TWO ESSAYS ON THE CORPORATE BOND MARKET

by
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ABSTRACT

This dissertation consists of two papers. The first paper examines the propagation of firm-specific shocks as well as market-wide shocks between 1995-2003 using Treasury and corporate bond market data. It then tests the implications of previously proposed models of contagion. I find little support for the industry and counterparty structure hypothesis, suggesting that fundamentals do not generate contagion. Consistent with the information transmission, rebalancing, and liquidity-shock hypotheses, I find evidence of flight to quality during the event periods. However, in contrast to the prediction of the liquidity-shock channel, the corporate bond market, on average, seems to be more liquid during event periods (evidenced by higher trading volume, trading frequency, and mean bond age). Furthermore, there are no significant changes in the trading of assets with the low transaction costs, which is contrary to the rebalancing theory. These findings are more in favor of the correlated information channel as a means of inducing contagion.

The second paper examines the effect of liquidity on corporate bond prices using the newly formed TRACE data set. In the spirit of Acharya and Pedersen's (2005) liquidity-adjusted capital asset pricing model (LCAPM), I

examine the impact of multiple sources of risk on corporate bond prices. The results do not lend strong support for the existence of liquidity risk in the corporate bond market or for the LCAPM, especially when liquidity is captured using the trading frequency, trading volume, and turnover. Contrary to the predictions of the LCAPM, more illiquid portfolios do not have higher values for the three liquidity betas; betas that capture the commonality in liquidity with the market, the sensitivity in returns with the market-wide liquidity, and the liquidity sensitivity with the market returns. Furthermore, after running cross-sectional regressions I do not find strong evidence either for the validity of the model or that liquidity risk does matter for the corporate bond prices.

CHAPTER 1

CONTAGION: EVIDENCE FROM THE BOND MARKET

1.1. Introduction

During the 1990s there were a number of financial crises that spread rapidly across the globe, that led to serious concerns about the stability of financial markets. For example, the Mexican peso collapse of 1994 (tequila crisis) propagated to other Latin American markets resulting in increases in both volatility and the comovement of their financial markets. The Thai crisis of 1997 (Asian flu) initially affected the Asian Tigers, and then propagated to other developing regions of the world. The Russian default in the summer of 1998 (Russian virus) and the subsequent collapse of LTCM, resulted in massive losses to numerous financial intermediaries as prices moved against their positions. Furthermore, there was a substantial drop in market liquidity across several unrelated markets, and a movement of investors towards safer and more liquid assets (flight to quality and liquidity). This turmoil in financial markets prompted a coordinated research effort by the central banks of developed nations and the Bank of

International Settlements to understand the determinants of market liquidity, and to design preventive policies for the future.[1]

In recent years, there were also a number of domestic shocks that rippled through the markets, causing falling prices, widening spreads, and flight to quality trades. These shocks were market-wide, such as the burst of the internet bubble and the September 11th terrorist attacks, or company-specific (collapses of firms such as WorldCom, Conseco, Enron, and United Airlines). According to Moody's Default Studies,[2] in 2002 36 issuers with individual debt obligations of at least $1 billion defaulted worldwide. The average real size of default was $1.7 billion, four times the 1983-2001 average. Roughly 34% of the total dollar volume came from firms that held investment-grade status within a year of default. Furthermore, years 2001 and 2002 yielded the highest percentage of issuer downgrades.[3] A most recent example of such an event is the downgrade of General Motors and Ford Motor Cos. to ‘junk’ status. Their troubles had a broad impact on the corporate bond market, widening spreads, and pushing down the yield on Treasury securities. As Steve Rodosky mentions: ‘It's obviously a flight to

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[1]For more details, see the reports by the Bank of International Settlements (1999).
[2]Default & recovery rates of corporate bond issuers: 1920 - 2003, Moody's Investors Service, February 2003.
[3]The percentage of fallen angels was at 5.2% in 2002, up from just over 2% in 2001.

quality trade that we are seeing.'[4] Furthermore, questions remain as to the reasons why we observe these episodes. Tony Crescenzi points out: 'The question here is: Is GM a company-specific problem or a market problem?'[5]

The empirical literature on financial market spillovers and contagion has mainly focused on examining the effects on stock market returns.[6] The emphasis of these papers centers on whether contagion does indeed exist in the markets, and how it should be measured.[7] However, the literature does not address sufficiently the reasons for the propagation of these shocks.[8] Although a number of theories have been used to explain these episodes (transmission due to economic fundamentals, information transmission,

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[4]Senior vice-president at Pimco, a California fund group, The Wall Street Journal, Thursday, March 17, 2005.
[5]Chief bond-market strategist at Miller Tabak & Co., The Wall Street Journal, Thursday, March 17, 2005.
[6]Although it is difficult to list here the extensive empirical body of work on equity market contagion, see Hamao, Masulis, and Ng (1990), King and Wadhwani (1990), Lin, Engle, and Ito (1994), Forbes and Rigobon (2001, 2002), Connolly and Wang (2003), Bae, Karolyi, and Stulz (2003), Bekaert, Harvey, and Ng (2003), Kallberg and Pasquariello (2004), Hegde and Paliwal (2005), and Phylaktis and Xia (2005) for some related papers. See Das (2003) for a recent, short survey on contagion.
[7]There is no consensus in the literature for the exact definition of contagion. The definition that is used in this paper is the propagation of a financial shock from one asset or market to other assets or markets. For a discussion of alternate definitions see the web site *http://www.worldbank.org/economicpolicy/managing%20volatility/contagion/definitions.html.*
[8]Exceptions are recent papers by Kallberg and Pasquariello (2004) and Hegde and Paliwal (2005). The first study examines the excess comovement of industry indexes in the U.S. stock market, while the second examines the interaction of financial contagion and market liquidity during the Asian crisis.

rebalancing theories, liquidity shocks due to wealth/borrowing constraints or margin calls), no propagation mechanism has yet emerged as the dominant channel empirically.[9] Furthermore, most of these models were designed to address stylized facts from the international and domestic equity markets. This ex-post approach is vulnerable to the following critique – that maybe they can only explain that specific event. Important, unanswered questions include: What are the dominant channels of propagation of a shock during a time of crisis? Can these models be applied to explain the propagation of other types of shocks, or applied to other types of financial markets? This paper addresses these issues by bringing a new dataset (U.S. Treasury and corporate bonds) and examining the propagation of market-wide (stock market downturns) and firm-specific shocks (major defaults and credit rating downgrades to `junk' status) between 1995-2003, testing the implications of

[9]Although not part of the existing theoretical contagion literature, Barberis and Shleifer (2003) develop a model of 'style investing' that can generate contagious effects. This refers to a pattern of investment where investors group assets into categories (such as small-cap stocks, large-cap stocks, growth stocks, value stocks, industry stocks, country stocks, junk bonds, or bonds of the same rating and maturity) and then distribute funds among these categories rather than among individual securities. A negative asset-specific shock into one of the styles, will induce investors to withdraw money from that style, and invest in some other style, creating contagion. Dimson and Nagel (2002) and Barberis et al. (2005) offer empirical support of the existence of this trading behavior. Masson (1998) offers also another potential explanation of contagion based on irrational herding behavior.

the above-mentioned models of contagion.[10] To achieve this, I observe several trends and market characteristics during the event periods that are of ever-increasing importance to policy regulators, such as the flight to quality and liquidity as well as the levels of market liquidity.[11] The time span and type of shocks that I am examining covers most of the major international and domestic shocks of recent years. Information on the corporate bond market is obtained using a large panel data set that comes from the Fixed Investment Securities Database (FISD) and National Association of Insurance Commissioners (NAIC) transactions data.

