.02).

7. CONCLUSIONS

In this paper, we study liquidity and its impact on the price of single name CDS where the reference entity is a corporation. The conclusion drawn from preliminary observations is that the bid-ask spreads are very wide, especially for the high-yield corporate names in our study. While the liquidity in the CDS market has improved over time, by the end of our study period (the first quarter of 2003), the bid-ask spread was still quite wide (10\% of the CDS premium), when compared to typical bid-ask spreads in the equity market. The improvement of liquidity is even more pronounced when viewed in event time.

We employed a two-factor Cox-Ingersoll-Ross affine model for the liquidity and hazard rates to estimate their dynamics. We find that the parameters of the hazard rate factor are more sensitive to ratings (proxies for credit quality) and those for the liquidity factor are more sensitive to market capitalization and the number of quotes, both of which are usually good proxies for liquidity.

Several studies have used CDS premiums as a pure measure of the price of credit risk. To investigate the effect of using CDS premiums in this way, we use simulations to show that small errors in the CDS credit spread can lead to substantially larger errors in the bond credit spread for the reference entity. Empirically, we use a reduced-form model to estimate hazard rates from CDS premiums, with and without taking CDS
liquidity into account. When we use these hazard rates to calculate bond spreads, we find that incorporating the CDS liquidity factor results in much better estimates of the liquidity spreads for the bonds in our sample. Thus, while CDS premiums can be used effectively in the analysis of corporate bond spreads, we must be careful to take into account the existence of a liquidity effect in the CDS market.

Contrary to the results reported in the literature that bond credit spreads are substantially wider than CDS premiums, our results show that, since a small CDS liquidity premium can translate into a large liquidity discount in a bond’s price, we can successfully reconcile CDS premiums and bond credit spreads by incorporating liquidity into the model.
REFERENCES


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Huang, Jing-zhi, and Ming Huang, 2003, How much of the corporate-Treasury yield spread is due to credit risk? Working paper, Pennsylvania State University.


Tang, Dragon Yongjun and Hong Yan, 2007, Liquidity and Credit Default Swap Spreads, Working paper, Kennesaw State University and University of South Carolina.

Table 1.1: Correlation between Normalized Bid-Ask Spread and the Number of Trades

We divide the data set into subsets according to credit rating and industrial group. Within each subset, we calculate two daily time series: the average normalized bid-ask spread and the total number of trades. We then calculate the correlation between these two series for each subset. The numbers in the second column for each subset are the numbers of observations.

<table>
<thead>
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<th></th>
<th>FIN</th>
<th>INDU</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>-14%</td>
<td>1753</td>
<td>178</td>
</tr>
<tr>
<td>AA</td>
<td>-11%</td>
<td>2464</td>
<td>1390</td>
</tr>
<tr>
<td>A</td>
<td>-15%</td>
<td>16122</td>
<td>13574</td>
</tr>
<tr>
<td>BBB</td>
<td>-20%</td>
<td>3096</td>
<td>12918</td>
</tr>
<tr>
<td>BB</td>
<td>-19%</td>
<td>1254</td>
<td>702</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>366</td>
<td>366</td>
</tr>
<tr>
<td>C and below</td>
<td>0</td>
<td>-100%</td>
<td>4</td>
</tr>
<tr>
<td>NA</td>
<td>2</td>
<td>347</td>
<td>349</td>
</tr>
<tr>
<td>Total</td>
<td>-15%</td>
<td>24691</td>
<td>29479</td>
</tr>
</tbody>
</table>
Table 1.2: Trend Slope of Bid-Ask Spread over Time

We divide the data set into subsets according to credit rating and industrial group. Within each subset, we calculate the daily time series of the average normalized bid-ask spread. We then perform an OLS regression of this series against time. The numbers in the first column for each sector are the slopes of the regression lines in basis points for annum. The numbers in the second column for each sector are the numbers of observations.

<table>
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<th>Total</th>
</tr>
</thead>
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<td>305</td>
</tr>
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<td>AA</td>
<td>-580</td>
<td>2464</td>
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</tr>
<tr>
<td>A</td>
<td>-226</td>
<td>16122</td>
<td>-359</td>
</tr>
<tr>
<td>BBB</td>
<td>-434</td>
<td>3096</td>
<td>-409</td>
</tr>
<tr>
<td>BB</td>
<td>-700</td>
<td>1254</td>
<td>-690</td>
</tr>
<tr>
<td>B</td>
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<td>-1999</td>
<td>366</td>
</tr>
<tr>
<td>C and below</td>
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<td>0</td>
<td>4</td>
</tr>
<tr>
<td>NA</td>
<td>2</td>
<td>139</td>
<td>347</td>
</tr>
<tr>
<td>Total</td>
<td>-301</td>
<td>24691</td>
<td>-386</td>
</tr>
</tbody>
</table>
Table 1.3: CDS Spread as a Percentage of Bond Yield

Ratios of CDS bid premiums and CDS ask premiums to bond yield spreads, where the spreads have been averaged over days and over rating and industry group subsets of our filtered data set. For each subset, the upper left number is the bid premium ratio, the upper right number is the ask premium ratio, and the lower number is the number of observations. The total number of observations is 9316 company days.

<table>
<thead>
<tr>
<th></th>
<th>FIN</th>
<th>INDU</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>20.85%</td>
<td>24.31%</td>
<td>16.84%</td>
</tr>
<tr>
<td></td>
<td>164</td>
<td>240</td>
<td>1610</td>
</tr>
<tr>
<td>AA</td>
<td>16.66%</td>
<td>19.84%</td>
<td>15.18%</td>
</tr>
<tr>
<td></td>
<td>195</td>
<td>386</td>
<td>581</td>
</tr>
<tr>
<td>A</td>
<td>27.60%</td>
<td>36.72%</td>
<td>27.95%</td>
</tr>
<tr>
<td></td>
<td>2182</td>
<td>3435</td>
<td>5617</td>
</tr>
<tr>
<td>BBB</td>
<td>35.60%</td>
<td>47.98%</td>
<td>56.69%</td>
</tr>
<tr>
<td></td>
<td>191</td>
<td>2022</td>
<td>2213</td>
</tr>
<tr>
<td>BB</td>
<td>83.20%</td>
<td>98.68%</td>
<td>70.21%</td>
</tr>
<tr>
<td></td>
<td>181</td>
<td>144</td>
<td>325</td>
</tr>
<tr>
<td>Total</td>
<td>30.46%</td>
<td>39.48%</td>
<td>34.70%</td>
</tr>
<tr>
<td></td>
<td>2913</td>
<td>6261</td>
<td>9316</td>
</tr>
</tbody>
</table>
Table 1.4: Percentage difference between Mid-implied and Ask-implied Liquidity Spreads

We compute, for each day, the bond liquidity spread using both mid estimates and ask estimates. The liquidity spread, either mid or ask, is calculated as the market yield of the bond minus the model implied credit spread (for which we use the CIR model with hazard rate estimates). We obtain two sets of liquidity spreads, one from CDS mid quote premiums and one from CDS ask premiums. Then we take the percentage difference of the mid spread from the ask spread. The results are averaged over days in each rating and industry group subset. The numbers in the second line of each rating category are numbers of observations. The left column of each sector is the liquidity spread estimated with only the hazard factor and the right column is estimated with both the hazard and liquidity factors. The total number of observation is 9316 company days.

<table>
<thead>
<tr>
<th></th>
<th>FIN</th>
<th>INDU</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>2.67%</td>
<td>-0.24%</td>
<td>0.77%</td>
</tr>
<tr>
<td></td>
<td>164</td>
<td>240</td>
<td>404</td>
</tr>
<tr>
<td>AA</td>
<td>1.18%</td>
<td>-0.20%</td>
<td>13.49%</td>
</tr>
<tr>
<td></td>
<td>195</td>
<td>386</td>
<td>581</td>
</tr>
<tr>
<td>A</td>
<td>5.09%</td>
<td>-0.06%</td>
<td>8.31%</td>
</tr>
<tr>
<td></td>
<td>2182</td>
<td>3435</td>
<td>5617</td>
</tr>
<tr>
<td>BBB</td>
<td>2.82%</td>
<td>-0.24%</td>
<td>3.87%</td>
</tr>
<tr>
<td></td>
<td>191</td>
<td>2022</td>
<td>2213</td>
</tr>
<tr>
<td>BB</td>
<td>0.32%</td>
<td>-0.25%</td>
<td>2.67%</td>
</tr>
<tr>
<td></td>
<td>181</td>
<td>144</td>
<td>325</td>
</tr>
<tr>
<td>Total</td>
<td>4.21%</td>
<td>-0.07%</td>
<td>6.69%</td>
</tr>
<tr>
<td></td>
<td>2913</td>
<td>6261</td>
<td>9316</td>
</tr>
</tbody>
</table>
Table 1.5: Regression Results for Liquidity Risk Premium

We run a linear regression of liquidity risk premium (which is computed as market price of risk times factor value) on number of quotes, rating, sector (dummy), and credit risk premium. The number of points in the regression is 274. The adjusted R-square of the regression is 22.39%.

Ratings are converted to a numerical scale with a difference of one for each rating notch.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coef</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
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<td>2.00</td>
</tr>
<tr>
<td>number of quotes</td>
<td>-56.49</td>
<td>-7.98</td>
</tr>
<tr>
<td>rating</td>
<td>-65.33</td>
<td>-0.15</td>
</tr>
<tr>
<td>sector (0=fin; 1=indu)</td>
<td>-2899.71</td>
<td>-1.02</td>
</tr>
<tr>
<td>credit risk premium</td>
<td>0.07</td>
<td>0.41</td>
</tr>
</tbody>
</table>
Distribution of normalized bid-ask spreads for the entire data set. The spreads are computed for each name as the average ask minus the average bid divided by the average bid-ask midpoint.
This plot shows the time series of CDS bid and ask quotes and trade premiums for Procter and Gamble in the filtered data set. There are 66 bids, 79 asks, and 11 trades, one of which falls outside the bid-ask band when simple linear interpolation is used. The average normalized bid-ask spread is 57.31%. Procter and Gamble has a credit rating of AA-. 
This plot shows the time series of CDS bid and ask quotes and trade premiums for Disney in the filtered data set. There are 344 bids, 325 asks, and 95 trades, none of which fall outside the bid-ask band when simple linear interpolation is used. The average normalized bid-ask spread is 15.02%. Disney has a credit rating of A-.
For each name in the data set, we calculate the average normalized bid-ask spread and the total number of trades. For each number of trades on a day, the plot shows the mean normalized bid-ask spread and one standard deviation on each side of it.
For each date in the data set, we calculate the average normalized bid-ask spread. The line in the graph is the result of an OLS regression of these spreads on time, with calculated regression coefficients shown in the equation of the line given in the figure.
For each date in the dataset, calculate the average CDS premium and the total number of premiums.

The line on the graph is the result of an OLS regression of these premium levels on the number of premiums, with calculated regression coefficients shown in the equation of the line given in the figure.

Plot shows the time series of the total number of quotes and trades for each date in the data set.
We define event time by calling day zero the first day on which there is a CDS quote for each name. For each event date in the data set, we calculate the number of CDS quotes for all names and plot them against the event dates.
We define event time by calling day zero the first day on which there is a CDS quote for each name. For each event date in the data set, we calculate the average normalized bid-ask spread. The line in the graph is the result of an OLS regression of these spreads on event time, with calculated regression coefficients shown in the equation of the line given in the figure.
Figure 1.10: Ratio of Bond Liquidity Spread to CDS Liquidity Spread

Given values for the hazard rate and the liquidity rate, we use our model in equations (4) – (7) to calculate the credit and liquidity spreads for a bond and a corresponding CDS. The graph is created from a grid of hazard and liquidity rates with a spacing of 0.01.
Figure 1.11: Percentage Error in Bond Yields Using CDS Spread as Pure Credit Risk Measure.

Given values for the hazard rate and the liquidity rate, we use our model in equations (4) – (7) to calculate the credit and liquidity spreads for a bond and a corresponding CDS. We then price the bond using the entire CDS spread to determine the hazard rate, and using the CDS credit spread that takes into account the liquidity spread to determine the hazard rate. We then calculate the two corresponding bond yields and the percentage difference between them. The graph is created from a grid of hazard and liquidity rates with a spacing of 0.01.
We estimate the four parameters of the square-root processes [equation (8)] for the liquidity and hazard rates for each firm in the sample, using the Chen and Scott maximum likelihood method. The results are then averaged over rating subsets of the financial and corporate industrial groups. The four estimated parameters are $\alpha$ (risk neutral mean reversion rate), $\mu$ (risk neutral mean reversion level), $\sigma$ (volatility), and $\lambda$ (market price of risk). In each of the graphlets, diamonds represent financial firms and squares represent corporate firms.
We estimate the four parameters of the square-root processes for the liquidity and hazard rates for each firm in the sample using the Chen and Scott maximum likelihood method. The results are then averaged over size-sorted subsets of the financial and corporate industrial groups. The size is represented by numerals 1 through 10 where “1” represents the lowest market capitalization decile and “10” represents the highest market capitalization. The four estimated parameters are $\alpha$ (risk neutral mean reversion rate), $\mu$ (risk neutral mean reversion level), $\sigma$ (volatility), and $\lambda$ (market
price of risk). In each of the graphlets, diamonds represent financial firms and squares represent corporate firms.

![Exxon-Mobil](image)

**Figure 1.14: Two Bonds of Exxon-Mobil**

Yields for the two bonds of Exxon-Mobil (XOM) that are present in the TRACE database. There are a total of 76 observations for the two bonds.
APPENDIX

Restructuring

In the following table we see that in the U.S., there were no CDS with modified restructuring (MR) prior to 2001 and that as MR became the settlement standard, full restructuring (R) gradually disappeared from the market (from 2,256 observations in 2001 to 12 in 2003). On the contrary, full restructuring is popular in Europe and MR is not. Use of the MR convention has declined there and the R convention has grown.

Another observation from this table is that while the U.S. dollar is the dominant currency, once restricted to 5-year maturity and senior debt only, the European market is more active than the U.S. market. Under full restructuring, the data shows 80,454 observations in the European markets, while under modified restructuring there are 60,475 observations in the U.S. market. This is an interesting observation of the market in its own right, but it is outside the scope of this study.

<table>
<thead>
<tr>
<th>5-Yr Senior</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR AMER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>obs</td>
<td>3,856</td>
<td>38,841</td>
<td>17,778</td>
<td>60,475</td>
<td></td>
</tr>
<tr>
<td>bid</td>
<td>1,453</td>
<td>18,281</td>
<td>8,339</td>
<td>28,073</td>
<td></td>
</tr>
<tr>
<td>ask</td>
<td>1,762</td>
<td>16,928</td>
<td>8,205</td>
<td>26,895</td>
<td></td>
</tr>
<tr>
<td>trade</td>
<td>641</td>
<td>3,632</td>
<td>1,234</td>
<td>5,507</td>
<td></td>
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<tr>
<td>MR EUR</td>
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</tr>
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<td>114</td>
<td>12</td>
<td>2,382</td>
</tr>
<tr>
<td>bid</td>
<td>2,311</td>
<td>1,053</td>
<td>46</td>
<td>7</td>
<td>1,106</td>
</tr>
<tr>
<td>ask</td>
<td>2,168</td>
<td>1,050</td>
<td>33</td>
<td>2</td>
<td>1,085</td>
</tr>
</tbody>
</table>
Bid-Ask Spread Interpolation

In this section, we describe the interpolation method used in the study. Simple linear interpolation between two adjacent bids or two adjacent asks can have bid prices that are higher than the corresponding asks. This is illustrated in Figure a. We correct this problem by interpolating the spreads. For each time when the bid is greater than the ask, we move forward and backward in time until we find the first points in each direction where the bid is less than the ask. We then linearly interpolate the spread between those two points, as shown in Figure b. For each point in that time interval, we preserve the bid or ask price that was in the original data and use the interpolated spread to calculate the other one. If the original data item was a trade, we assume that it is the midpoint between bid and ask, and use half of the interpolated spread on each side of the trade for the bid and ask. Figure c shows the result of the process.

Figure c implies that, because of the need for data on both sides of a given point to carry out the interpolation, we need to narrow our time period so that there are no “end effects” in our interpolated data. The number of spreads per day in the interpolated dataset is small at the beginning of the period, and starts to decline again near the end. Accordingly, we will start our restricted time interval on the first day when there are at least 100 quotes (day 283) and we will end it when the number of spreads on a day starts
to decline from its maximum value of 290 (day 973). This still gives us about a two-year period of data to work with.

Figure a

Figure b
Name Matching

In order to combine the CDS data with the , we need to match the companies in the CDS dataset to the FISD. In the CDS data, companies are identified only by name and dealer-specific proprietary identifiers. There are no standard identifiers such as CUSIPS. Therefore, it is necessary to match names between the two data sources. We begin by searching for each of the 1,372 CDS names in the Issuer table of FISD. Failure to match usually results from differences in spelling and abbreviations (including the use of periods). For the names not found in FISD, we remove all words that commonly abbreviated, such as “bank”, “corporation”, “international”, “inc”, “ltd”, “ag”, etc. Repeating the search with these reduced names results in many more matches. However, in some cases, more than one match occurs, and these situations have to be resolved by individual inspection. Finally, we look at the remaining unmatched names.
one at a time to see if any more matches can be made. In the end, we are able to match
1,135 of the 1,372 CDS names in FISD.
CHAPTER 2. THE EFFECT OF APR VIOLATIONS ON THE SENIORITY AND TIMING OF DEBT ISSUANCE

1. INTRODUCTION

Firms issue securities in sequence. In other words, when a new debt issue hits the market, the firm usually has several issues already outstanding. The purpose of this paper is to model this sequential issuing process, taking into account the costs of conflict between classes of debt with differing priorities should bankruptcy occur. This is one of the first explorations of how the bankruptcy process can directly affect the types of securities a firm might choose to issue. We test some of our propositions using a fixed income database and using a sample of firms in bankruptcy.¹

Our theory shows how conflicts during bankruptcy may make it optimal for a firm to issue senior debt only or junior debt only. When debt with different priorities is issued, we determine the optimal sequence of events. One of the cornerstones of our analysis is the idea that when the absolute priority rule is violated, senior debt holders provide a subsidy to junior debt holders, making junior debt cheaper to issue than it would otherwise be.

In our model, a firm needs financing in order to take a positive-NPV investment. The firm does not have cash, nor it can rely on equity markets. The firm can, however, choose between junior and senior debt. Senior debt is a claim whose liquidation value in

¹ There has been some analysis of how debt classes with different priorities affect the costs and outcome of bankruptcy (see for example, Gilson John and Lang (1990)). There has also been some work on how different classes of debt might pay for bankruptcy costs and how this will affect the bankruptcy process (see Gilson et al. (2000) and Bris et al. (2004)) or Welch (1997)). Other papers have looked at conflicts between equity holders and bondholders in bankruptcy. However, the crux of our analysis is based upon the interaction and conflict of interest between different classes of debt.
case of default will be the residual value of the project. The issuance of senior debt does not preclude any further debt issuance. However, any future debt cannot be senior to the current senior portion.

Alternatively the firm can decide to start the financing sequence with junior debt. In our setting, in the absence of any additional financing, junior debt behaves like senior debt. However, if the firm were to issue new debt, this could be senior and then junior claimholders would have a call-option type of payoff, as they would be residual claimants on the liquidation value of the project.

In equilibrium, the pricing of debt securities takes into account the firm's ex-post incentives to issue new securities. Intuitively, if junior debt holders find that in equilibrium it will be optimal for the firm to issue senior debt later, they will require a higher yield ex-ante. Once the firm faces a higher yield, it will indeed find it optimal to issue senior debt. On the other hand, under certain parameter restrictions, if the firm issues senior debt and senior debt holders price it assuming no further issuance of securities, then it is ex-post optimal for the firm to issue additional junior debt. In that case, beliefs are not consistent, and therefore this cannot be an equilibrium. In the paper we parametrize the conflict between senior and junior creditors and describe the regions for which each type of equilibrium exists.

We test some of our propositions using the Fixed Income Securities Database from Mergent. Of the more than 10,000 issuers represented in this database, over 2000 have issued bonds only at the "senior subordinated" security level.² We compare these

² If there is no senior debt, one may ask, "Subordinated to what?" However, this question is answered by the American Bar Foundation (1971) "Commentaries on Model Indentures", which gives the following language for a subordination clause in a bond contract: "The Company agrees that the payment
firms to firms that issue only senior bonds and those that issue both kinds, but none at any
other seniority level. In general, firms issuing only senior bonds are much larger than
those issuing only junior bonds, while those issuing both kinds are intermediate in size.
For the last group we study the order in which bonds of different seniorities were issued.
We also study a sample of firms in bankruptcy and find that their corporate
characteristics and their debts are consistent with our model.

In the next section, we discuss previous work on the relation between seniority of
debt and the bankruptcy process. Section 3, contains a model of debt financing and
bankruptcy. Section 4 discusses the sequential issuance of debt with different seniorities
and extends the model to include the bankruptcy costs that result from the conflict
between different classes of creditors. Section 5 describes empirical tests of our model
using the bond database. Results are discussed in section 6. In section 7, we summarize
and conclude.

2. RELATED WORK

Our work is related to four strands of the literature. The first strand is the
literature on seniority of debt claims. The second strand is the empirical literature on
APR violations, and the third is the theoretical literature on the consequences of such
violations. The final, and closest strand of literature is the body of work on incentives of
different classes of creditors within the bankruptcy process itself.

of principal and interest on all of the Debentures is hereby expressly subordinated to the prior payment in
full of all Senior Debt. The term "Senior Debt" means indebtedness of the Company, whether outstanding
on the date of execution of this Indenture or thereafter created unless it is provided that such indebtedness
is not senior…" Thus, the bond allows for the future issuance of other bonds that are senior to it.
In a world without bankruptcy, naturally seniority is of no consequence. However, once frictions are introduced, one can consider various effects of seniority on debt and equity valuation. Diamond (1993), relates debt seniority to maturity. His main result is that short-term debt will be senior to long-term debt. Winton (1995) shows that when a firm needs to raise funds from several investors, it is optimal to use debt with different seniority levels and an absolute priority rule. Having a senior claim allows an investor to put less effort into costly verification of firm output. If all investors are paid under the same circumstances, there will be an inefficient duplication of effort in verification.3

A related strain of the literature explains why bank debt is usually senior, even though junior creditors should have greater incentives for monitoring. Welch (1997) shows that because of their strength and organization, banks are in a better position to contest bankruptcy plans that they don’t like. When they are senior creditors, this strength deters the junior creditors from contesting the plan. If they were junior, they would be more likely to contest proposals, thereby resulting in increased waste of the firm's resources in the form of payments to lawyers. Longhofer and Santos (2000) point out that bank seniority encourages the formation of close relationships between lenders and borrowers, especially when the borrowers are small businesses. All the above papers contain theoretical models. Many of the authors discuss the empirical implications of their models, but they do not actually test them.

Our model is simpler than previous models in several ways; however, it adds a very important feature to the analysis, namely, we allow for violations of the absolute

3 Other authors have also studied seniority from the point of view of optimal security design. See for example, Berkovitch and Kim (1990), Hart and Moore (1995), Park (1995), Rajan and Winton (1995), Repullo and Suarez (1998), Riddiough (1995).
priority rule (APR) in bankruptcy. The conflict that is introduced between debt holders of different priorities has an effect on the proceeds from financing at different seniority levels.

APR violations have been discussed in the literature for a long time. Warner (1977), discussed railroad bankruptcies and finds some evidence that the market correctly adjusts the prices of debt claims to compensate for the possibility of future violations. Eberhart and Sweeney (1992) and Pulvino and Pidot (1997) reach similar conclusions. Several empirical studies have looked at the frequency of violations of APR. Eberhart, Moore, and Roenfeldt (1990) find that violations occur in 75% of bankruptcies in their sample. They also find that stock prices before the settlement reflect the expected violations, and that these violations are inversely related to the unexpected component of the length of chapter 11 proceedings. Widespread APR violations are also reported by Franks and Torous (1989). More recently in a larger sample than those used in the previous studies, Carapeto (2005) concludes that 67% of the bankruptcy settlements violate absolute priority, between creditor classes as well as between debt and equity. In Bharath et al. (2007) the incidence of APR violations is reported to be lower after 1990 (this is related to an increase in DIP financing and employee retention plans (KERP)). However, APR violations are still there, and also, there is no information about APR violations between classes of debt holders.

The reported existence of APR violations has motivated a significant theoretical literature, which considers the impact of these violations on the behavior of management and investors. Some models show that APR violations are beneficial (Eberhart and Senbet (1993), Berkovitch, Israel, and Zender (1997,1998)) by, for example,
discouraging both excess risk taking and underinvestment by the management of a
distressed firm. Other work finds detrimental effects ex ante, before the onset of
find that APR violations are good for small firms but are not beneficial for larger firms.
Most models consider two classes of claimants: either debt holders and equity holders or
secured debt holders and unsecured debt holders. The former situation is modeled in
Bebchuk (2002). The latter is analyzed by Bebchuk and Fried (1996, 2001), who discuss
the difficulty of valuing the collateral of a secured debt contract, which is required for
any bankruptcy settlement, and propose a new market-based mechanism for doing so. In
this paper, we also consider two classes of claimants, but here they are both holders of
unsecured debt, with different levels of seniority.

The closest set of papers to our work analyzes the impact of debt classes with
different priorities on the costs and outcome of bankruptcy. For example, Gilson, John,
and Lang (1990) study the incentives for private restructuring of debt without formal
bankruptcy. Such restructurings are more likely to happen when banks hold more of the
debt, since bank debt usually has senior status. There has also been some work on how
different classes of debt might pay for bankruptcy costs and how this will affect the
bankruptcy process. Gilson, Hotchkiss, and Ruback (2000) study the relation between
the market value of a firm emerging from bankruptcy and the valuation implied by
management’s forecast of future cash flows contained in the reorganization plan. They
show that senior (junior) debt holders have an incentive to undervalue (overvalue) the
firm to obtain the maximum value under reorganization. Bris, Schwartz, and Welch
(2005) model the allocation of professional costs in the bankruptcy process. Courts
cannot distinguish between professional expenditures that increase value and those that result only in a redistribution of the assets of a bankrupt company. Therefore, subsidies for professional costs should be designed to encourage only value-enhancing activities.

Our paper uses elements from previous work as well as some new analysis to suggest how debt issuance is affected by priorities in bankruptcy. Our empirical analysis determines the factors that most influence the choice of seniority in bond issuance.

3. THE MODEL

We present a very simple binomial model of a project that may succeed or fail. Our focus will be on the allocation of claims in bankruptcy and the consequences of these outcomes for ex-ante seniority structure.

3.1. The Firm

We assume a firm endowed with an investment project at $t = 0$ that costs $I$. The investment is perfectly scalable and divisible, so the firm can decide to buy only a fraction $x$ of the project, in which case the payoff will be proportional to $x$. The project may succeed or fail. If it succeeds, with probability $1-p$, it yields revenues of $(1+h)I$. Otherwise, the project returns $qI$, the liquidation value of the firm, where $q < 1$. The parameter $q$ summarizes two effects: the loss from the operation of the project, and the administrative costs of bankruptcy. We specifically exclude from these bankruptcy costs any costs resulting from the conflict between claimants with different seniorities. The latter costs will be modeled separately. The bankruptcy costs included in $q$ depend on: (1) the effectiveness of the court, which will determine, for instance, the length of the
case; and (2) project characteristics such as the deployability of the assets. We assume that $h$ is such that the net present value of the project is positive: The NPV is given by

$$NPV = (1 - p)(1 + h)I + p(qI) - I = [(1 - p)(1 + h) + pq - 1]I$$  \hspace{1cm} (1)$$

For this expression to be positive,

**Assumption 1:** \( h > p \frac{1-q}{1-p} \)

We will assume that debt has some advantages, so as to make the discussion of bankruptcy meaningful. Therefore, the project will be financed by debt if possible, with a residual amount financed by equity. This is consistent with several versions of a pecking order theory, and can be justified by tax effects. However, admittedly, we are not looking for a complete security design framework (see Bris, Schwartz, and Welch (2005) for similar assumptions).

If the entrepreneur finances the project entirely with equity, then her expected gain from the project, i.e. the expected change in the value of the equity, $V_e$, will be equal to the NPV given by (1).