The use of bond data has some extra advantages and provides a natural setting to test theories of contagion. For example, some of the models that I examine deal with firm-specific events that are directly related to the bond market. Thus, given these types of shocks, corporate debt offers a natural setting for examining their propagation. Furthermore, using

[10]To my knowledge, there are only a few papers that looked at contagion within the bond market. Eichengreen, Hale, and Mody (2001) examine how the financial crises of the 1990s affected the price, volume, and maturity of bonds issued by emerging market governments. Gande and Parsley (2005) investigate the spillover effects of a sovereign credit rating change of one country on the sovereign credit spreads of other countries. Collin-Dufresne, Goldstein, and Helwege (2004) develop and test an information-based model to capture contagion within the U.S. bond market. Halstead, Hegde, and Klein (2004) examine the spillover effects from the Orange County bankruptcy.

[11]See Gulko (2002), Longstaff (2004), Scruggs and Glabadanidis (2003), Underwood (2004), Connolly, Stivers, and Sun (2004), Vayanos (2004), and Collin-Dufresne, Goldstein, and Helwege (2004) for some related papers on flight to quality and liquidity.

corporate bond data seems to be more appropriate in testing the liquidity-shock model and examining the impact of liquidity, as it is substantially less liquid than the equity or Treasury markets.

The key findings can be summarized as follows: First, examination of shocks on industry rivals, even after controlling for the industry concentration, shows only a slight widening of their yield spreads, suggesting fundamentals do not generate contagion. Second, there is evidence of flight to quality during event weeks, consistent with the information transmission, rebalancing, and liquidity shock theories. Specifically, the two-year Treasury bill rate typically decreases 4bp while corporate spreads go up 3bp and 21bp for the investment-grade and high-yield market, respectively. Third, contrary to the predictions of the liquidity-shock theory, the corporate bond market is actually more liquid during event periods. This is shown by a higher level of trading volume, frequency, and mean bond age during event periods, compared to non-event periods. Furthermore, there are no significant changes in the trading of the assets with the low transaction costs, which is contrary to the rebalancing theory. The higher level of trading volume and frequency is consistent with the information transmission theory of contagion. It can be the outcome of dispersion or update of beliefs of market participants.

The remainder of the paper is organized as follows. Section 1.2 discusses the relevant literature, both theoretical and empirical, and presents the hypotheses. Section 1.3 describes the data sources and sample of events. Section 1.4 discusses the framework used for analyzing the spillover effects. Section 1.5 concludes.

1.2. Related Literature and Hypotheses

1.2.1. Contagion due to Economic Fundamentals

This channel of propagation posits that contagion can be the outcome of economic fundamentals between firms or markets. For example, Lang and Stulz (1992) and Jarrow and Yu (2001) predict that a firm-specific shock can have a negative impact on the firm's suppliers and customers, while the effect on the rival firms depends on the level of concentration within the particular industry. More specifically, a firm-specific shock in less concentrated industries can have a negative impact on rival firms because it reveals negative information about the components of cash flows that are common to all firms in the industry, the contagion effect. However, in more concentrated industries, these firm-specific events can have a positive impact on rival firms because of redistribution of wealth from the distressed firm to its competitors, the competitive effect. For suppliers and customers, these events will probably have a negative effect, especially in cases of strong ties to the distressed firm. Empirical evidence on the rivals' stock price supports the above predictions [Lang and Stulz (1992)]. Furthermore, there is empirical support for the above predictions in the credit default swap market [Jorion and Zhang (2005)]. To test this channel, I use the following hypothesis:

(H1) For less (more) concentrated industries there is a widening (narrowing) of the yield spread of rival firms following firm-specific events.

1.2.2. Correlated Information Channel

The central result of the correlated information channel is that at times of higher volatility of systematic information, contagion effects are more pronounced. For example, King and Wadhwani (1990) present a model where price changes in one asset can be transmitted to other assets because of information asymmetries. Investors have imperfect information and cannot distinguish an idiosyncratic from a systematic shock. In their model, the higher the proportion of systematic volatility compared to idiosyncratic volatility, the more pronounced the effect on price changes. Pasquariello (2004) proposes a model where heterogeneity of information among informed investors may be the reason for financial contagion. In the same spirit, Kallberg and Pasquariello (2004) show that information heterogeneity (proxied by the dispersion of analysts' earnings forecasts) explains a significant portion of the excess comovement among U.S. stock industry indexes. The information channel as a means in explaining contagion has also been used by Collin-Dufresne, Goldstein, and Helwege (2004). They propose a model where contagion within the bond market propagates through a Bayesian updating of beliefs. They also empirically show that credit events, captured by a jump of 200 basis points of an individual firm, lead to market-wide increases in credit spreads.

To test the correlated information channel empirically, I am utilizing trading volume and frequency in the corporate bond market to capture the information transmission. Trading volume refers to the actual amount transacted, while trading frequency refers to the number of transactions. Abnormal trading volume has been associated in the past with dispersion of beliefs, or lack of consensus, among traders [Beaver (1968)]. In this framework, trading is a result of disagreement, or differential information, among market participants [He and Wang (1995), Kim and Verrecchia (1997). For example, prior empirical studies in the finance and accounting literature have shown that the informational role of trading increases following macroeconomic announcements [Fleming and Remolona (1997, 1999), Balduzzi, Elton, and Green (2001), Green (2004)], or surrounding earnings announcements [Morse (1981), Bamber (1986), Ziebart (1990), and

Kim and Verrecchia (1994)], raising the level of information asymmetry among market participants. Information asymmetry in this context can refer to the fact that agents in the market have differential information, or that informed investors have firm-specific, private information regarding certain announcements or events that is not shared by uninformed investors.[12] Consistent with this channel, Hegde and Paliwal (2005) find evidence of substantial increases in stock trading volume during the East Asian crisis. Using these variables, I test the following hypothesis:

(H2) Event periods are associated with higher levels of trading volume (actual amount transacted) and trading frequency (number of transactions) in the market.

1.2.3. Rebalancing Channel

The main theme of the rebalancing models is that contagion can be the outcome of the rebalancing activities of risk-averse agents. For example, Kodres and Pritsker (2002) in their analysis of the East Asian crisis of 1997, argue that when market participants experience a shock in one market, they can transmit this shock to other markets in the process of optimally

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[12]See Jain (1988), Jones, Kaul, and Lipson (1994a, 1994b), and Chae(2005) for some other related papers on trading volume.

rebalancing their portfolios.[13] In the same spirit, Fleming et al. (1998) propose a model where cross-market hedging can create information spillovers and volatility linkages between two markets. The intuition here is that for a trader who invests in both the stock and bond markets, an information event that changes her expectation for the stock market, can also change her demand for bonds (creating trading and volatility in both markets), due to the act of rebalancing her portfolio. An implication of the cross-market rebalancing models is that when it is costly to rebalance (because of high transaction fees, bid-ask spreads) the effects of contagion are less pronounced.