### 3.2. Debt

We use the following notation:

- $V_d =$ time 0 (market) value of the debt, i.e. the proceeds from debt financing
- $D =$ face value of debt, i.e. the amount that must be repaid at time 2
- $V_e^* =$ expected change in equity with debt financing

If debt is fairly priced, and enough debt is issued to finance the entire initial investment, $I$, then the expected change in the value of equity after debt claims are taken care of is still $V_e$. In the absence of any other friction, this will be the equity value if the project is
financed with one single class of debt. The reason is that, in case the firm defaults, a
single creditor will liquidate the firm and realize the entire liquidation value, \( qI \). The time
0 value of the firm’s debt will then be:

\[
V_d = (1 - p)D + pqI
\]

If the entire initial investment is financed by debt, then \( V_d = I \), and the face value of debt
issued must be \( D = I \frac{1 - pq}{1 - p} \). Then,

\[
V_e^* = (1 - p)I\left[ (1 + h) - \frac{1 - pq}{1 - p}\right] + p(0) = I\left[ (1 - p)(1 + h) + pq - 1 \right] = V_e = NPV
\]

This is our base case. Strictly speaking, if everybody is risk neutral, we do not
need to finance the entire investment by debt, and any division between debt and equity
will be feasible. In what follows, we consider equilibrium strategies, in other words,
strategies that will be sequentially rational.

### 3.3. Bankruptcy

We now consider the more interesting cases where the entrepreneur can issue
different classes of debt. Formally, the entrepreneur will finance a percentage \( \alpha \) of the
project with “senior” debt, and the remaining \( 1 - \alpha \) with “junior” debt. The difference
between senior and junior debt is in the priority treatment upon bankruptcy. Following

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\(^4\) We are assuming throughout that the risk-free interest rate is zero. Thus, if there is no possibility
of bankruptcy \( (p = 0) \), the debt is riskless and the face value of the debt (the amount to be repaid) is the
same as the amount borrowed \( (D = I) \). Note that we can write the term \( \frac{1 - pq}{1 - p} \) as \( 1 + r \), where \( r \) is the
overall interest rate. Equivalently, the default risk spread is \( r - r_f = r = \frac{p(1-q)}{1-p} \).
papers such as Welch (1997) or Bris et al. (2005), and as discussed earlier, we assume that courts uphold the Absolute Priority Rule (APR) with probability \( 1 - \theta, 0 < \theta < 1 \). The cost and benefit of professional effort are both zero. Let \( S \) and \( J \) be the face values of the senior and junior bonds. Welch (1997) and Bris et al. (2005) assume that if APR is violated, the equal (proportional) priority rule (EPR or PPR) will be used. In this case, if \( S \) and \( J \) are the face values of the senior and junior debts, and \( V = qI \) is the value available to be distributed, then the senior are junior creditors receive \( \frac{S}{S+J} V \) and \( \frac{J}{S+J} V \) respectively. If \( X(q) \) is the payoff to the junior creditors, then we have:

\[
X_{APR}(q) = \max(qI - S, 0) = \begin{cases} 
0 & q < \frac{S}{I} \\
qI - S & \frac{S}{I} < q < \frac{S+J}{I} 
\end{cases}
\]

\[
X_{EPR}(q) = \frac{J}{S+J} qI
\]

\[
X_\theta = \theta X_{EPR} + (1 - \theta) X_{APR} = \theta \frac{J}{S+J} qI + (1 - \theta) \max(qI - S, 0)
\]

These payoffs are shown in Figure 2.1. Note that the junior creditors are always better off under EPR, since \( X_{APR}(q) < X_{EPR}(q) \). Therefore, \( X_\theta > X_{APR}(q) \) as well.

We denote by \( G(q, \theta) \) the difference between the actual allocation, and the allocation to the junior creditors under APR. The interpretation of \( G(q, \theta) \) is two-fold. It represents the expected benefits to the junior creditors of inducing the court to violate APR. Additionally, \( G(q, \theta) \) represents the court’s expected degree of leniency with respect to junior creditors. If the first interpretation is accepted, then our implicit
assumption is that \( G(q, \theta) \) is already net of influence costs.\(^5\) In the second case, our model assumes that \( G(q, \theta) \) is court-specific, as some courts tend to violate APR more often than others.\(^6\) In both cases, \( G(q, \theta) \) is a transfer from senior to junior bondholders. Therefore, from (2) we have:

\[
G(q, \theta) = X_\theta(q) - X_{\text{APR}}(q) = \theta \left[ \frac{J}{S + J} q I - \max(q I - S, 0) \right] \equiv \theta G(q)
\] (3)

When the junior creditors are out of the money \((S > q I)\), then \( G(q, \theta) \) is increasing in \( q \). Intuitively, as \( q \) increases, liquidation becomes more efficient and the junior creditors are better off under EPR. However, when the junior creditors are in the money \((S < q I)\), then \( G(q, \theta) \) is decreasing in \( q \). The reason is that as liquidation is more efficient, a one-dollar increase in the liquidation proceeds translates into a one-dollar increase in the junior creditors' recovery under APR, but only a fraction of it under EPR, because they have already received a partial payment. Figure 2.1 shows that the junior creditors have the highest incentive to fight against APR when \( S = q I \).\(^7\) For the remainder of the paper, we refer to \( G(q) \) as \( G \) for simplicity.

Equation (4) below defines the face value of senior debt, \( S \), for each choice of \( \alpha \). With probability \( 1-p \), the firm is solvent and senior debt is fully paid. With probability \( p \), the firm defaults and the senior creditors receive the minimum of the liquidation proceeds

\(^5\) This terminology is taken from Welch (1997). In Section 5 we relax this assumption, by adding explicit bankruptcy costs to the model.

\(^6\) See Bris, Welch, and Zhu (2006) and Chang and Schoar (2006).

\(^7\) More generally, \( G \) takes its maximum value whenever the recovery value \( q I \) is between \( S \) and \( J \), regardless of which of the two is larger. The graph looks somewhat different when \( J \) is larger.
and the amount they are owed. However, with probability $\theta$ the court will allocate $G$ to the junior debt and thus the expected senior payoff will be reduced by that amount.

$$V_s = (1 - p)S + p[\min(qI, S) - \theta G] = \alpha I$$ (4)

We can solve (4) for $S$ in two cases:

$$S = \begin{cases} 
\alpha I + p\theta G & S < qI \\
\frac{\alpha I - pqI + p\theta G}{1 - p} & S > qI
\end{cases}$$ (5)

Similarly, the time-0 and face values of the junior debt, $V_J$ and $J$, are related as follows:

$$V_J = (1 - p)J + p[\max(qI - S, 0) + \theta G] = (1 - \alpha)I$$ (6)

As for the senior debt, we can solve (6) for $J$ in two cases:

$$J = \begin{cases} 
\frac{(1 - \alpha)I - pqI + pS - p\theta G}{1 - p} & S < qI \\
\frac{(1 - \alpha)I - p\theta G}{1 - p} & S > qI
\end{cases}$$ (7)

where the second equality in the first case is obtained by substituting $S$ from the first case in (5). Equations (5) and (7) define $S$ and $J$ as functions of the model parameters $p$, $q$, $\theta$, and $\alpha$.

An interesting conclusion can be summarized in Proposition 1 below:

**Proposition 1**: If the firm were to issue junior and senior debt simultaneously, then $V_e$ would be independent of $\alpha$.

**Proof**: See Appendix A for the details.
The conclusion is that the firm is indifferent with respect to the mix of junior and senior debt, when they are issued simultaneously. However, when the choice is sequential, the entrepreneur will strategically decide, after the first security has been priced by the market, whether issuing the second class of debt is optimal or not. Such behavior will be taken into account by the market when pricing securities. Below we explore the incentives firms face when issuing securities sequentially.

4. SEQUENTIAL ISSUANCE OF DEBT SECURITIES

The main focus of this paper, the optimal sequence of issuing debt securities, has not been addressed directly in the literature. To model this, we assume that the firm makes an initial choice and then it has an option to refinance the project given the initial issue decision.

4.1. Senior Debt First

Specifically, we assume that at time zero, the firm issues one class of debt (and possibly some equity) to finance the project. If the project is not fully financed with debt at time zero, then at time one, there is an option to replace the equity with another class of debt. Finally, at time two, the payoffs are realized.

Let us consider first the case where the entrepreneur initially issues an amount, \( aI \), of senior debt. While debt covenants may prevent the firm from issuing debt with equal or higher seniority status after \( t = 0 \), senior debt holders often cannot prevent the firm from issuing junior debt afterwards. Therefore, senior debt holders must anticipate the optimal strategy for the firm in that regard when they price the bonds they buy.
We will begin with a benchmark case, where only senior debt is issued. Suppose there is no equity, so that \( \alpha = 1 \). If senior debt holders anticipate no further issuance of debt, then they will calculate their promised payment \( S \) as:

\[
V_S = (1 - p)S + p \min(qI, S) = \alpha I = I
\]  

(8)

Because \( I = V_S < S \), we must have \( S > qI \) and

\[
S = \frac{1 - pq}{1 - p} I
\]

(9)

as in the no-bankruptcy case in section 3.2.

The firm could also issue \( (1 - \alpha)I \) of equity, with \( \alpha < 1 \). Then

\[
V_S = (1 - p)S + p \min(qI, S) = \alpha I
\]

(10)

Now it is possible that \( S < qI \), in which case the senior debt will always be paid off, so \( S = \alpha I \). If, \( S > qI \), then solving (10) for \( S \) gives

\[
S = \frac{\alpha - pq}{1 - p} I
\]

(11)

In either case, the change in the value of equity resulting from the project is

\[
V_e^S = (1 - p)\left[(1 + h)I - S\right] + p \max(qI - S, 0) - (1 - \alpha)I
\]

(12)

In the first case, \( S < qI \), substituting \( S = \alpha I \) into (12) gives

\[
V_e^S = (1 - p)I\left[1 + h - \alpha\right] + p(qI - \alpha I) - (1 - \alpha)I
\]

\[
= I\left[(1 - p)(1 + h) - (1 - p)\alpha + pq - p\alpha - 1 + \alpha\right]
\]

\[
= I\left[(1 - p)(1 + h) + pq - 1\right] = NPV
\]

In the second case, \( S > qI \), substituting (11) into (12), we get
\[ V_c^S = (1 - p)I \left[ 1 + h - \frac{\alpha - pq}{1 - p} \right] + p(0) - (1 - \alpha)I \]
\[ = I \left[ (1 - p)(1 + h) - (\alpha - pq) - (1 - \alpha) \right] \]
\[ = I \left[ (1 - p)(1 + h) + pq - 1 \right] = NPV \]

In either case, the equity value is increased by the NPV of the project. However, if the firm issues senior debt first, and the project has some equity, the entrepreneur will replace the equity with junior debt at time 1. This is shown below.

Proposition 2: If the firm issues senior debt first to finance part of the project (\( \alpha < 1 \)), then it will be optimal for it to issue additional junior debt.

Proof: There are two cases to be considered. First, suppose that \( S < qI \). Then, as above, \( S = \alpha I \) and \( V_c^S = NPV \) so the senior debt is riskless. Note that the term \( p \theta G \) in the first case of (5) does not appear because there is no junior debt at the time the senior debt is issued. Suppose that the other \( (1 - \alpha)I \) is then obtained by issuing junior debt. From (6), the proceeds from this additional financing satisfy

\[ V_j = (1 - \alpha)I = (1 - p)J + p(qI - \alpha I + \theta G) \]

and

\[ J = \frac{(1 - \alpha)I - p(q - \alpha I + \theta G)}{1 - p} \]

is the face value of the junior debt.\(^8\) If no violation of APR is possible, \( \theta = 0 \) and

\[ J = \frac{(1 - \alpha - pq + p \alpha)I}{1 - p} \]. For \( \theta \neq 0 \), the face value of the junior debt is reduced by \( \frac{p \theta G}{1 - p} \), so the equity value is increased by that amount (with probability \( 1 - p \)). Let \( V_c^{XY} \) denote

\(^8\) If \( G \) is the expression in brackets in equation (3), then for each case of the relative sizes of \( S \) and \( qI \), we have a quadratic equation that can be solved for \( J \) in terms of the other parameters.
the equity value when debt security $X$ is issued before debt security $Y$. Then:

$$V_e^{SJ} = (1 - p)[I(1 + h) - (S + J)] + p(0)$$

$$= (1 - p) \left[ I(1 + h) - \left( \frac{1 - \alpha - pq + p\alpha - p\theta G}{1 - p} \right) \right]$$

$$= I \left[ (1 - p)(1 + h) - \alpha + p\alpha - 1 + \alpha + pq - p\alpha \right] + p\theta G$$

$$= I \left[ (1 + h)(1 - p) + pq - 1 \right] + p\theta G > V_e^S$$

Now, consider the second case, in which $S > qI$ and $S$ is given by (11). Then,

$$V_J = (1 - \alpha)I = (1 - p)J + p(0) + p\theta G$$

and

$$J = \frac{(1 - \alpha)I - p\theta G}{1 - p}$$

Again, $J$ is reduced by $\frac{p\theta G}{1 - p}$, so $V_e^{SJ}$ is increased as in (14).

In either case, it is not optimal for the firm to issue only senior debt. ■

The intuition is simple: once senior debt has been issued and priced, junior debt can be issued more cheaply, since part of the value is taken away from senior debt holders as deviations from absolute priority. Therefore, in equilibrium, it also must be the case that when senior debt is issued, investors anticipate the issuance of junior debt later. In other words, lacking a pre-commitment device, once one issues senior debt, part of the price for junior debt has already been paid. This will be formally shown below:

**Corollary 1**: Issuing senior debt followed by junior debt is an equilibrium strategy.

**Proof**: The purchasers of the senior debt, which would have a face value of $S_0$ if no further debt could be issued, will anticipate that junior debt will be issued later and
that APR may be violated in bankruptcy, in which case the payoff would be only \( S_0 - \theta G \), where \( \theta \neq 0 \). Senior debt holders will then demand an increase in the face value to compensate for this loss of value. The calculations made by the senior and junior creditors will then be the same as in the case of simultaneous issuance discussed in section 3.3. The face values of the debts will be given by equations (5) and (7). The change in the face value of the senior debt will be:

\[
\Delta S = S - S_0 = \begin{cases} 
p\theta G & S < qI \\
\frac{p\theta G}{1-p} & S > qI 
\end{cases}
\]  

(16)

However, the face value of the junior debt will decrease by the same amount, so we will still have \( V^{SJ}_e = NPV \). In either case, if the firm does not issue junior debt, it pays an extra amount to the senior debt holders without the compensating saving from the junior financing. Therefore, issuing only senior debt is not optimal and in equilibrium the firm will issue both kinds of debt: senior followed by junior.

As noted, the advantage of issuing junior debt is that part of its value comes at the expense of existing senior debt. Therefore, in equilibrium, senior debt holders will price the subsequent issuance of junior debt, and the firm will be indifferent between issuing both junior and senior debt at \( t = 0 \), and issuing senior debt at \( t = 0 \) and junior at \( t = 1 \). However, issuing only senior debt at \( t = 0 \) is not an equilibrium, since it is priced lower than it should be. Issuing only senior debt can be optimal only in the case of costly bankruptcy, which we will discuss below.