To test the rebalancing models, I require a variable to measure the bid-ask spreads of the Treasury and corporate bond market. Therefore, I calculate transaction costs of the corporate bond market using an approach similar to Chakravarty and Sarkar (2003) and Hong and Warga (2000). I use this variable to test the following hypothesis:

(H3) Contagion is the outcome of higher level of trading on issues with lower transaction costs (bid-ask spreads).

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[13]This model is used to explain why the East Asian crisis propagated to Latin American countries. The authors argue that neither the correlated information or correlated liquidity shock channel can help to explain this cross-sectional pattern of contagion.

1.2.4. Correlated liquidity shock channel

The central point of the correlated liquidity shock channel is that subsequent to an initial shock, we should observe decreased liquidity in several markets. The decreased liquidity can be due to margin calls [Calvo (1999)], borrowing constraints [Yuan (2005)], or wealth constraints [Kyle and Xiong (2001)]. The intuition here is that because of the above constraints, an economic shock might force traders to sell-off fundamentally unrelated assets (especially the more liquid ones), thus creating a financial liquidity crisis. Consistent with this channel, Hegde and Paliwal (2005) find evidence of declines in market liquidity during the East Asian crisis, especially for stocks that were more liquid (or less risky) prior to the crisis. Vayanos (2004) presents a related model that captures the flight to quality and liquidity during periods of uncertainty. Empirical evidence shows that liquidity premia seem to vary substantially over time and the variation depends strongly on the extent of uncertainty in the market [Amihud and Mendelson (1991a), Kamara (1994), Longstaff (2004), De Jong and Driessen (2005)]. This model predicts that at times of uncertainty, risk premia as well as liquidity premia increase.

To empirically test this channel, I construct various liquidity measures for the corporate bond market. As it is often noted, liquidity is an elusive concept that has various dimensions: tightness, depth, and resiliency. It is hard to define, let alone capture.[14] For this reason, it is imperative to examine different measures. Measures based on daily returns [Lesmond et al. (1999), Amihud (2002), Pastor and Stambaugh (2003), Chen, Lesmond, and Wei (2005)], are difficult to construct in the corporate bond market, given the lack of availability of high frequency transactions. Due to the above limitations, the market-wide proxies of corporate bond liquidity that I am utilizing in this study are: (1) effective bid-ask spreads, (2) trading volume, (3) trading frequency, and (4) bond age.

Higher bid-ask spreads is a sign of a less liquid market. Several researchers have used in the past this measure, both for the equity and debt market, as well as for asset-specific liquidity (or illiquidity) and market-wide liquidity [Amihud and Mendelson (1986, 1989), Sarig and Warga (1989), Chordia, Roll, and Subrahmanyam (2000, 2001), Hasbrouck and Seppi (2001), Chordia, Sarkar, and Subrahmanyam (2005), and Longstaff, Mithal,

[14]A traditional way that has been used to describe liquidity is the ability to trade large quantities, with low transaction costs, and without making a great impact on the market price.

and Neis (2005) are some representative papers]. I also employ trading volume and frequency as proxies of liquidity (naturally, they are highly correlated), which are predicted to fall (in contrast to the information model). These are also traditional measures that have been used in the past in the liquidity literature [Brennan and Subrahmanyam (1996), Brennan et al. (1998), Elton and Green (1998), Chordia, Subrahmanyam, and Anshuman (2001), Delianedis and Geske (2001), Fleming (2003), and Piqueira (2004)].

Another proxy for market-wide liquidity that I employ is the mean bond age (market-wide average of the difference between the issue date and the trade date, in years). Bond age has been used in the literature as an individual-illiquidity proxy [Sarig and Warga (1989), Longstaff, Mithal, and Neis (2005), and Ericsson and Renault (2006)]. This variable is inversely related to the level of individual-bond liquidity. The intuition is that over time, the bonds enter into investors' portfolios, become inactive, and thus illiquid. However, if you take bond age as a market-wide measure of liquidity, this should be positively related to the level of market-wide liquidity. At times of poor liquidity, we would expect the mean bond age to drop since investors will be more inclined to hold younger (on-the-run) bonds which are considered more liquid.[15]

To test the above channel, I also utilize data on Treasury market liquidity. The measures that I am employing are quoted bid-ask spreads, on-the-run/off-the-run yield spreads, as well as price impact coefficients. Using all of the above variables, I test the following hypotheses:

(H4a) At a time of shock, the corporate bond market becomes less liquid (as approximated by higher effective bid-ask spreads, lower trading volume and frequency, and lower mean bond age).

(H4b) At a time of shock, the Treasury bond market becomes less liquid (as approximated by higher quoted bid-ask spreads, higher on-the-run/off-the-run yield spreads, and higher price-impact coefficients).

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[15]Chakravarty and Sarkar (2003), in their study of trading costs in the Treasury, municipal, and corporate bond markets, show that the mean bond age is highest in the Treasury market. This is an indication that investors are holding or trading off-the-run bonds in the Treasury market (compared to the municipal or corporate bond markets), since this is the most liquid of the three.

1.3. Data Sources and Events

1.3.1. Data Sources

The primary database is a large panel data set from the Fixed Investment Securities Database (FISD) and the National Association of Insurance Commissioners (NAIC).[16] The FISD database consists of issue- and issuer-specific variables on all U.S. corporate bonds maturing in 1990 or later. The NAIC database consists of detailed information (such as issue and issuer cusip, trade date, dealer information, price, size of trade, type of institution, and type of transaction) on all transactions by life insurance companies, property and casualty insurance companies, and Health Maintenance Organizations (HMOs) from 1995 until 2003. An advantage of using this database compared to other sources of bond data, is the availability of actual transaction quotes rather than algorithmically determined 'matrix' prices.[17]

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[16] This is the same database that was used by Campbell and Taksler (2003), Bessembinder, Maxwell, and Venkataraman (2005), Krishnan, Ritchken, and Thomson (2005), and Cai, Helwege, and Warga (2005).

[17] In July 1, 2002, the National Association of Securities Dealers (NASD) began a program known as the Trade Reporting and Compliance Engine (TRACE) system, in an effort to increase transparency in the corporate bond market. NASD members are required to report the relevant information on all secondary market transactions, within a relatively short period of time (currently at 15 minutes). This system now almost includes the complete corporate bond market. The main reason however that I cannot use this database for my study is the fact that it does not include historical information, and my

Insurance companies hold about 30% of all outstanding corporate bonds (according to the Flow of Funds published by the Federal Reserve). A natural question to ask here is whether the findings from this study can be generalized, since insurance companies hold a portion of the market. Furthermore, they are considered more conservative (or buy and hold) compared to other bond investors, such as hedge funds or pension funds. Chakravarty and Sarkar (2003) indirectly address this issue in their study of trading costs in several bond markets. They compare the trade size (daily volume) of Treasury bond transactions from insurance companies, with transactions from GovPX, a database of Treasury bond transactions that includes most of the major interdealer brokers, to examine if there are significant differences. They find similar levels of trade size for comparable bonds for both data sets.

For every bond in the sample, I first calculate the yield to maturity. I then compute the corporate bond spread which is defined as the difference between the bond's yield to maturity and the interpolated yield to maturity of the benchmark U.S. Treasury. For the benchmark Treasuries, I use linear

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aim is to capture specific financial shocks that happened in the late 1990s' and early 2000s'.

interpolation to obtain estimates of the yield curve from the Federal Reserve's Constant Maturity Treasury (CMT) daily series. After placing a number of restrictions on the type of bonds and eliminating suspicious transactions, I am left with 455,167 observations. Appendix A has a detailed list of the procedure that I used. About 60% of these are buy transactions, and the rest are sells. In order to get a better sense of the number of observations as well as levels of yields and spreads, I group the bonds by year, credit rating, type of market (high-yield or investment-grade), industry (industrial, financial, and utility), and maturity.[18]

Table 1.1 indicates the number of transactions, issues, and issuers, by year, credit rating, industry, and maturity. Panel A shows that the bulk of the observations (54%) are between 2001-2003, while the number of issues and issuers traded peak up in 2001 and 2003 respectively. Across credit ratings, the bulk of the observations are on bonds with an A and BBB credit rating. 82% of the observations fall under the investment-grade market, and the rest under the high-yield market. Across industries, the bulk of the observations, issues, and issuers are in the industrial sector, while the utility sector has the

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[18]FISD provides credit ratings by four agencies (S&P, Moody's, Fitch, and Duff and Phelps). I use the S&P ratings.

least. Across maturity the bulk of the observations fall under the short- and medium-term. A very small percentage of the transactions, are on bonds with more than 30 years remaining to maturity. Table 1.2 shows the average corporate bond yields (in percentages) and spreads (in basis points), broken down by year, for all credit ratings as well as for all industry sectors. For the aggregate market, yields have been the highest in 2000 and the lowest in 2003. In terms of spreads, they peaked in 2002, while the lowest level was in 1997. In terms of industry sectors, industrials have the highest yields and spreads, followed by the utility and financial sectors respectively.

A sample of data on Treasury market liquidity is also available, that was constructed using GovPX data.[19] The sample on bid-ask spreads covers the period January 3, 1997, to September 27, 2002, for price impact coefficients from January 3, 1997, to April 28, 2000, and for on-the-run/off-the-run yield spreads from January 3, 1997, to December 29, 2000. The frequency of this data set is at the weekly level.

[19]I thank Michael Fleming for allowing me to use this dataset.

1.3.2. Events

The Bankruptcy Datasource Index, which is available from the Lexis-Nexis Academic Universe, together with the Default Reports from Moody's are used to obtain a list of defaults of U.S. companies between 1995-2003. The list of defaults includes Chapter 11 filings, missed interest payments and principals, as well as distressed exchanges.[20] Various sources such as the Wall Street Journal, Business and Industry, and Bloomberg are used to identify the exact default date.[21] I start with a total of 1,184 default events, and after merging with Compustat using the company name and ensuring that I have total assets information two years prior to default, I am left with 745 events. I then put a size restriction of at least two billion in total assets that leaves me with 63 events.[22] As a robustness check, I also utilize a total

[20]Lexis-Nexis includes all the bankruptcies of US firms with more than 50 million in assets. Moody's Default Reports contains all the defaults among Moody's-rated long-term debt issuers.

[21]For Chapter 11 filings, the default date is defined in the following way: If there is a missed interest payment or principal prior to the filing date, then this is the default date. If not, then using sources such as the Wall Street Journal and Business and Industry, I look for articles stating that management is warning of a possible bankruptcy filing. For the events that I cannot identify the default in such a manner, I use the actual filing date.

[22]I focus on large bankruptcies since I want to capture events that can have an industry- and market-wide effect. For the same reasons, Lang and Stulz (1992) focus on bankrupt firms with liabilities in excess of 120 million. Furthermore, Collin-Dufresne, Golstein, and Helwege (2004) and Jorion and Zhang (2005) show that credit events due to larger firms have more profound effects either within the industry or to the whole market.

liability criterion of at least two billion as a measure of size. The number of events is slightly smaller.

The FISD database is used to obtain rating downgrades into 'junk' status. I start with a sample of 1,581 issuer downgrades (either by S&P or Moody's, whichever happens first in a given year). These downgrades could be one-notch or more. After merging with Compustat using both cusip and company name and ensuring that I have total assets information two years prior to the downgrade, I am left with 875 events. Using then a size restriction of at least ten billion in total assets, I am left with 50 events.[23] Again for robustness purposes, I use a total liabilities criterion of at least ten billion. The number of events is slightly smaller. A critical question that arises here is whether the main results of this paper hold with different size criterions. To address this issue, I rerun some of the tests with larger size restrictions (at least three billion and fifteen billion in total assets for default

[23]The FISD database also contains information on dates when issues are placed on negative watch. This date would have been preferable to the actual downgrade date. However, for my final sample of 50 events I did not have such a date, possibly because rating agencies are sometimes too slow to place a firm on negative watch and are thus forced to downgrade the firm (without prior placement on negative watch).

events and credit rating downgrades, respectively). These restrictions reduce the number of events to 101. The main results become stronger and more significant.

For the stock market downturn events, I observe the time-series returns of S&P 500 for the period of my analysis to identify the dates of the downturns. I define a stock market downturn as a day that the S&P 500 stock index loses 3% or more of its value. I then check the reason for the downturn using Lexis-Nexis. The use of 3% or more stock index loss ensures that my events capture the 1997 East Asian crisis, the Russian default of 1998 and the subsequent collapse of LTCM, the burst of the internet bubble of 2000, as well as all the accounting scandals of recent years. There were 23 stock market downturn events between January 1, 1995 and December 31, 2003.

Table 1.3 is a sample of all three type of events. It includes the ten largest defaults of my sample. It also includes the ten largest downgrades, and the list of all 23 stock market downturns together with the cause of the downturn. Figure 1.1 provides a graphical representation of the frequency of events per year (broken down into credit rating downgrades, defaults, and stock market downturns). In total, the number of events is 136 (63 bankruptcies, 50 credit rating downgrades, and 23 stock market downturns). Not surprisingly, the graph indicates that most of the events occur in years 2001 and 2002, given the large number of defaults and downgrades in these years.

1.4. Empirical Tests

1.4.1. Effects due to Economic Fundamentals

To examine this channel of propagation, I look at the effects on industry rivals following company-specific events. I first construct equally-weighted industry portfolios. Because high frequency data is not available in the bond market, I choose to utilize the Fama-French 48 industry sectors (instead of industries based on two-digit or four-digit sic code).[24] Firms in the portfolio satisfy the following characteristics: (1) They have the same Fama-French industry code as the 'event' firm, and (2) they are available in the FISD-NAIC database.