We can formulate an interesting and somewhat counterintuitive implication of the model, which we later test:
**Corollary 2:** Firms that can credibly commit to issuing senior debt only, can issue such debt at a lower yield than firms that issue two classes of securities.

The intuition is as discussed previously. If the firm shows a credible commitment not to issue junior debt, then senior debt becomes cheaper. But if no commitment is possible, then senior creditors will factor the cost of junior debt into the price of their claim, thereby resulting in a higher yield.

### 4.2. Junior Debt First

Suppose now that the firm raises an amount \((1 - \alpha)I\) of junior debt at \(t = 0\).

Issuing junior debt in the absence of senior debt is similar to issuing unsecured debt when the firm has fixed assets that can be used as collateral for future secured debt issues. The equilibrium condition to price junior debt in this case is the same as equation (10) with \(S\) and \(\alpha\) replaced by \(J\) and \(1 - \alpha\), namely,

\[
V_J = (1 - p)J + p \min(qI, J) = (1 - \alpha)I
\]  

(17)

Similar to the senior case, if \(J < qI\), then the junior debt will always be paid off, so \(J = (1 - \alpha)I\). If, \(J > qI\), then

\[
J = \frac{(1 - \alpha) - pq}{1 - p} I
\]  

(18)

In either case, the change in equity resulting from the project is

\[
V_e^J = (1 - p)I[(1 + h) - J] + p \max(qI - J, 0) - \alpha I = NPV
\]  

(19)

using the same calculation as for the senior-only case.
We next determine whether, having issued junior debt initially, the firm will subsequently issue senior debt. Proposition 3 identifies the equilibrium in this type of sequence.

**Proposition 3:** If the firm issues junior debt first to finance part of the project \((1 - \alpha < 1)\), then it will be optimal for it to issue additional senior debt.

**Proof:** See Appendix.

The intuition for this proposition is as follows. Once the project and the initial junior financing are set, the parameters \(p, q, \alpha, \theta\), and \(I\) are fixed. There are limits to the amounts of APR violations—namely, they are limited by the recovery or liquidation value, \(qI\), by the amount the seniors are owed, \(S\), and by the amount the juniors are owed, \(J\). Because of these limits, \(S\) can never be large enough to make issuing only junior debt more profitable than issuing both junior and senior debt.

In conclusion, when we ignore the costs of conflict, it is always optimal to issue both senior and junior debt, either simultaneously or sequentially.

**4.3. Explicit Costs of Conflict**

The discussion so far has only focused on the incentives inherent in recoveries. We now explicitly introduce litigation and conflict costs. Following Welch (1997) we note that upon default, disagreements between junior and senior creditors over the liquidation value of the firm give rise to costs of litigation. Naturally, the fewer classes of debt are issued, the lower are such costs, but as long as there is any equity in the firm (which is always the case) there will be some costs of litigation. However, the costs of an additional class may be outweighed by the benefits described above. The following analysis will suggest how such costs affect the seniority decision at issuance.
We assume that the cost of conflict is proportional to the amount of junior debt issued, $(1 - \alpha)I$. This implies that these costs are decreasing in the amount of senior debt. This is also intuitive because senior debt holders are more powerful, so the dead-weight loss of litigation is lower.

**Assumption 2:** The cost of a conflict between junior and senior creditors is $C = c(1 - \alpha)I$, where $0 < c < 1$.

Intuitively, there is a cost of issuing junior debt in conjunction with senior debt, which equals a percentage, $c$, of the amount of junior debt issued. Under this assumption, our previous results, that after either level of debt is issued it is optimal to issue the other, are changed, as is shown in the next two propositions.

**Proposition 4:** For firms that have issued senior debt, financing with senior debt alone is preferred to financing the project with both junior and senior debt if costs of conflict are sufficiently high. Otherwise, both types of securities may be issued in equilibrium (similar to the case without costs).

**Proof:** See Appendix.

It follows from Proposition 4 that when “class warfare” is costly for the firm, the firm sometimes commits to issue only senior debt, and such a commitment is credible because if the firm were to issue junior debt afterwards, it would incur an additional cost $c(1 - \alpha)I$ in bankruptcy. Unlike the no-cost case in Section 4.1, where the firm realizes that senior debt is ex post overpriced if junior debt is issued afterwards, in the case of costly litigation there is no incentive to issue junior claims that will result in a dead-weight loss. However, the costs of conflict must be sufficiently large so as to overcome
the incentives discussed earlier. The case of firms that issue junior debt first is similar, as shown in the next proposition.

**Proposition 5:** For firms that have issued junior debt, financing with junior debt alone is preferred to financing the project with both junior and senior if conflict costs are sufficiently high. Otherwise, both securities may be issued in equilibrium.

**Proof:** See Appendix.

When we substitute reasonable values of the parameters $p$, $q$, $\alpha$, and $c$ into the inequalities in the proof of the proposition, we get lower bounds for $\theta$ that are very close to 1 in the first three cases. To gain intuition for the previous proposition, let us consider a numerical example using case 4. Suppose that, in order to finance an investment of $100, the firm first raises 70% in junior debt ($\alpha=0.3$). Assume that the project has a probability of failure, $p = 0.1$, a liquidation value of $q = 0.8$, and an expected bankruptcy cost factor of $c = .1$, so that the total costs would be $7$. If the probability of APR violation is $\theta = 0.7$, then from (25), we have $G = 8.79$. The model then yields face values for junior and senior debt of $J = 70$ and $S = 31.39$ respectively. In bankruptcy, the firm will pay out the full $73 available after costs. Using EPR, the juniors get $50.40 and the seniors get $22.60. (Under strict APR, the seniors would get $31.39 and the juniors would get $41.61, so $G = 8.79$.) However if the project succeeds, the juniors get their full $70, while the seniors get $31.39 and the extra $1.39 is a cost to equity. From (27), the ex ante expected change in equity is $0.05 more if senior debt is issued, so it is optimal to do so. The reason this issuing strategy is optimal is because the lower bound in case 4 for not issuing senior debt is 0.2069, while we have assumed $c = 0.1$. 
If, instead, we assume that $c = 0.3$, the face values for junior and senior debt are $J = \$70$ and $S = \$35.28$ respectively. In bankruptcy, only $\$59$ will be available after costs. Using EPR, the juniors get $\$39.23$ and the seniors get $\$19.77$. (Under strict APR, the seniors would get $\$35.28$ and the juniors would get $\$23.72$, in other words, $G = \$15.51$.)

However if the project succeeds, the juniors get their $\$70$, while the seniors receive $\$35.28$ and the extra $\$5.28$ is a cost to equity. In this case, the ex ante expected change in equity value is $\$4.85$ less if senior debt is issued, so it is not optimal to do so. Here, the lower bound in case 4 for not issuing senior debt is $0.1461 < c = 0.3$. In equilibrium, after the initial $\$70$ financing with junior debt, the firm will choose to finance the rest of the project with equity to avoid the extra expected cost that issuing senior debt entails.

There are two complementary ways to look at the conditions that must be satisfied for junior only to be an equilibrium issuing strategy. First, we require that the expected conflict gains for junior creditors ($\theta G$) be large enough. This requires that (a) the probability that the courts violate APR is high, and (b) that junior creditors succeed at diverting funds from the seniors.\(^9\) Second, the expected costs of conflict must be sufficiently large, either because the amount of junior financing ($(1-\alpha)I$) is large, the unit cost of conflict ($c$) is large, or both.

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\(^9\) Note that the reverse is true for senior only issuance: low probability of APR violations and small amounts diverted from seniors to juniors are required.
4.4. Empirical Predictions

In this section, we suggest some predictions of our model that will be tested empirically in the ensuing sections.

The model suggests, first and foremost, that some firms may choose to issue junior debt only (Proposition 5), senior debt only (Proposition 4), or a combination thereof (Propositions 1-3). As we will see, this unique prediction of our model is supported directly by the data, without much analysis. We will refer to this as Prediction A.

Based on Propositions 2 and 3, we can predict that senior (junior) debt issues should always be followed by junior (senior) debt issues. These propositions assume that the costs of conflict proportional to the amount of junior debt are small, but a fixed cost component, as is assumed in many models, will not change the conclusion. This is Prediction B.

A related prediction, based upon Proposition 2 and Corollaries 1 and 2, is that if you can commit to senior debt only, then you can issue senior debt at lower yields, everything else equal. This is Prediction C.

Propositions 4 and 5 also suggest that there are some circumstances under which firms would choose to issue senior debt only or junior debt only. Since the conditions are based upon the probability and size of APR violations, we should expect to find variations over time in the set of firms issuing junior debt only. Further, a tentative suggestion is that as costs of conflict increase, firms with junior debt tend to issue more junior debt. We call this Prediction D.

We test these predictions below.
5. **EMPIRICAL TESTS OF THE MODEL USING BOND DATA**

An empirical test of our model would require us to reconstruct the full capital structure of a sample of firms, including public debt (bonds), private loans, and equity. The available databases do not provide such information. Therefore, our empirical analysis is based on two complementary sets of results. In a first set of tests, we provide results based on bond issuance activity by firms. In a subsequent empirical analysis, we provide results based on the full capital structure of firms filing for bankruptcy.

5.1. **Data**

First, we use data from the Fixed Investment Securities Database (FISD) from Mergent, Inc.\(^{10}\) This database has complete at-issue information on 162593 bonds issued by 10177 companies. Issue dates range from 1894 (a 100-year bond) to June, 2004 and maturity dates are January 1, 1990 or later. 90% of the bonds have issue dates in 1986 or later. (For another 5% of the bonds, the issue date is not available.) FISD provides issue ratings from four agencies (Duff and Phelps, Fitch, Moody's, and Standard and Poor's).

Since our study involves company level analysis, we use S&P issuer ratings provided by Compustat rather than the issue ratings.

For each issue listed in FISD, a security (seniority) level is provided. Table 2.1 shows the number of firms that have issued at least one bond at each seniority level and the number of firms issuing bonds only at that level.\(^{11}\) The majority of the firms issue

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\(^{10}\) The FISD is provided as relational database tables, both as plain text files and as a Microsoft Access database. As a result, many tools are available for extracting desired data.

\(^{11}\) One might think that firms that issue only junior debt have bank loans or other private debt and so are not allowed to issue senior public debt. However, as pointed out by Billett, King, and Mauer (2007),
bonds at only one security level. This is consistent with our Predictions A and D\textsuperscript{12}.

Table 2.1 also suggests that very few firms issue bonds at the three lowest levels. Therefore, we will use senior issues and senior subordinated bonds to test our predictions on senior and junior bonds.

There are 7501 firms issuing bonds at only these two levels, of which 967 issue at both levels. Note that almost two thirds of the firms issuing senior subordinated bonds issue bonds only at that level. Most of these firms have between one and ten issues, with a maximum of 28. Clearly, issuance of only "junior" debt is not unusual in practice. However, the number of firms issuing debt at the two levels is sufficient for our empirical test.

We begin by comparing the firms in our three categories on various standard financial measures. For each bond issued by the companies in our groups from 1985-2004, we list the date of issue and the issuer (six-character) Cusip. These items are used to obtain the company financial data from the Compustat annual database, as of the end of the fiscal year that contained the issue date. If the financial data corresponding to an issue is not available in Compustat or if some of the data items we need have missing values, we drop those issues from the sample. The composition of our final data set is presented in Table 2.2.

\textsuperscript{12} Our ideas also extend the conclusions of Brick and Fisher (1987), that within a one period framework, provisions of the tax code make a single class of debt a value-maximizing strategy.
Table 3 shows financial statistics for the companies in our three categories. These ratios are calculated from data items obtained from Compustat. Since the data cover a twenty-year period, the market capitalization, which is the only numeric data item that is not a ratio, has been adjusted for inflation (to base 1982-84 dollars) using the Consumer Price Index obtained from the Bureau of Labor Statistics.

From Table 2.3 it is clear that companies that issue only senior debt and those that issue only junior debt are very different. Senior companies are ten times as large, are more profitable, pay more dividends, have lower leverage, and have higher credit ratings than firms that issue junior debt only. Companies that issue both types of debt are in between the other two groups on most measures and generally closer to the senior companies. This is broadly consistent with Propositions 4 and 5 and Predictions B and D. The theory says that junior-only debt is optimal when the recovery rate, q, is high. This could be consistent with the high capital expenditure rate that we observe for these firms.

The two noticeable exceptions to the ordering of the financial measures are that companies in the middle group have high Market-to-Book ratios and low Capital Expenditures-to-Assets ratios. It may be that these companies have higher variability in these measures and that different status at different times accounts for the issuing of the different types of debt.

In general, when costs of conflict are high, one would expect one class of debt, and otherwise two classes will be optimal. Larger companies may have more debt

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13 For all the numerical data, averages are used. Since credit ratings are ordered, but not numeric, the values shown are medians and no comparison ratios are given.
holders and thus costs of conflict may be high. Similarly, small companies may have bank debt, which will increase the costs of conflict. Between these two groups are some mid-size companies which find it optimal to issue two classes of debt.

5.2. Determinants of Debt Seniority

In the next set of tests, we run a probit regression for firms that issue both types of bonds. We want to determine what factors influence the choice of seniority for a particular issue. For each company, we look at the issues in chronological order and calculate the following items from the existing debt at the time of issue:

- number of senior bond issues outstanding
- number of senior subordinated bond issues outstanding
- total number of bond issues outstanding
- face value of senior bond issues outstanding
- face value of senior subordinated bond issues outstanding
- total face value of bond issues outstanding
- time since last issue
- amount of last issue
- seniority of last issue (1 for senior, 0 for senior subordinated)
- maturity, offering yield, and treasury spread of the new issue

We use these variables, along with the company financial ratios in a probit regression for the probability of the new issue being senior (0) or senior subordinated (1). There are two cases to consider: new issues at a time when there are other issues already outstanding that are included in our data set (Table 2.4) and issues when there are no outstanding issues included in our data set (Table 2.5), since in the latter case, the variables in the above list are either zero (e.g. number of issues outstanding, total face value of issues outstanding) or undefined (e.g. properties of last issue).