The methodology that I utilize is an event-study approach, similar to Warga and Welch (1993) and Jorion and Zhang (2005). The measures that I am employing are CCY/S and CCAY/S. CCY/S refers to the cumulated change in raw yields/spreads between a pre- and post-event window, the unadjusted measure, whereas CCAY/S refers to the cumulated change in adjusted yields/spreads, the risk-adjusted measure. The adjustment here is calculated by subtracting from the raw yield/spread level the yield/spread of an equivalent benchmark index. Appendix B explains in detail the

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[24]The information for these industry sectors can be obtained from Ken French's website, at *http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.*

construction of the two measures. Unlike the usual event studies with stock data, I observe changes between small windows instead of daily changes. The pre-event window covers one-week period from days -7 to -2 prior to the event date, and the post-event window from days -1 to +4.

My original sample includes 113 events, where 63 are defaults and 50 are credit rating downgrades. Because of the documented clustering of defaults or similar occurrences that can dilute the impact of previous events, I only keep the first event in any industry and month. After merging the event file with the actual transaction file and matching issues between the pre- and post-event window, I am left with 76 events (41 defaults, and 35 credit rating downgrades) that cover 21 Fama-French industry sectors. The industry with the highest number of events is telecom, with 14 events, followed by utilities, with 12 events. Panel A of table 1.4 reports the mean (in basis points), t-statistics, as well as the percentage of positive observations of the two measures using the event windows described above. As described in Appendix B, the analysis is conducted using two different approaches: first, bonds of the same company are aggregated to one bond/firm, and second, every bond is used as an independent observation. In all cases, the results are insignificant. Examining also the number of positive observations, on average, half of the events produce widening of the spreads of rival portfolios, whereas the rest result in narrowing of the spreads. A plausible reason for these results is because I did not adjust for the degree of competition in the industries. As Lang and Stulz (1992) point out, a bankruptcy or some form of distress announcement does not necessarily need to convey bad news for industry competitors. More concentrated industries can experience redistribution of wealth from the bankrupt firm to the rivals, the competitive effect, having a positive impact on competitors' bonds and narrowing their spreads. Adjusting for the degree of competition can potentially explain these results.

Based on the above observations, I calculate a Herfindahl index to capture the industry concentration.[25] Each year, industries are classified as 'low' or 'high' concentration using the median of this index for that year. Industries that have a value lower than the median are considered less concentrated, whereas the ones with a higher value are considered more concentrated. Panels B and C of table 1.4 report the mean (in basis points) and relevant t-statistics of the two measures using both approaches (one bond/firm and all bonds). Out of the 76 events, 57 belong to an industry with a Herfindahl

[25] I construct this index for each year using all 48 Fama-French industries. I use net sales from Compustat annual tapes.

ratio below the median for the year prior to the event, while 19 are above. Again, in all cases the results are insignificant, suggesting that fundamentals might not be the driving force behind contagion.[26] This finding is not surprising, given the fact that the majority of the studies that have examined contagion in equity markets, after controlling for economic fundamentals, still find significant excess correlation between different assets or markets. Furthermore, informed investors that feel that bonds of rival firms are actually underpriced and are trading at low prices, might actually be buying these bonds, raising their prices and lowering yields. If that's the case, then it is not surprising that there is no significant effect on the bonds of rival firms.

Anecdotal evidence supports this scenario. For example, during the woes of the telecom industry in the first half of year 2002, Bill Gross, director at Pimco and probably the biggest player in the bond market, was buying billions of dollars of bonds of companies such as Sprint, AT&T Wireless, Deutsche Telecom, and France Telecom. At that point in time, Pimco owned $4 billion of Sprint's bonds (more than 17% of the company's outstanding debt) and $2 billion of AT&T's bonds (almost 6% of the company's debt).[27]

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[26]The same procedure is done using the lowest quartile to divide the industries into the two subgroups. The results are similar.

[27]'Why the bond king loves the unloved', The Wall Street Journal, May 31, 2002.

1.4.2. Information, Rebalancing, and Liquidity Hypotheses

1.4.2.1. Flight to Quality and Liquidity

One of the implications of contagion is the flight to quality and liquidity episodes. These episodes can be the outcome of information transmission, liquidity shocks that increases the desire of investors to hold more liquid assets, or due to rebalancing activities of risk-averse agents. For example, Colin-Dufresne, Goldstein and Helwege (2004), in their examination of firm-specific jump events of 200 basis points, find that there is a market-wide response following these occurrences and a movement of investors towards Treasury securities. Longstaff (2004) shows that at times of uncertainty there is a flight to liquidity. This is measured using the yield spread between the securities of Refcorp, a U.S. government agency, and Treasury securities. The additional yield on Refcorp issues, is considered to be the reward of investors for holding these less liquid bonds. Fleming et al. (1998) present a model where cross-market hedging can create volatility linkages between the stock and the bond market.

To examine these episodes, Table 1.5 reports the changes in the yields/spreads of the corporate bond market and the Treasury yields of issues with different maturities (from the CMT daily series) during trading weeks that an event has occurred, and compare these results to changes during non-event weeks. The choice of the weekly frequency arises due to limitations of daily or monthly frequency data. Weekly corporate market portfolios are constructed by first averaging the yields/spreads of every issuer for the trading week, and then equal-weighting all issuers.

Looking at the results, there is evidence of an increase in the spreads of corporate bonds, and a decrease in the yield of Treasury securities, consistent with the information, liquidity, and rebalancing models. Specifically, there is on average a 3bp increase in spreads during the event weeks, compared to a 1bp decrease during non-event weeks, for the investment-grade market. For the high-yield market, there is a 21bp increase in spreads during event periods, compared to a 4bp decrease during non-event periods. For the Treasury market, there is a significant larger drop in the yield of all issues during event periods compared to non-event periods. As expected, the most significant drop seems to be for short- or intermediate-term issues, rather than long-term. This is consistent with the idea that flight to quality and liquidity would be more prevalent on short- or intermediate-term Treasury securities (considered to be more liquid). Furthermore, from a total of 98 weeks, about two-thirds of them (depending on the maturity of the issue) result in flight to quality, evidenced by a downward movement of the Treasury yield.

Examining also more closely specific important events (such as the East Asian crisis in October of 1987, the Russian default in August of 1998 and the subsequent collapse of LTCM, the September 11th terrorist attacks, and the WorldCom default), there was a clear and very significant evidence of flight to quality and liquidity (results not reported for brevity). For example, the week after the September 11th terrorist attacks, the yield on the three-month and two-year Treasury issues dropped by 91 and 62 bp, respectively. Furthermore, the yield and the spread of the aggregate corporate bond market increased by 69 and 110 bp, respectively. During the WorldCom default (defined in my sample as the week that WorldCom admitted a $3.8 billion error in its accounting statements, about a month prior to the Chapter 11 filing date), the yield and the spread in the corporate bond market increased by 116 and 84 bp, respectively. If WorldCom is a firm-specific event, then why do we observe such a significant flight to quality episode during this period? This important question is addressed in the next section.

1.4.2.2. Information, Liquidity, and Rebalancing Proxies

As described above, the information, liquidity-shock, and rebalancing channels can be used to explain the flight to quality and liquidity episodes. This section draws a distinction between the three channels using various proxies that capture the information transmission, the liquidity in the markets, as well as the cost of rebalancing.

Table 1.6 presents summary statistics for various proxies that help to distinguish between the three models. Panels A and B present the statistics for effective bid-ask spreads, and Panels C , D, and E present the statistics for trading volume, frequency, and bond age of the corporate bond market. Panels F, G, and H present the statistics for quoted bid-ask spreads, on-the-run/off-the-run spreads, and price impact coefficients of the Treasury market. I calculate bid-ask spreads in the corporate bond market using the following approach: For a bond with at least one buy and one sell transaction within a given day, the effective bid-ask spread during that window is the dollar-value weighted difference between the buy and sell transactions, where the dealers are assumed to act as market makers. Similar to Chakravarty and Sarkar (2003), I eliminate unusually high traded spreads (exceeding $5 in absolute value). My sample consists of 5,527 bonds and

19,047 bond days (number of bonds times number of days each bond traded) for the aggregate market. The mean level of round-trip trading costs is 14 cents/$100 par for the aggregate market, 18 cents for the investment-grade market, and -13 cents for the high-yield market.[28] A reason for the negative mean level of bid-ask spreads in the high-yield market could be due to the small number of single-day matches. Furthermore, as Hong and Warga (2000) point out, negative bid-ask spreads can also arise because of inventory constraints, interest rate risk, and firm risk, faced by dealers and market participants. Then, the estimates of bid-ask spreads using trade data can also be biased due to nonsynchronous trading. Flow of information during the day can result in either an upward or downward bias of the bid-ask spreads. This is indicative by the high level of standard deviation. Furthermore, Schultz (2001), in a study of estimates of transaction costs, finds no evidence that lower rated bonds should have higher transaction costs.

I also estimate the effective spreads using a non-overlapping two-day window, in order to see how sensitive are my results to the one-day

[28]I also calculate bid-ask spreads by dividing the actual spread with the midpoint of the buy-sell price. Using this method, the bid-ask spreads of the investment-grade and high-yield market are closer in line to each other. This is because investment-grade bonds are trading much closer to par than high-yield issues.

estimation window. In this procedure, I combine bid-ask spreads from a single-day window with bid-ask spreads of issues that can only be matched using a two-day window. My sample in this case increases to 5,809 bond issues and 28,145 bond days, for the aggregate bond market. The estimates are slightly higher, 17 cents for the aggregate market, 18 for the investment-grade, and -9 for the high-yield sector, consistent with the inclusion of less active bonds. These results, with the exception for the high-yield market, are comparable with previous findings (for both mean and median levels). Chakravarty and Sarkar (2003), using transaction data from insurance companies between 1995-1997, estimate the mean level of bid-ask spreads for corporate bonds to be 21 cents for a single-day window and 35 cents for a two-day window. Hong and Warga (2000) estimate an effective spread of 13 cents for investment-grade bonds, and 19 cents for high-yield bonds using a single-day window, same data and same time period. Schultz (2001) uses a different methodology that is based on a regression of the difference between the trade price and an estimated bid price on a dummy variable that takes a value of one for buys and zero for sells. He estimates round-trip trading costs to be 27 cents. One reason that he finds larger trading costs can be because of the fact that his methodology allows for a larger set of observations and examination of less active bonds.

In terms of trading volume and frequency, the mean daily level for the aggregate market is $609 million and 201 transactions, respectively. For the individual markets, the mean daily level is $550 million for volume and 165 for transactions for the investment-grade market, compared to 60 million and 37 transactions for the high-yield market. The significantly higher levels for the investment-grade market, represents the fact that this is a larger sector. Furthermore, insurance companies tend to trade predominantly in investment-grade issues. For bond age, the average daily level is 2.60, 2.70, and 2.19 years, for the aggregate, investment-grade, and high-yield market, respectively. In terms of the Treasury market, the mean level of bid-ask spreads is 0.73 bp points for the three-month bill, and 1.18 32nds of a point for the ten-year note (where one point equals one percent of par).[29] As expected, the bid-ask spreads increase with the term of the issue. Regarding the on-the-run/off-the-run yield spreads, the mean level is 16.85 bp and 10.73 bp for the three-month bill and ten-year note, respectively. In terms of

[29]The denominations here are consistent with market quoting standards.

price impact coefficients, the mean level is 0.15 bp and 0.19 32nds of a point for the three-month bill and ten-year note, respectively.

Table 1.7 reports differences in mean levels for the above measures between event and non-event weeks. Observing the bid-ask spreads, there seems to be no statistical difference between these periods. However, trading volume is significantly higher during event weeks. Specifically, the average sum of trading volume (for the aggregate market) during event periods is $3,980 million compared to $2,660 million during non-event periods. The same pattern holds for trading frequency.[30] The average total level of transactions is 1,330 and 873 for event and non-event weeks, respectively. Surprisingly, investors seem to trade more on older bonds (off-the-run) during turbulence times. Specifically, the mean level for the aggregate market is 2.76 years, compared to 2.54 years during non-event weeks. These findings from the corporate bond market are contrary to the liquidity shock channel hypothesis, and more in favor of the information transmission hypothesis. Higher trading volume and frequency, as well as a higher level of bond age during event periods, indicate a more liquid market.

[30]Trading volume and frequency are two measures that are highly correlated.

Examining the findings on trading volume and frequency more closely, one possible reason for the differences is the time effect. Specifically, there has been a much higher level of these measures in recent years (2001-2003), compared to the rest of the period (1995-2000). Since most of the events that I am examining occur in recent years, then it is likely that the actual time period of the event weeks is the reason for these differences, and not the existence of the event. In order to check for this possible bias, I estimate the nonlinear trend for the weekly time series observations, and I reexamine differences between event and non-event weeks using the de-trended observations. The results (not reported here for brevity) seem to be robust to the time effect, with still significant higher levels (although smaller) of the above measures during event weeks.

Panels F, G, and H show differences in the levels of bid-ask spreads, on-the-run/off-the-run spreads, as well as price impact coefficients for the Treasury market.[31] In terms of bid-ask spreads, I do observe significant differences between event and non-event weeks. Specifically, for the three-month bill bid-ask spreads are, on average, 0.84 bp during event weeks compared to 0.69 bp during non-event weeks. The same significant

[31]As noted earlier, the data available for the Treasury market do not cover the whole time period from 1995-2003.

difference in bid-ask spreads can be observed for all other types of Treasury issues. Competition between the dealers and gain or loss of their market power can help to explain the significant changes in the bid-ask spreads in the Treasury market, unlike the corporate bond market. The Treasury market is in general a liquid market and when an event occurs and investors move to the safety of Treasury securities, dealers have the ability to raise bid-ask spreads as a reward for providing these assets. On the contrary, the corporate bond market is in general a less liquid market and the dealers have a lot of market power. However, when an event occurs that initiates more trading, they can lose some of their market power and cannot raise bid-ask spreads as much as they would like to.[32] Finally, in terms of on-the-run/off-the-run spreads and price impact coefficients, there are statistical differences between event and non-event weeks.