From Table 2.4 and Table 2.5, it is clear that companies tend to stick to one seniority level. The most important determinant of issuing junior debt is already having
junior debt. This is consistent with our Prediction A that junior only and senior only may be optimal, and conforms to the suggestion in Propositions 4 and 5 that once costs of conflict are added into the equation, one class can indeed be an optimal strategy. As noted, firms that choose to issue senior only and junior only are different, but once a decision has been made, companies tend to stick to that decision. This is also consistent with the capital structure literature, which suggests that capital structure does not change much over time (see Leary and Roberts (2005) and Welch (2004)).

5.3. Benefit of One Seniority Level

The last test we offer using this data considers Prediction C; namely, if a firm could commit to using only senior debt, it would not have to pay the premium to compensate the purchasers of senior debt for later issues of junior debt. The most obvious way to make this commitment would be to include a covenant in the debt contract that prohibits later issues of junior debt. In the entire FISD, there are 1052 issues that have such a covenant against subordinated or junior debt. However, 938 of these issues are themselves at the senior subordinated level and only 84 are at the senior level. Clearly, firms do not often use covenants as a way to commit to issuing senior debt only.14

The other way that a firm can commit to using only senior debt is by its behavior. If over a period of many years it issues only senior debt, investors may become convinced that it will continue to do so. If our model is correct, then if investors are convinced that a firm is committed to issuing senior debt only, it should be able to issue

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14 Covenants against additional issues of senior debt are even less common. There are 254 of them in the FISD, of which 186 are again on senior subordinated issues.
senior debt at a lower yield than similar companies that are known to issue junior debt as well. We have identified 8991 pairs of senior issues, one from a company that issues only senior debt and another from a company that issues senior as well as “junior” debt. We matched the issues on the following criteria. Both are senior issues offered on the same date, both have the same credit rating, and the maturities are within 200 days of each other.

Table 2.6 shows that the bonds from the companies that issue at both levels pay on average 75 basis points more in yield. Since these bonds are at all possible credit ratings and maturities, we also calculated the ratios of the yields. The average ratio over all issues is 1.27. When we look at the average ratios for single credit ratings, we find that they are almost all larger than 1, except in a few of the lower-rated categories where the number of data points is very small and the differences are not significant. Perhaps the behavioral commitment not to issue junior debt is less credible for firms with low credit ratings. This confirms the model's Prediction C that senior-only companies should pay lower spreads.

Similarly, the model predicts that junior-only firms would pay a higher yield on their junior bonds than firms issuing at both levels would pay on their comparable junior bonds. We don't have a lot of data for testing this hypothesis. The same matching process that we used above for the senior bonds produced only 103 pairs of junior bonds. For these pairs, the junior-only firms pay an average of an additional 20 basis points on their junior bonds, but this result is not statistically significant.
6. EVIDENCE FROM BANKRUPTCY DATA

In this section, we provide additional tests for a sub-sample of firms that have filed for either Chapter 11 or Chapter 7. Filing firms have to report detailed financial information, and in particular the composition of debt securities outstanding. This enables us to consider some of the implications of the model given the entire seniority structure of firms, rather than just issuing information. Further, we can consider only those firms for which the tradeoffs illustrated in the model are at play. Since these firms have gone bankrupt, we can reasonably assume that ex-ante they had faced a high probability of such an event.

Moreover, in the context of bankrupt firms, our model makes several testable predictions. First and foremost, our model predicts that, conditional on reorganization, where APR violations occur, we are less likely to observe firms that issue only junior debt. This result is supported by the data, as shown below. Additionally, our model describes, for the firms that optimally issue a combination of senior and junior debt, the expected bankruptcy costs and deviations from APR in equilibrium, given the characteristics of the bankruptcy costs.

6.1. Data

We use the sample of bankrupt firms in Bris, Welch and Zhu (2006) and Baird, Bris and Zhu (2007). Both papers describe the dataset in detail. The sample consists of the corporate Chapter 11 bankruptcies in the District of Arizona and the Southern District of New York between 1995 and 2001. The sample excludes dismissals or transfers to other courts, as well as "pre-packs". Therefore it consists only of "pure" Chapter 7 and 11 cases. For each case, we have information on the duration of the case, the fees paid by
the firm and the creditors, and the creditors’ recovery rates. Additionally, we have data on firm characteristics like the number of senior and junior creditors, the size of their claim, whether they include banks, the size of the company, and the amount of equity owned by the managers.

There are 82 Chapter 7 cases, and 221 Chapter 11 cases for which we know how many senior and junior creditors there are. These cases form our base sample, which gets reduced to about 100 cases only in our cross-sectional regressions.

6.2. Junior and Senior Debt Issuance

Table 2.7 shows the distribution of cases depending on the presence or absence of senior and junior creditors. Interestingly, the second panel of Table 7 shows that there are no Chapter 11 cases with only junior debt. This is consistent with our model.

In Chapter 7 there are 31 cases with junior debt but no senior debt. This result is very interesting for two reasons. First, it shows that very often firms without senior debt default (this is the case in 31 out of 83 Chapter 7 cases). Second, it shows that only when APR violations can be fully avoided (Chapter 7) do we observe junior debt only. This requires an implicit commitment by the firm not to reorganize, but rather to liquidate, if default happens. We do not have direct evidence on such commitments, but the data show that firms with only junior debt file consistently for Chapter 7.

Although the data is from a different time period, the results shown in Table 2.7 are consistent with those of Kaplan and Stein (1993) and Cotter and Peck (2001) about companies that went through leveraged buyouts in the 1980's. Kaplan and Stein show that companies in the later deals used more junior debt and became more likely to default. Cotter and Peck find that the relationship between debt seniority and default likelihood
depends on who the buyers are in the LBO. Buyout specialists used more junior debt and yet were less likely to default, while the reverse is true for buyers who were outside investors. In either case, we can expect to see defaults among companies with both junior and senior debt.

7. CONCLUSION

We present a model that shows how interactions between creditor groups in bankruptcy can affect the debt issuance decisions of firms. In particular, we suggest that deviations from APR should be priced and affect the issuing decisions of junior and senior debt. We show that firms that issue debt with a specific seniority level may tend to keep issuing debt at the same level to avoid the costs of conflicts in bankruptcy. Our model also has predictions as to what types of firms may change seniority level in sequential issues. When we introduce explicit costs of conflict in our model, we find that as these costs increase, firms will tend to stay with one class of debt. The empirical implications of our model are consistent with the somewhat surprising fact that most firms issue debt at one seniority level only, and quite a few of them cluster at the senior subordinated level. We also find that companies that issue only senior subordinated debt are much smaller than those that issue senior debt, while those that issue at both levels are intermediate on most financial measures. This is broadly consistent with our theoretical analysis. Our model is also supported by the fact that companies that issue only senior debt pay lower spreads than companies that issue at both levels. Finally, we study a sample of firms in bankruptcy and again find significant relationships between corporate characteristics and the types of debts that they issue, as predicted by the model.
We view this work as a first step towards a more comprehensive analysis, which will subsume bankruptcy considerations into the pricing and optimal issuance of debt securities.
REFERENCES


APPENDIX

Proof of Proposition 1.

This follows from the fact that the total face value of the debt, \( S + J = \frac{1-pq}{1-p} I \), is independent of \( \alpha \). As usual, we have two cases to consider. If \( S < qI \), we use the first formulas of (5) and (7) to get:

\[
S + J = \frac{(1-p)S + (1-\alpha)I - pqI + pS - p\theta G}{1-p} = \frac{S + (1-\alpha)I - pqI - p\theta G}{1-p} = \frac{S}{1-p} + \frac{(1-\alpha)I - pqI - p\theta G}{1-p} = \frac{1-pq}{1-p} I
\]

In the second case, we have

\[
S + J = \frac{\alpha I - pqI + p\theta G + \alpha I - p\theta G}{1-p} = \frac{\alpha I - pqI + p\theta G + I - \alpha I - p\theta G}{1-p} = \frac{1-pq}{1-p} I
\]

Thus, the total face value of the debt with simultaneous issue of senior and junior is the same as the face value of debt when only a single class is issued, as calculated in Section 3.2.

Note that if \( q = 1 \), the debt is risk-free and \( S + J + I \), as it should be, since we have assumed that the risk-free rate is zero. As \( q \) decreases, the total risk premium,

\[
S + J - I = \frac{p(1-q)}{1-p} I,
\]

increases. ☐
Proof of Proposition 3.

If the firm issues junior debt first, it will not be optimal to issue senior debt later if $V_{eJS}^S < V_{eJ}^J$, where $V_{eJ}^J = NPV = [(1 - p)(1 + h) + pq - 1]I$ from equation (1), and

$V_{eJS}^S = (1 - p)[(1 + h)I - S - J]$. This condition is equivalent to:

$$(S + J) > \frac{(1 - pq)}{1 - p} I \iff (1 - p)(S + J) > (1 - pq)I$$

(20)

The right-hand side of the first inequality in (20) says that the total repayment with two-level debt financing is greater than the total repayment with a single level of debt, derived in section 3.2. Having only junior debt will be a more profitable strategy if the face value of the senior debt to be issued would be sufficiently large. We will show that this is never the case: there are limits to how large the transfer from seniors to juniors ($G$) can be, and therefore how large $S$ can be.

There are four cases to be considered, defined by the conditions $S < qI$ or $S > qI$ and $J < qI$ or $J > qI$, i.e. whether or not the recovery is sufficient to pay off each debt individually. The values of $S$ are given by equation (5), since the senior debt buyers know that junior debt already exists. On the other hand, the borrower has not guaranteed to issue senior debt after the junior. Otherwise, the junior debt would have the reduced face value given by equations (13) or (15). Here, when $J < qI$, the value of $J$ is given by equation (18), while when $J > qI$, $J = (1 - \alpha)I$. Combining these values, we have:

Case 1: If $S > qI$ and $J > qI$, then $J = \frac{(1 - \alpha - pq)}{1 - p} I$ and $S = \frac{(\alpha - pq) I + pG}{1 - p}$, so

$$(1 - p)(S + J) = (\alpha - pq)I + pG + (1 - \alpha - pq)I = (1 - 2pq)I + pG$$

(21)

Then equation (20) becomes
\[(1 - 2pq)I + p\theta G > (1 - pq)I \Leftrightarrow \theta G > qI \Leftrightarrow G > qI/	heta > qI,\]

but the last condition is impossible because the amount expropriated from the seniors cannot exceed the liquidation value of the project.

Case 2: If \(S > qI\) and \(J < qI\), then \(J = (1 - \alpha)I\) and \(S = \frac{(\alpha - pq)I + p\theta G}{1 - p}\), so

\[(1 - p)(S + J) = (\alpha - pq)I + p\theta G + (1 - \alpha)(1 - p)I = (1 - p - pq + \alpha p)I + p\theta G \quad (22)\]

Then (20) becomes \((1 - p - pq + \alpha p)I + p\theta G > (1 - pq)I \Leftrightarrow \theta G > (1 - \alpha)I\), but then \(G > (1 - \alpha)I/	heta > (1 - \alpha)I = J\). The last condition is impossible because the transfer to the juniors cannot exceed what they are owed.

Case 3: If \(S < qI\) and \(J > qI\), then \(J = \frac{(1 - \alpha - pq)}{1 - p}I\) and \(S = \alpha I + p\theta G\), so

\[(1 - p)(S + J) = (1 - p)(\alpha I + p\theta G) + (1 - \alpha - pq)I = (1 - \alpha p - pq)I + (1 - p)p\theta G \quad (23)\]

Then (20) becomes \((1 - \alpha p - pq)I + (1 - p)p\theta G > (1 - pq)I \Leftrightarrow \theta G > \alpha I/(1 - p)\). Since the amount transferred from the seniors cannot exceed what they are owed \((G < S)\), we have

\[S = \alpha I + p\theta G \Leftrightarrow G = \frac{1}{p\theta} (S - \alpha I) \leq S \Leftrightarrow S \left(\frac{1 - p\theta}{p\theta}\right) \leq \frac{\alpha I}{p\theta} \Leftrightarrow S \leq \frac{\alpha I}{1 - p\theta} \]

Then, substituting the last inequality into the second equation, we get

\[G \leq \frac{1}{p\theta} \left[ \frac{\alpha I}{1 - p\theta} - \alpha I \right] = \frac{\alpha I}{p\theta} \left[ \frac{1}{p\theta} - 1 \right] = \frac{\alpha I}{p\theta} \left[ \frac{p\theta}{p\theta} - 1 \right] = \frac{\alpha I}{1 - p\theta}.\]

On the other hand, using our previous deduction from (20), we have

\[\theta G > \frac{\alpha I}{1 - p} \Leftrightarrow G > \frac{\alpha I}{\theta - \theta p} > \frac{\alpha I}{1 - \theta p} \]
and we have a contradiction.

Case 4: If $S < qI$ and $J < qI$, then $J = (1 - \alpha)I$ and $S = \alpha I + p\theta G$, so

$$(1 - p)(S + J) = (1 - p)(\alpha I + p\theta G) + (1 - p)(1 - \alpha)I = (1 - p)(I + p\theta G) \quad (24)$$

Then equation (20) becomes

$$(1 - p)(I + p\theta G) > (1 - pq)I \iff G > \theta G > (1 - q)I/(1 - p) > (1 - q)I/(1 - p\theta).$$

Substituting the expressions for $S$ and $J$ in this case into (3), we get a quadratic equation for $G$ with $p, q, \alpha, \theta$, and $I$ as parameters. This equation has only one positive solution, which is less than $(1 - q)I/(1 - p\theta)$ unless $\alpha = 1$ and $p\theta = 0$, in which case the two expressions are equal, and again we have a contradiction.