Although higher level of trading can be an indication of information transmission, it can also be the case that investors are rebalancing their portfolios by trading more on the securities that have lower transaction costs. To draw a distinction between the information and rebalancing channels, I separate corporate issues into liquid and illiquid to observe if there is a

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[32]I thank Chris Lamoureux for pointing this out to me.

higher level of trading on the liquid assets (that have lower transaction costs). Table 1.8 reports differences in the trading of liquid and illiquid assets for years 2001-2003. The reason that I choose this period to examine these differences is because, unlike earlier years, there are comparable numbers of event weeks and non-event weeks. Specifically, there are 64 event weeks and 94 non-event weeks. I separate assets into liquid and illiquid using the following procedure: First, for every year I keep only bonds with an issuance date prior to that year and maturity date after that. For the remaining ones, I calculate for each one the total sum of transactions and use the median to separate them into two groups. Issues that fall below the median form the illiquid group and those that fall above the median form the liquid group. I then compare differences in the sum of trading volume and frequency for both groups between event and non-event weeks. Results indicate no statistical difference for both groups. Further examination seems to indicate that the higher level of trading observed during event periods is driven by newly-issued bonds. These findings are against the rebalancing theory, and seems to indicate that contagion is induced by an information transmission, probably because of an update of belief of investors.

1.5. Conclusions

This study contributes to our understanding of financial market spillovers and contagion by bringing a new set of data and examining the implications of previously proposed models of contagion. These theories predict that an economic shock can be spread because of economic fundamentals linking assets or markets, pure information transmission, liquidity shocks, or rebalancing activities of market participants. Using a sample of major defaults, credit rating downgrades into 'junk' status, and stocks market downturns, I examine the propagation of these events within the Treasury and corporate bond market between 1995-2003.

My main findings are as follows: The effects of company-specific shocks on industry rivals are not significant, suggesting that contagion might not be due to economic fundamentals. This might not be that surprising, given the fact that the empirical contagion literature has found significant excess correlation between assets or markets, even after controlling for economic fundamentals. However, I do observe episodes of flight to quality during the event periods, indicated by a fall in the Treasury yields and widening of the corporate bond spreads. The flight to quality is supported by the information transmission, rebalancing, and liquidity-shock channels of contagion, that induces investors to move away from risky assets to the safe haven of the Treasury market. Distinguishing then between these three channels of contagion, I actually find that the level of trading in the corporate bond market is higher during these flight to quality episodes. A higher level of trading is contrary to the popular belief that liquidity 'dries up', which has so often been associated with turbulence times. A possible reason for this finding, is that unlike previous studies that concentrate on a few, important financial crises (October 1987 U.S. stock market crash, East Asian crisis, Russian default and collapse of LTCM), I examine a large sample of a variety of events. Furthermore, unlike most previous studies that look at equity data, I examine the implications of contagion using bond market data.

I also find that investors seem to trade on older bonds during these episodes, which is consistent with a more liquid market. After distinguishing between liquid and illiquid assets, I do not find significant differences for either group between event and non-event periods. If rebalancing was the dominant reason for contagion, then I would expect to see higher level of trading on the liquid issues (the ones with the lower transaction costs). All of the above findings seem to be contrary to the fundamental linkage, rebalancing or liquidity-shock theories as the dominant channels of contagion, and more in favor of an information transmission.

Figure 1.1: Events at Yearly Frequency

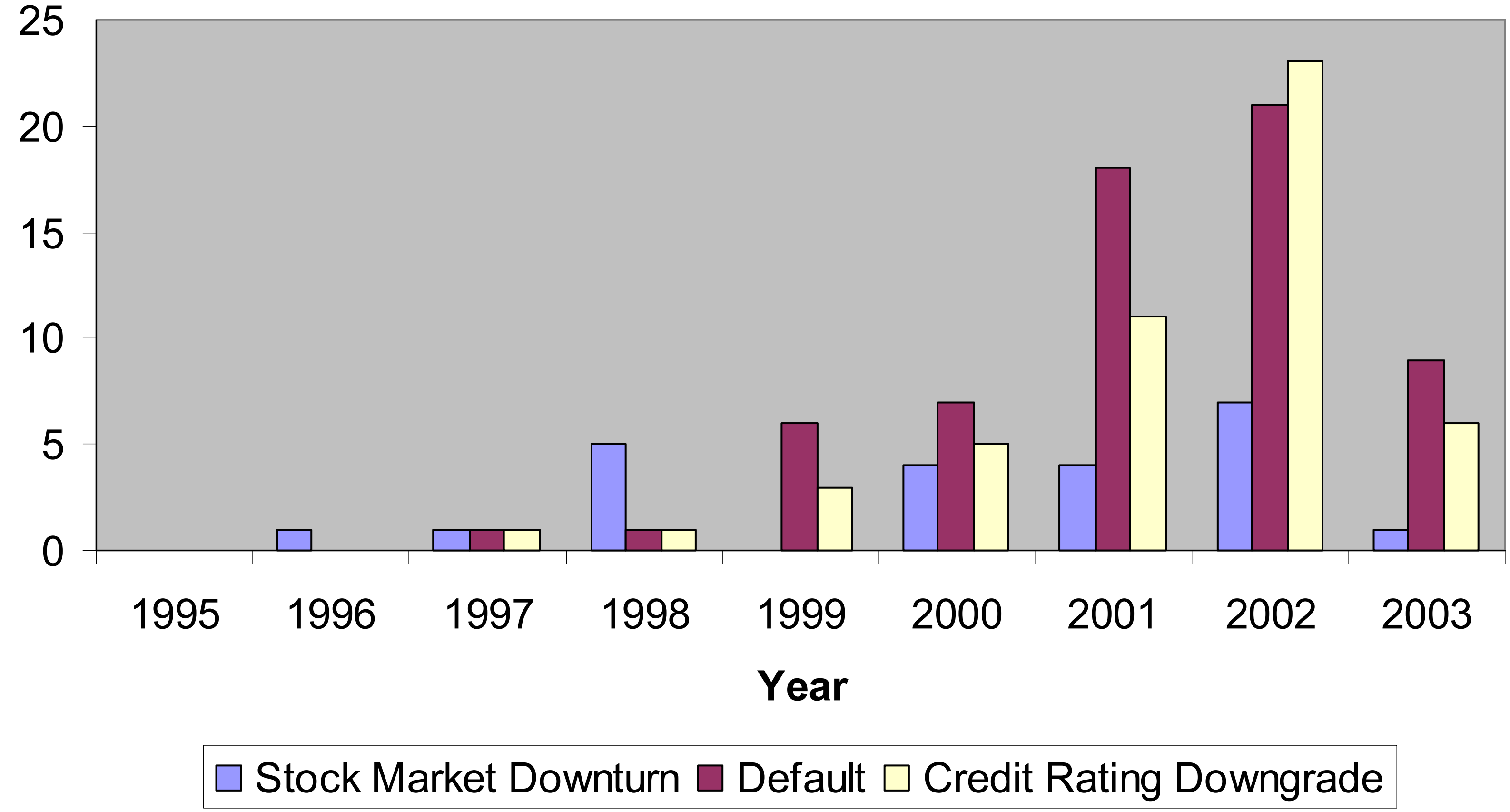

Table 1.1
Number of Transactions, Issues, and Issuers

I include corporate bonds with a fixed rate, credit rating, from U.S. issuers, with semi-annual coupons, nonputtable, and nonconvertible. I exclude asset-backed securities, credit enhancements, yankees, Canadian, bonds in foreign currencies, issues offered globally, bonds with announced calls, perpetual, exchangeable, and preferred securities. The industry groups include the industrial, financial, and utility sectors.