**Proof of Proposition 4.**

Case 1: If the firm issues senior debt first, then the face value, $S$, will be $S = \alpha I$ if $\alpha < q$. Following the proof of Corollary 1 but incorporating the bankruptcy costs, we have

$$V_J = (1 - \alpha)I = (1 - p)J + p[qI - \alpha I - c(1 - \alpha)I + \theta G]$$

so the face value of the junior debt is

$$J = \frac{[(1 - \alpha) - p(q - \alpha) + pc(1 - \alpha)]I - p\theta G}{1 - p}$$

In (14), we saw that $V_e^{SJ} - V_e^S = p\theta G > 0$, so it was always optimal to issue junior debt. Here, however, we have

$$V_e^{SJ} - V_e^S = p\theta G - (1 - \alpha)cpI$$

which is negative if (25) holds, in which case it is not optimal to issue junior debt.
\[
S < (q - c(1 - \alpha))I \text{ and } \theta G < c(1 - \alpha)I \text{ or } c > \frac{\theta G}{(1 - \alpha)I} \quad \text{or,} \quad (25)
\]

Case 2: If the firm issues senior debt first, then the face value, \( S \), will be
\[
S = \frac{(\alpha - pq)}{1 - p} I \text{ if } \alpha \geq q. \quad \text{In this case, incorporating the bankruptcy costs, we have}
\]
\[
V_j = (1 - \alpha)I = (1 - p)J + p[-c(1 - \alpha)I + \theta G]
\]
so the face value of the junior debt is
\[
J = \frac{[(1 - \alpha) + pc(1 - \alpha)]I - p\theta G}{1 - p} = \frac{(1 - \alpha)(1 + cp)I - p\theta G}{1 - p}
\]
In this case,
\[
V_e^{SJ} - V_e^S = p\theta G - pI[c(1 - \alpha) - q]
\]
which is negative if (26) holds, in which case it is not optimal to issue junior debt.

\[
S > (q - c(1 - \alpha))I \text{ and } \theta G < (c(1 - \alpha) - q)I \text{ or } c > \frac{\theta G}{(1 - \alpha)I} + q. \quad (26)
\]

\[\Box\]

**Proof of Proposition 5.**

We have four cases to consider, as in Proposition 3. However, here the value of \( S \) and \( J \) that separates the cases is \((q - c(1 - \alpha))I\) rather than \(qI\). We will show that in each case there is a critical value of \( c \), above which it is not optimal to issue senior debt after the junior. In each case, taking the bankruptcy costs into account, we have
\[
V_e^J = NPV = [(1 - p)(1 + h) + pq - 1]I \text{ and } V_e^{JS} = (1 - p)[(1 + h)I - S - J] - p[c(1 - \alpha)I], \text{ so}
\]
\[ V_e^{JS} - V_e^{J} = -(1 - p)(S + J) - pcl(1 - \alpha) - (pq - 1)I \tag{27} \]

Case 1: Substituting (21) into (27), we have

\[ V_e^{JS} - V_e^{J} = -p \theta G + pqI - pcl(1 - \alpha) \]

which is negative if

\[ \theta G > qI - c(1 - \alpha)I \iff c > \frac{qI - \theta G}{(1 - \alpha)I}. \]

Case 2: Substituting (22) into (27), we have

\[ V_e^{JS} - V_e^{J} = -p \theta G + p(1 - \alpha)I - pcl(1 - \alpha) = p[-\theta G + (1 - \alpha)(1 - c)I] \]

which is negative if

\[ \theta G > (1 - \alpha)(1 - c)I \iff c > 1 - \frac{\theta G}{(1 - \alpha)I}. \]

Case 3: Substituting (23) into (27), we have

\[ V_e^{JS} - V_e^{J} = -(1 - p)p \theta G + p \alpha I - pcl(1 - \alpha) \]

which is negative if

\[ \theta G > \frac{\alpha I - c(1 - \alpha)I}{1 - p} \iff c > \frac{\alpha I - (1 - p)\theta G}{(1 - \alpha)I}. \]

Case 4: Substituting (24) into (27), we have

\[ V_e^{JS} - V_e^{J} = -(1 - p)p \theta G + p(1 - q)I - pcl(1 - \alpha) \]

which is negative if
\[ \vartheta G \frac{1-q}{1-p} I - \frac{c(1-\alpha)I}{1-p} \Leftrightarrow c > \frac{1-q}{1-\alpha} - \frac{(1-p)\vartheta G}{(1-\alpha)I}. \]

In each case, we have found a lower bound for the bankruptcy cost parameter, \( c \), above which it is optimal to issue only junior debt. \( \square \)
Figure 2.1: Payoff to Junior Creditors under Different Priority Schemes

Given the total investment required for the project, $I$, and the face values of junior and senior debt, $J$ and $S$, this figure shows the expected payoff to junior creditors as a function of the recovery rate $q$ for different priority rules. Under the Absolute Priority Rule (APR), senior debt holders are paid in full before junior debt holders receive any payment. Under the Equal Priority Rule (EPR), payments in all states are proportional to the amounts owed to each class of debt holders. $X_0$ represents the expected payoff when EPR is used with probability $\theta$ and APR with probability $1-\theta$. 
Table 2.1. Security Levels of Bond Issues in FISD

For each of the seven seniority levels included, the first column shows the number of firms in the FISD that issue at least one bond at that level and the second column shows the number of firms that issue bonds only at that level.

<table>
<thead>
<tr>
<th>Security Level</th>
<th>Number of Firms Issuing at this level</th>
<th>Number of firms issuing at this level only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior Subordinated</td>
<td>88</td>
<td>14</td>
</tr>
<tr>
<td>Junior</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Subordinated</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>Senior Subordinated</td>
<td>3508</td>
<td>2232</td>
</tr>
<tr>
<td>Senior</td>
<td>5853</td>
<td>4304</td>
</tr>
<tr>
<td>Senior Secured</td>
<td>1014</td>
<td>559</td>
</tr>
<tr>
<td>No level reported</td>
<td>1429</td>
<td>1134</td>
</tr>
</tbody>
</table>

Any Level                 9972
More than one Level       1725
Total number of firms     10177
Number of firms with no issues 205
Table 2.2: Size of data set.

This table shows the number of issues in the reduced data set that includes those companies that issue bonds only at the senior or senior subordinated levels. These companies are further divided into those that issue senior only, those that issue senior subordinated only, and those that issue at both levels. Financial data for the companies is available on an annual basis. Therefore, to avoid duplication in the calculation of financial summary statistics, we reduce the data further to one issue per company per year.

<table>
<thead>
<tr>
<th>Security Level</th>
<th>Number of Companies</th>
<th>Number of Issues (One per Year)</th>
<th>Number of Issues (Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior</td>
<td>797</td>
<td>1097</td>
<td>29793</td>
</tr>
<tr>
<td>Senior Subordinated</td>
<td>533</td>
<td>616</td>
<td>4105</td>
</tr>
<tr>
<td>Both</td>
<td>361</td>
<td>624</td>
<td>17727</td>
</tr>
</tbody>
</table>
Table 2.3. Average Financial Measures of Companies by Types of Bonds Issued.

This table shows the averages over firm-years of financial measures for the three categories of companies in our data set. The Senior column describes those companies that issue senior bonds only. The Seniorsub column describes those companies that issue senior subordinated bonds only. The Both column describes those companies that issue senior and senior subordinated bonds only. Values in the Seniorsub/Senior column are ratios of the Seniorsub column to the Senior column. Values in the Both/Senior column are ratios of the Both column to the Senior column. t12 is the t statistic for equality of the means of the first two groups. t13 is the t statistic for equality of the means of the first and third groups. t23 is the t statistic for equality of the means of the second and third groups. All averages are calculated using one value for each company in each year in which the company issued any bonds. *, **, and *** indicate significance at the 10%, 5%, and 1% levels respectively. Since credit ratings are ordered, but not numeric, the values shown are medians and no comparison ratios are given. Payout is the payout ratio. PE is the price/earnings ratio. PB is the price to book ratio. Size is the market capitalization adjusted for inflation to base 1982-84 dollars using the CPI. ROA is the return on assets. ROE is the return on equity. D/A is the ratio of total debt to total assets. OI/A is the ratio of operating income to total assets. CapExp/A is the ratio of capital expenditures to total assets. IntCov is the interest coverage ratio. All values are calculated from annual Compustat data.

<table>
<thead>
<tr>
<th>CredRat</th>
<th>Senior</th>
<th>Seniorsub</th>
<th>Both</th>
<th>Seniorsub/Senior</th>
<th>Both/Senior</th>
<th>t12</th>
<th>t13</th>
<th>t23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payout</td>
<td>0.544</td>
<td>0.103</td>
<td>0.062</td>
<td>0.189</td>
<td>0.115</td>
<td>2.02</td>
<td>1.89</td>
<td>0.28</td>
</tr>
<tr>
<td>PE</td>
<td>13.170</td>
<td>24.115</td>
<td>15.692</td>
<td>1.831</td>
<td>1.192</td>
<td>-1.05</td>
<td>-0.3</td>
<td>0.86</td>
</tr>
<tr>
<td>PB</td>
<td>2.828</td>
<td>2.347</td>
<td>4.335</td>
<td>0.830</td>
<td>1.533</td>
<td>0.89</td>
<td>-1.01</td>
<td>-1.29</td>
</tr>
<tr>
<td>Size</td>
<td>5228.826</td>
<td>556.961</td>
<td>3089.222</td>
<td>0.107</td>
<td>0.591</td>
<td>11.57***</td>
<td>3.77***</td>
<td>-6.24***</td>
</tr>
<tr>
<td>ROA</td>
<td>0.022</td>
<td>-0.006</td>
<td>0.025</td>
<td>-0.264</td>
<td>1.115</td>
<td>3.25***</td>
<td>-0.58</td>
<td>-3.64***</td>
</tr>
<tr>
<td>ROE</td>
<td>0.041</td>
<td>0.000</td>
<td>0.023</td>
<td>0.012</td>
<td>0.561</td>
<td>0.41</td>
<td>0.3</td>
<td>-0.22</td>
</tr>
<tr>
<td>D/A</td>
<td>0.292</td>
<td>0.426</td>
<td>0.340</td>
<td>1.457</td>
<td>1.164</td>
<td>-13.34***</td>
<td>-4.72***</td>
<td>7.11***</td>
</tr>
<tr>
<td>OI/A</td>
<td>0.121</td>
<td>0.107</td>
<td>0.116</td>
<td>0.880</td>
<td>0.961</td>
<td>2.89***</td>
<td>1.18</td>
<td>-1.95*</td>
</tr>
<tr>
<td>CapExp/A</td>
<td>0.072</td>
<td>0.088</td>
<td>0.063</td>
<td>1.214</td>
<td>0.877</td>
<td>-3.19***</td>
<td>2.46**</td>
<td>4.79***</td>
</tr>
<tr>
<td>IntCov</td>
<td>3.428</td>
<td>-0.049</td>
<td>2.304</td>
<td>-0.154</td>
<td>0.310</td>
<td>4.50***</td>
<td>1.480</td>
<td>-5.13***</td>
</tr>
</tbody>
</table>
Table 2.4: Probit Regression for seniority of issues of bonds, when there are already outstanding issues. Positive coefficients mean that junior issues are more likely.

This table reports the results of a probit regression, where the dependent variable is the probability of issuing a senior subordinated bond when there are other bonds outstanding. All financial variables are from the end of the fiscal year in which the bond was issued. CapExp_A is the ratio of capital expenditures to assets. Credit_Rating is the Standard and Poor's long-term issuer credit rating converted to a numeric scale from 2 (AAA) to 27 (D). D_A is the ratio of total debt to assets. DsubC_D is the ratio of convertible subordinated debt to total debt. Dsub_D is the ratio of non-convertible subordinated debt to total debt. IntCov is the ratio of income before extraordinary items to interest payments. OI_A is the ratio of operating income to assets. PB is the ratio of market capitalization to common equity. PE is the ratio of share price to earnings per share. Payout is the ratio of dividends to earnings. ROA is the ratio of income before extraordinary items to total assets. ROE is the ratio of income before extraordinary items to common equity. logsize is the log of the market capitalization adjusted by the CPI to base 1982-84 dollars. logamtpre is the log of the face value of the most recent issue. amtsen is the amount of senior debt outstanding. isenpre is the seniority of the previous issue (1 = junior, 0 = senior.) nsen is the number of senior issues outstanding. nsub is the number of senior subordinated issues outstanding. offering yield and term are for the bond that is being issued. tsl is the time since the previous issue. tspread is the treasury spread for the new issue. year is the calendar year of the new issue.

*,**, and *** indicate significance at the 10, 5, and 1% levels.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient Estimate</th>
<th>Standard Error</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>54.0294 **</td>
<td>26.9914</td>
<td>4.01</td>
</tr>
<tr>
<td>CapExp_A</td>
<td>0.5354</td>
<td>0.8383</td>
<td>0.41</td>
</tr>
<tr>
<td>Cred_Rating</td>
<td>0.1159 ***</td>
<td>0.0275</td>
<td>17.8</td>
</tr>
<tr>
<td>D_A</td>
<td>0.0014</td>
<td>0.0268</td>
<td>0</td>
</tr>
<tr>
<td>DsubC_D</td>
<td>3.0166 ***</td>
<td>0.2801</td>
<td>116.02</td>
</tr>
<tr>
<td>Dsub_D</td>
<td>3.6193 ***</td>
<td>0.2662</td>
<td>184.8</td>
</tr>
<tr>
<td>IntCov</td>
<td>0.0081</td>
<td>0.01</td>
<td>0.66</td>
</tr>
<tr>
<td>OI_A</td>
<td>0.8822</td>
<td>1.0145</td>
<td>0.76</td>
</tr>
<tr>
<td>PB</td>
<td>0.0071</td>
<td>0.0083</td>
<td>0.73</td>
</tr>
<tr>
<td>PE</td>
<td>-0.0004</td>
<td>0.0004</td>
<td>0.67</td>
</tr>
<tr>
<td>Payout</td>
<td>-0.0426</td>
<td>0.0394</td>
<td>1.17</td>
</tr>
<tr>
<td>ROA</td>
<td>0.4243</td>
<td>1.1102</td>
<td>0.15</td>
</tr>
<tr>
<td>ROE</td>
<td>0.0573</td>
<td>0.082</td>
<td>0.49</td>
</tr>
<tr>
<td>logsize</td>
<td>-0.077</td>
<td>0.0673</td>
<td>1.31</td>
</tr>
<tr>
<td>logamtpre</td>
<td>0.0687</td>
<td>0.0634</td>
<td>1.18</td>
</tr>
<tr>
<td>amtsen</td>
<td>0</td>
<td>0</td>
<td>0.21</td>
</tr>
<tr>
<td>isenpre</td>
<td>0.0579</td>
<td>0.1306</td>
<td>0.2</td>
</tr>
<tr>
<td>nsen</td>
<td>0.0037</td>
<td>0.0101</td>
<td>0.13</td>
</tr>
<tr>
<td>nsub</td>
<td>-0.2467 ***</td>
<td>0.0418</td>
<td>34.9</td>
</tr>
<tr>
<td>offyield</td>
<td>-0.045 **</td>
<td>0.0193</td>
<td>5.45</td>
</tr>
<tr>
<td>term</td>
<td>0.0025</td>
<td>0.0055</td>
<td>0.2</td>
</tr>
<tr>
<td>tsl</td>
<td>0.0001</td>
<td>0.0001</td>
<td>2.07</td>
</tr>
<tr>
<td>tspread</td>
<td>-0.0001</td>
<td>0.0004</td>
<td>0.08</td>
</tr>
<tr>
<td>year</td>
<td>-0.0283 **</td>
<td>0.0136</td>
<td>4.33</td>
</tr>
</tbody>
</table>
Table 2.5: Probit Regression for seniority of issues of bonds, when there is no data about outstanding issues. Positive coefficients mean that junior issues are more likely.

This table reports the results of a probit regression, where the dependent variable is the probability of issuing a senior subordinated bond when there are no other bonds outstanding. All financial variables are from the end of the fiscal year in which the bond was issued. CapExp_A is the ratio of capital expenditures to assets. Credit_Rating is the Standard and Poor's long-term issuer credit rating converted to a numeric scale from 2 (AAA) to 27 (D). D_A is the ratio of total debt to assets. DsubC_D is the ratio of convertible subordinated debt to total debt. Dsub_D is the ratio of non-convertible subordinated debt to total debt. IntCov is the ratio of income before extraordinary items to interest payments. OI_A is the ratio of operating income to assets. PB is the ratio of market capitalization to common equity. PE is the ratio of share price to earnings per share. Payout is the ratio of dividends to earnings. ROA is the ratio of income before extraordinary items to total assets. ROE is the ratio of income before extraordinary items to common equity. logsize is the log of the market capitalization adjusted by the CPI to base 1982-84 dollars. amtpre is the face value of the most recent issue. offyield is the offering yield, tspread is the treasury spread, and year is the calendar year for the new issue.

*, **, and *** indicate significance at the 10, 5, and 1% levels.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient Estimate</th>
<th>Standard Error</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>97.9889</td>
<td>71.2187</td>
<td>1.89</td>
</tr>
<tr>
<td>CapExp_A</td>
<td>-0.9506</td>
<td>1.7721</td>
<td>0.29</td>
</tr>
<tr>
<td>Cred_Rating</td>
<td>0.0357</td>
<td>0.0728</td>
<td>0.24</td>
</tr>
<tr>
<td>D_A</td>
<td>0.2795</td>
<td>0.2897</td>
<td>0.93</td>
</tr>
<tr>
<td>DsubC_D</td>
<td>2.8038***</td>
<td>0.4667</td>
<td>36.09</td>
</tr>
<tr>
<td>Dsub_D</td>
<td>4.6294***</td>
<td>0.9181</td>
<td>25.43</td>
</tr>
<tr>
<td>IntCov</td>
<td>-0.0041</td>
<td>0.0219</td>
<td>0.04</td>
</tr>
<tr>
<td>OI_A</td>
<td>1.0628</td>
<td>2.52</td>
<td>0.18</td>
</tr>
<tr>
<td>PB</td>
<td>-0.0166</td>
<td>0.0285</td>
<td>0.34</td>
</tr>
<tr>
<td>PE</td>
<td>-0.0003</td>
<td>0.0026</td>
<td>0.02</td>
</tr>
<tr>
<td>Payout</td>
<td>-0.0876*</td>
<td>0.0456</td>
<td>3.68</td>
</tr>
<tr>
<td>ROA</td>
<td>2.3069</td>
<td>3.0839</td>
<td>0.56</td>
</tr>
<tr>
<td>ROE</td>
<td>0.1011</td>
<td>0.6427</td>
<td>0.02</td>
</tr>
<tr>
<td>logsize</td>
<td>0.0667</td>
<td>0.1778</td>
<td>0.14</td>
</tr>
<tr>
<td>offyield</td>
<td>-0.0523</td>
<td>0.0426</td>
<td>1.5</td>
</tr>
<tr>
<td>tspread</td>
<td>0.0001</td>
<td>0.0009</td>
<td>0.01</td>
</tr>
<tr>
<td>year</td>
<td>-0.0499</td>
<td>0.0361</td>
<td>1.91</td>
</tr>
</tbody>
</table>
Table 2.6: Comparison of offering yields on senior debt issued by companies that issue senior debt only and companies that issue both senior and senior subordinated debt.

This table reports the relation between offering yields of 8991 pairs of senior bonds. In each pair, one of the bonds is issued by a company that issues only senior bonds, and the other is issued by a company that issues both senior bonds and senior subordinated bonds. The two bonds in each pair have the same offering date, the same credit rating, and maturity dates within 200 days of each other. For each pair, we calculate the ratio of the yield on the second bond (two-level company) to the yield on the first bond (senior-only company) and the difference of the two yields. For the entire set, and for each credit rating, we calculate the average of the ratios and the average of the differences, reported in the third and fourth columns above. We also perform a t-test for equality of the yields and the t statistics are shown in the last column.

* **, and *** indicate significance at the 10, 5, and 1% levels.

<table>
<thead>
<tr>
<th>Rating</th>
<th>N</th>
<th>Mean Yield Ratio</th>
<th>Mean Yield Difference</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>8990</td>
<td>1.27</td>
<td>75.83</td>
<td>46.16 ***</td>
</tr>
<tr>
<td>AAA</td>
<td>1225</td>
<td>1.7013</td>
<td>114.7997</td>
<td>15.43 ***</td>
</tr>
<tr>
<td>AA+</td>
<td>83</td>
<td>1.0833</td>
<td>21.3074</td>
<td>1.21</td>
</tr>
<tr>
<td>AA</td>
<td>145</td>
<td>1.0859</td>
<td>19.6542</td>
<td>1.534</td>
</tr>
<tr>
<td>AA-</td>
<td>570</td>
<td>1.0761</td>
<td>28.5062</td>
<td>0.937 **</td>
</tr>
<tr>
<td>A+</td>
<td>2664</td>
<td>1.2084</td>
<td>74.6002</td>
<td>40.48 ***</td>
</tr>
<tr>
<td>A</td>
<td>2668</td>
<td>1.3136</td>
<td>102.7437</td>
<td>39.33 ***</td>
</tr>
<tr>
<td>A-</td>
<td>492</td>
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<td>71.9457</td>
<td>11.38 ***</td>
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<tr>
<td>BBB+</td>
<td>458</td>
<td>1.065</td>
<td>26.6875</td>
<td>4.74 ***</td>
</tr>
<tr>
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<td>365</td>
<td>1.0944</td>
<td>29.8186</td>
<td>3.42 ***</td>
</tr>
<tr>
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<td>1.024</td>
<td>-10.6641</td>
<td>-0.87</td>
</tr>
<tr>
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<tr>
<td>BB</td>
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<td>-1.37</td>
</tr>
<tr>
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<td>-51.0362</td>
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<td>-94.5542</td>
<td>-1.8 *</td>
</tr>
<tr>
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<td>-104.6104</td>
<td>-2.08 **</td>
</tr>
<tr>
<td>B-</td>
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<td>29.9</td>
<td>0.46</td>
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<tr>
<td>CCC+</td>
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<td>1.0847</td>
<td>61.502</td>
<td></td>
</tr>
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<td>D</td>
<td>8</td>
<td>1.0081</td>
<td>-78.1019</td>
<td>-0.55</td>
</tr>
</tbody>
</table>
Table 2.7. Distribution of Junior and Senior Claims

The Table reports the number of cases with and without junior/senior debt. The sample includes all corporate bankruptcies, with sufficient data, filed under Chapter 7 and Chapter 11 between 1995 and 2001 in the Federal Bankruptcy Courts of Arizona and Southern District of New York. Data is obtained online and hand-coded from the Public Access to Court Electronic Records (PACER). We exclude from the original sample: pre-packs, dismissals, transfer to other courts or chapters (except for Chapter 11 to Chapter 7 conversions), and cases of subsidiaries of the same company after the initial filing by the parent.

<table>
<thead>
<tr>
<th>Panel A. Chapter 7 Liquidations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior Debt</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>31</td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B. Chapter 11 Reorganizations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Debt</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
</tr>
</tbody>
</table>
CHAPTER 3. MERGERS AND DEBT SENIORITY

1. INTRODUCTION

It is well known that when corporations go through mergers and acquisitions, their capital structures change. Typically, a firm's leverage increases after a merger is completed. In this paper we look in more detail at the debt of such companies. In particular, we are interested in what changes occur in the seniority structure of the debt. As shown in Chapter 2 there can be an advantage for firms to maintain a debt structure in which all the debt is senior, if future senior issues are planned. While there are some situations in which it may be optimal to issue new junior debt, companies that show a commitment to issuing only senior debt, by doing so over a period of time, pay a lower spread on future senior issues. This suggests the following question. What happens to the seniority in the new capital structure when a firm that has only senior debt acquires a firm that has some junior debt? One hypothesis is that the senior-only firm would want to maintain that status and so would move quickly to replace the inherited junior debt with new senior debt. This assumes, of course, that the premerger capital structure of the acquirer was optimal. On the other hand, there are costs associated with new issues that might be larger than the benefits that could be obtained from the maintenance of a senior-only debt structure.

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2 Note that firms with junior debt tend to be significantly smaller than senior-only firms so acquisition in the other direction (a firm with junior debt acquiring a senior-only firm) is much less likely.
We test these possibilities using merger data from Thomson Financial's SDC Platinum merger database, and bond issue data from Mergent's Fixed Income Securities Database.

In the next section, we discuss the previous work on changes in capital structure that follow mergers. Section 3 describes our data sample. Section 4 describes the empirical tests we carried out and the results. Section 5 concludes.

2. CAPITAL STRUCTURE AFTER MERGERS

There is an extensive theoretical literature on the financial benefits of mergers. The traditional explanation is that a firm may have unused debt capacity that could be used by another firm that acquires it. The combined firm will realize additional tax savings that were not being used by the acquired firm. Lewellen (1971) shows that the process of merging may increase the debt capacity of the merged firm beyond the sum of those of the two individual firms. As long as the future income streams of the two companies are not perfectly correlated, the probability of bankruptcy is reduced for the new firm. Periods of low income for one of the firms can be offset by higher income of the other. As a result, lenders will be willing to provide more capital to the merged firm than they would to the two firms individually. Similar results are obtained by Lee and Barker (1977) and Lintner (1971). An empirical study by Stevens (1973) shows that firms that are acquired have lower leverage than similar firms that are not acquired, indicating that acquiring firms are looking for unused debt capacity.
The increased debt capacity of a merged firm is also related to the concept of "coinsurance". As pointed out by Kim and McConnell (1977), the reduced probability of bankruptcy will increase the value of the premerger outstanding debt, with a corresponding decrease in the equity value. To counteract this affect, merged firms can use their new debt capacity to increase their leverage above the premerger levels. The result would be no increase (or decrease) in bond holder value and an increase in stockholder value. In a sample of conglomerate mergers, Kim and McConnell find that there are no abnormal returns to bond holders and that there is increased leverage in the merged firms. Since the bond holders do not have negative returns with increased leverage, the coinsurance effect is present. The increased leverage is sufficient to eliminate any benefit to the bond holders from coinsurance. In a later empirical study, Shrievs and Pashley (1984) find similar results for both conglomerate and non-conglomerate mergers. They also find that the change in capital structure (increased leverage) tends to persist for at least five years after the merger. The theory suggests that the smaller the correlation of premerger cash flows of the two firms, the greater should be the increase in postmerger leverage. This prediction is confirmed in Shrievs and Pashley's sample. Additional evidence for bond holder benefits from mergers is given by Penas and Unal (2004), who show that merged banks pay lower spreads on new debt than the acquiring bank paid before the merger. If new debt is required, then the stockholders also benefit from these lower spreads, through lower future interest

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3 Kim and McConnell refer to the earlier work on coinsurance by Higgins and Schall (1975) and Galai and Masulis (1976).

4 Similar results are reported by Asquith and Kim (1982).
payments. Indeed, Penas and Unal find that bank mergers do not shift wealth between debt and equity holders, but that both groups have positive abnormal returns around the merger date. These papers use different definitions for the abnormal returns obtained by bond holders.

We should note here that Scott (1977) shows that the optimal level of debt for a merged firm may be less than the sum of the debt levels of the acquirer and target. Scott's model differs from some of the others by explicitly including noncontractual obligations, such as sales taxes and payments from legal judgments and settlements. Depending on the specific situation, maximizing the total value of the merged firm may require either increasing or decreasing the debt from premerger levels.

There are other relationships between mergers and capital structure. Harris and Raviv (1988) study the use of leverage increases by target management as a method of resisting takeovers. They find that leverage has an effect on the acquirer's choice of takeover method, e.g. tender offer versus proxy contest. Uysal (2006) studies target capital structures and finds that firms whose leverage is below their long-term targets are more likely to make acquisitions. These firms also make more acquisitions and acquire larger targets.

Capital structure policy after mergers is part of the more general question of how corporations determine their capital structures. Outside the idealized world of Modigliani and Miller, the theory described first by most finance textbooks is the static tradeoff between taxes and financial distress costs. This tradeoff results in the existence of an optimal amount of leverage. Under this theory, when its leverage moves away from the desired level, a firm will take action to move back toward the optimum, issuing or
retiring debt or equity as needed. However, much of the empirical evidence does not support this view. Welch (2004) finds that the primary determinant of capital structure is stock returns: significant changes in stock prices have long-term effects on leverage. Any move back toward the previous capital structure is very slow. Leary and Roberts (2005) have a different explanation for similar empirical data. They find that corporations do try to move back toward their target capital structures, but in such a way as to minimize the transaction costs involved in the rebalancing. For our purposes, the relevant fact, for which there is good empirical evidence from many studies, is that the process of returning to a target capital structure is generally a slow one, even after events that significantly and rapidly change capital structure. We will see that this is true for the seniority structure of debt as well as for the amount of debt.

The studies discussed above measure leverage using total debt. There is no consideration of the seniority structure of the debt before or after the merger. Large firms most commonly have only senior debt. In the Fixed Income Securities Database (FISD) from Mergent, Inc., 43% of the firms issue only senior (unsecured) debt. The average size of these firms is 11.6 times the average size of the 22% of firms that issue only senior subordinated debt, and 3.8 times the average size of the firms that issue debt at both of these levels.\(^5\) As a result, the most likely situation in a merger involving more than one seniority level of debt is that a senior-only company would acquire a company having some or all senior subordinated debt.

In Chapter 2, we show that a firm can save on the interest payments on its future debt issues by continuing to have an all-senior debt structure. Corollary 2 to Proposition

\^5\ See Chapter 2 for a more detailed comparison of these three groups of firms.
2 states, "Firms that can credibly commit to issuing senior debt only can issue such debt at a lower yield than firms that issue two classes of securities." Our empirical study shows that a senior-only firm pays an average of 75 basis points lower yield on new senior debt than does a company that issues both senior and senior subordinated debt, where the new bonds of the two companies are issued on the same date, with the same rating and maturity. In assimilating a company having junior debt, a merged company may then want to eliminate that debt as soon as possible and replace it with new senior debt. On the other hand, even if it cannot eliminate the junior debt, it would probably want to continue its policy of issuing new debt only at the senior level. This is phenomenon that we study in this paper. Thus, there are two alternative hypotheses that we consider here about the behavior of the merged company. First, it may want to return to the acquirer's original optimal capital structure. Second, it may want to continue the acquirer's original strategy for the seniority of debt issuance.

3. DATA

From Thomson Financial's SDC Platinum database, we obtain a list of mergers completed in 1990 or later, in which a public company acquires 100% of a public target company. There are 5475 of these deals. We then look up the bond issues of the targets in these deals in the Fixed Income Securities database (FISD) from Mergent, and find those for which the security level is listed as senior subordinated. There are 508 deals in which the target has at least one senior subordinated bond outstanding on the date of the merger, and a total of 1272 such bonds. These deals involve 430 different acquirers. We eliminate those deals in which the acquirer has no bonds maturing after the deal date,
whether issued before or after that date. This leaves 359 deals with 288 different acquirers, and targets having a total of 1032 outstanding senior subordinated bonds.

For each of the senior subordinated bonds we have identified, we want to determine if it has been retired after the merger. The FISD table Amt_Out_Hist contains a record of changes in the outstanding amount of an issue. If the issue was not retired, we may be able to explain this by the presence of covenants that would prevent an early payoff. The Redemption table in FISD provides information about the conditions under which the bond may be redeemed before maturity. It may also be the case that the acquirer is required to redeem the target's bonds once the merger is complete. Such put provisions are described in the Bondholder_Protective table.

We also obtain, from Compustat, data on the financial characteristics of the acquirer at the end of the year in which the merger occurred, and at the end of the previous year. From this data, we can see that the financial characteristics of the merged company are similar to those of the acquirer before the merger. In particular, for our sample the median change in leverage from before to after the merger is –1%. We report the median here because there are some clear outliers here than distort the mean: companies that have extremely small but non-zero total debt before the merger can have their debt multiplied hundreds of times through the acquisition. The median change in total assets is 23%, which again confirms that the acquirers are significantly larger than the targets. This also indicates that the financial characteristics of the merged firm will remain similar to those of the acquirer. Finally, the median change in long-term debt is approximately 25%.

4. RESULTS

The data do not support the hypothesis that the previously senior-only acquirers will attempt to eliminate the newly obtained junior\(^6\) debt from their capital structures. Of the 1032 junior bonds, 775 are designated as "callable", although only for 665 of them is a call date given. In 49 cases, that call date is after 2005, leaving 616 bonds that might have been paid off early. The database records 465 events for 192 bonds involved in 156 deals, in which the outstanding balance of debt from a junior bond was reduced. However, many of these debt reductions had already taken place before the merger. Only 160 of these debt reduction events, for 91 bonds acquired in 77 deals, occurred after the date of the merger, i.e. were carried out by the merged company. Thus, fewer than 9% of the acquired junior bonds are even partially paid off early by the merged firm, and in none of these cases are they fully paid off before maturity.

As mentioned above, in Chapter 2 we show that retaining senior-only status can be beneficial to the merged firm by lowering required yields on future issues. Immediate payoff of acquired junior debt would effectively carry over that status from the acquiring firm to the merged firm. Since the theory says that there would be an advantage to early payoff, there must be other explanations for our observation that these payoffs do not occur. We first consider the size of the debts. The acquired junior issues have an average size of $150 million and the acquired companies have an average of 2.85 such bonds. The outstanding issues of the acquirers at the time of the deal have an average

\(^6\) In the following, when we refer to "junior debt", we mean senior subordinated debt, since almost all bonds with a priority level below senior are in fact senior subordinated.
size of $300 million and there are an average of 15 such issues. Thus, we see that the newly acquired junior debt will constitute less than 10% of the total bond debt of the merged company. Since some of the target companies also have outstanding senior debt, this percentage is actually lower. If no new junior debt is issued, this percentage will decrease to zero as the acquired bonds mature. Thus, if the merged firm follows a senior-only issuance policy after the merger, it will (slowly) return to being a true senior-only firm over time. This is consistent with the slow return to a target capital structure reported by Welch (2004) and Leary and Roberts (2005).

In Chapter 2, we also show empirically that a firm can achieve the advantage of being a senior-only company simply by remaining that way over a period of time. No covenants in existing bond contracts are required for this purpose. Future senior bond purchasers want to know that they will not be subject to the potential conflicts in bankruptcy that would arise from the firm's issuance of junior debt. Such a commitment to senior-only issuance is rarely enforced by covenants. When junior debt is acquired rather than issued, the possibility of APR violations is still there. However, the larger the number of senior debt holders, the less incentive there is for junior debt holders to contest a bankruptcy settlement, so the small percentage of junior debt acquired that we observed above, combined with a continuing commitment to issue only senior debt in the future may be sufficient for the firm to achieve a lower cost in future senior issuance. In other words, the debt markets may continue to treat them as if they were senior-only

7 Since 52 of the acquirers have no outstanding bonds, the average number for the remaining 309 acquirers is 17.5.

companies. Next, we look at whether the issuance policies of the acquirers change after the merger.

For the 430 deals in which the target has outstanding junior bonds on the deal date, we can classify the acquirer's bonds as shown in Table 3.1. We are mainly interested in the 359 deals in which the acquirer either has outstanding bonds on the deal date or issues debt afterwards. In these deals, we can see how the firm's choice of debt seniority changes as a result of the acquisition.

Table 3.1. Acquirer's seniority of bond issues before and after a merger.

The table shows the number of deals in which the acquirer issued bonds of the various seniority types before and after the merger. The 359 deals (for 288 different acquirers) are all those with the following characteristics. The deal was completed in 1990 or later. Acquirer and target were both public companies. The acquirer owned 100% of the target after the merger. The acquirer either had outstanding public debt on the deal date or issued bonds afterwards. The target had outstanding senior subordinated ("junior") bonds on the deal date.

<table>
<thead>
<tr>
<th>After Deal</th>
<th>None</th>
<th>Senior</th>
<th>Junior</th>
<th>Both</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Deal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>28</td>
<td>14</td>
<td>8</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td>36</td>
<td>68</td>
<td>2</td>
<td>9</td>
<td>115</td>
</tr>
<tr>
<td>Junior</td>
<td>39</td>
<td>16</td>
<td>24</td>
<td>14</td>
<td>93</td>
</tr>
<tr>
<td>Both</td>
<td>35</td>
<td>31</td>
<td>1</td>
<td>34</td>
<td>101</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>143</td>
<td>41</td>
<td>65</td>
<td>359</td>
</tr>
</tbody>
</table>

Over 90% of the acquirers that had only senior bonds outstanding before the acquisition do not issue any junior debt afterwards. Thus, their seniority issuance policy is not affected by the addition of junior bonds to their capital structure from the merger. As pointed out above, the small size of the acquired junior debt may allow the debt
markets to continue to treat them as senior-only companies.\(^9\) We have also calculated the leverage for each company as long-term debt / total assets. We obtain the data from the Compustat annual files for the years before and after the merger. On average, there is no change in leverage for the companies that have issued only senior bonds before the merger.

There is less consistency in the other groups. Almost half of the companies that had no outstanding bonds at the time of the merger issue debt afterwards. This is consistent with the idea of increased debt capacity, and may also reflect the needs of the newly acquired business, which has a history of bond financing. These firms are about equally divided between those who issue some junior debt after the merger and those who issue only senior debt. As pointed out above, either one of these policies can be optimal, depending on the details of the firm's operating characteristics.\(^10\)

On the other hand, in almost one third (31%) of the entire sample, the merged company issues no new bonds after the deal is completed. These acquisitions must be financed by cash on hand, equity, and bank or other private loans. However, these companies only increase their overall leverage by an average of 3% after the merger.\(^11\)

\(^9\) The two companies that issue only junior debt after the merger each begin with only one outstanding senior bond and issue only two junior bonds afterwards. The nine companies that issue at both levels after the merger issue an average of 3.5 times as many senior bonds as junior bonds. Thus, the group of senior bond holders remains much stronger than the juniors.

\(^10\) In Propositions 4 and 5 of Chapter 2, we show that when the costs of conflict in bankruptcy are sufficiently high, it is optimal to issue debt at only one seniority level (junior or senior), but that when those costs are low, it is optimal to issue debt at both levels.

\(^11\) There are 93 acquirers that had only junior debt before the merger. 42% of these issue no more bonds after the merger. Of the others, the new issues are about equally divided between junior and senior. The leverage of these firms increases by 24% on average.
For a more detailed look at the changes in issuing policy after a merger, we run a multinomial logit regression for an independent variable with four values representing the four types of bond issuance behavior after a merger: (1) senior only, (2) junior only, (3) both, (4) none. The independent variables are dummies for the issuance seniority policy before the merger: senior only, junior only, or both. The results are shown in Table 3.2. The seniority policy before the merger is highly significant in determining the policy after the merger.

Table 3.2. Multinomial Logit Regression for Seniority of Issuance after Merger.

The table shows the Maximum Likelihood Analysis of Variance for a multinomial logit regression where the dependent variable represents the bond issuance seniority policy after a merger with four categories: senior only, junior only, both, and none. The independent variables are dummies for the issuance policy before the merger. Sbef = 1 for senior only before the merger and 0 otherwise. Jbef = 1 for junior only before the merger and 0 otherwise. Bbef = 1 for both senior and junior before the merger and 0 otherwise. All are significant at the .1% level.

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Chi-Square</th>
<th>Pr &gt; ChiSq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3</td>
<td>20.25</td>
<td>0.0002 ***</td>
</tr>
<tr>
<td>Sbef</td>
<td>3</td>
<td>19.56</td>
<td>0.0002 ***</td>
</tr>
<tr>
<td>Jbef</td>
<td>3</td>
<td>17.51</td>
<td>0.0006 ***</td>
</tr>
<tr>
<td>Bbef</td>
<td>3</td>
<td>18.44</td>
<td>0.0004 ***</td>
</tr>
</tbody>
</table>

In Table 3.3, we show the results of the same type of regression, with independent variables added for the financial characteristics of the issuer. The premerger issuance policies are still highly significant. The only financial characteristic that is highly significant is the leverage, as measured by the ratio of total debt to total assets.
Table 3.3. Multinomial Logit Regression for Seniority of Issuance after Merger.

The table shows the Maximum Likelihood Analysis of Variance for a multinomial logit regression where the dependent variable represents the bond issuance seniority policy after a merger with four categories: senior only, junior only, both, and none. The independent variables are financial characteristics of the issuer and dummies for the issuance policy before the merger. Financial variables are obtained from Compustat for the end of the year in which the merger occurred. PE is the price/earnings ratio. PB is the price/book ratio. Size is market capitalization. ROA is return on assets. ROE is return on equity. D_A is the debt to assets ratio. OI_A is operating income / total assets. CapExp_A is capital expenditures / assets. IntCov is interest coverage. Sbef = 1 for senior only before the merger and 0 otherwise. Jbef = 1 for junior only before the merger and 0 otherwise. Bbef = 1 for both senior and junior before the merger and 0 otherwise.

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Chi-Square</th>
<th>Pr &gt; ChiSq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3</td>
<td>13.22</td>
<td>0.0042 ***</td>
</tr>
<tr>
<td>PE</td>
<td>3</td>
<td>1.79</td>
<td>0.617</td>
</tr>
<tr>
<td>PB</td>
<td>3</td>
<td>7.42</td>
<td>0.0597 *</td>
</tr>
<tr>
<td>Size</td>
<td>3</td>
<td>0.36</td>
<td>0.9493</td>
</tr>
<tr>
<td>ROA</td>
<td>3</td>
<td>1.41</td>
<td>0.7026</td>
</tr>
<tr>
<td>ROE</td>
<td>3</td>
<td>4.4</td>
<td>0.2215</td>
</tr>
<tr>
<td>D_A</td>
<td>3</td>
<td>12.65</td>
<td>0.0055 ***</td>
</tr>
<tr>
<td>OI_A</td>
<td>3</td>
<td>2.28</td>
<td>0.5156</td>
</tr>
<tr>
<td>CapExp_A</td>
<td>3</td>
<td>2.61</td>
<td>0.4559</td>
</tr>
<tr>
<td>IntCov</td>
<td>3</td>
<td>2.93</td>
<td>0.4021</td>
</tr>
<tr>
<td>Sbef</td>
<td>3</td>
<td>15.43</td>
<td>0.0015 ***</td>
</tr>
<tr>
<td>Jbef</td>
<td>3</td>
<td>11.76</td>
<td>0.0083 ***</td>
</tr>
<tr>
<td>Bbef</td>
<td>3</td>
<td>12.29</td>
<td>0.0065 ***</td>
</tr>
</tbody>
</table>

We ran additional regressions (not reported) in which we used one categorical independent variable with four values for the premerger issuance seniority, analogous to the dependent variable. The results were similar.
In all cases, it is clear that the primary predictor of a firm's bond issuance seniority policy after a merger is its policy before the merger. There is no short-term attempt to compensate for changes in the seniority structure resulting from the acquisition of outstanding bonds of the target company. This result is consistent with the empirical observations of capital structure reported by Leary and Roberts (2005), Welch (2004), and others that companies do not rapidly try to compensate for changes in their leverage resulting from changes in equity prices. Leary and Roberts' explanation of slow change in capital structure as resulting from transaction costs may also be at work here. Our results are also consistent with Chapter 2, where we show that there may be advantages to maintaining a consistent seniority policy over time.

5. CONCLUSION

We have tried to determine if the acquisition of a target firm that has junior debt will affect the issuance strategy of the acquiring firm. Firms that have a policy of issuing only senior debt have an incentive to continue that policy, since they generally pay lower yields on new senior debt issues. We find no evidence that these companies attempt to dispose of their newly acquired junior debt before maturity, even though the majority of these bonds are callable. However, these acquirers do usually continue to issue only senior debt. Because the junior debt acquired is only a very small fraction of the merged capital structure, the market may act as if the acquiring firm is still a "senior-only" firm. The small amount of junior debt means that the junior creditors will be weak in bankruptcy negotiations, and so will not have an incentive to contest a settlement. We also find that senior-only companies do not significantly change their leverage after acquiring a company with outstanding junior bonds. Since companies with junior debt
are generally much smaller than those with senior debt, we conclude that these mergers
do not have a significant effect on the capital structures of the acquirers.
REFERENCES


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