Panel A: No. of transactions by year			Panel B: No. of issues by year		Panel C: No. of issuers by year	
	N	%	N		N	
1995-2003	455,167	100.0	8,409		2,431	
1995	22,741	5.0	2,521		957	
1996	27,089	6.0	3,051		1,136	
1997	29,520	6.5	3,592		1,292	
1998	43,105	9.5	4,184		1,410	
1999	45,805	10.1	4,591		1,510	
2000	40,455	8.9	4,407		1,489	
2001	75,713	16.6	4,795		1,607	
2002	85,895	18.9	4,500		1,579	
2003	84,844	18.6	4,459		1,651	
Panel D: No. of transactions by rating			**Panel E: No. of issues by rating**		**Panel F: No. of issuers by rating**	
	N	%	N		N	
AAA	6,471	1.4	209		57	
AA	38,719	8.5	1,277		271	
A	166,348	36.5	4,003		833	
BBB	161,239	35.4	3,519		998	
Total Inv-Gr.	372,777	81.9	6,937		1,571	
Below BBB (High-Yield)	82,390	18.1	2,218		1,155	
Panel G: No. of transactions by industry			**Panel H: No. of issues by industry**		**Panel I: No. of issuers by industry**	
	N	%	N	%	N	%
Industrial	276,631	60.8	4,398	52.3	1,547	63.6
Financial	119,113	26.2	2,544	30.3	570	23.4
Utility	66,638	14.6	1,472	17.5	315	13.0
Panel J: No. of transactions by maturity			**Panel K: No. of issues by maturity**		**Panel L: No. of issuers by maturity**	
	N	%	N		N	
Short (1-7 yrs)	196,358	43.1	5,245		1,860	
Medium (7-15 yrs)	185,358	40.7	4,654		2,048	
Long (15 yrs-30 yrs)	64,675	14.2	1,537		653	
V. Long (30 yrs-onwards)	8,776	1.9	420		51	

Table 1.2
Average Corporate Bond Yields and Spreads

Using panel data between 1995 to 2003, I report corporate bond yields (in percentages) and spreads (in basis points). For the benchmark Treasuries, I use linear interpolation to obtain estimates of the yield curve from the Federal Reserve's Constant Maturity Treasury (CMT) series. I include bonds with a fixed rate, credit rating, from U.S. issuers, with semi-annual coupons, nonputtable, and nonconvertible. I exclude asset-backed securities, credit enhancements, yankees, Canadian, bonds in foreign currencies, issues offered globally, bonds with announced calls, perpetual, exchangeable, and preferred securities. The industry groups include the industrial, financial, and utility sectors.

	AAA	AA	A	BBB	Total Inv-Gr.	Below BBB (High Yield)	Total Market	Industrial Total	Financial Total	Utility Total
Panel A: Breakdown by Year, All Maturities (Yields)										
1995-2003	5.37	6.19	6.21	6.91	6.50	11.33	7.37	7.76	6.43	7.45
1995	6.95	7.05	7.21	7.53	7.28	9.33	7.49	7.66	7.28	7.51
1996	6.22	6.90	6.99	7.30	7.07	9.38	7.29	7.52	6.95	7.32
1997	6.63	6.86	6.95	7.20	7.02	8.92	7.23	7.41	6.96	7.17
1998	6.15	6.14	6.32	6.77	6.46	9.01	6.81	7.03	6.44	6.68
1999	6.73	6.54	6.79	7.35	6.97	10.35	7.50	7.80	6.99	7.19
2000	6.64	7.26	7.62	8.43	7.90	12.54	8.67	9.04	8.06	8.06
2001	5.01	5.76	6.31	7.34	6.71	12.72	7.94	8.57	6.51	7.21
2002	4.85	5.14	5.57	7.06	6.28	13.51	7.81	8.18	5.79	8.84
2003	3.67	4.25	4.45	5.28	4.84	9.85	6.06	6.45	4.70	6.43
Panel B: Breakdown by Year, All Maturities (Spreads)										
1995-2003	39	96	126	211	158	695	255	292	159	271
1995	53	68	88	119	94	308	116	128	104	110
1996	0	71	85	116	92	329	115	130	94	113
1997	23	70	79	99	84	282	106	117	91	98
1998	65	85	104	144	116	381	152	171	125	136
1999	88	101	124	181	142	485	197	221	157	160
2000	45	118	152	232	179	639	256	293	193	198
2001	34	135	181	280	220	843	347	407	218	272
2002	12	123	155	293	220	978	380	408	218	468
2003	38	52	96	177	134	669	264	300	155	279

Table 1.3
Sample of Events

I report the list of the 10 largest defaults (in order of asset size), the 10 largest credit rating downgrades to junk status (in order of asset size), and all the stock market downturns (3% or more of the S&P 500 index level) for the period 1995-2003.

Panel A: 10 Largest Defaults

Default Date	Company	Asset Size (in billions of U.S. dollars)
6/26/02	Worldcom	99
8/12/02	Conseco	59
2/26/02	Williams Cos.	40
11/9/01	Enron	33
12/13/01	Global Crossing	30
12/2/02	United Airlines	26
6/3/03	Mirant	23
5/16/02	Adelphia Comm.	21
1/16/01	PG&E	21
1/16/01	Southern Cal. Edison	18

Panel B: 10 Largest Rating Downgrades to Junk St.

Rating Change Date	Company	Asset Size (in billions of U.S. dollars)
5/9/02	Worldcom	99
5/22/02	Qwest	74
12/13/02	TXU	45
6/12/02	Tyco International	40
6/12/01	Lucent Technologies	39
12/23/03	Firstenergy	37
1/4/01	Edison International	36
9/30/00	Comcast	36
11/9/01	Enron	33
9/26/02	Allmerica Financial	32

Panel C: Stock Market Downturns

Crash Date	S&P 500 Decline	Trigger of Downturn
3/8/96	-3.10%	Stronger-than-expected February jobs report.
10/27/97	-6.90%	East Asian crisis.
8/4/98	-3.70%	Negative sentiment due to continued Asian economic crisis.
8/27/98	-3.80%	Russian debt crisis.
8/31/98	-6.80%	Russian debt crisis.
9/30/98	-3.10%	Decline in global financial markets.
10/1/98	-3.00%	Decline in global financial markets.
1/4/00	-3.80%	Interest rate worries.
2/18/00	-3.00%	Interest rate worries.
4/14/00	-5.80%	Higher-than-expected CPI figure.
12/20/00	-3.10%	Fed did not lower interest rates.
3/12/01	-4.30%	Negative companies' earnings news.
4/3/01	-3.40%	New profit warnings from technology companies.
9/17/01	-4.90%	September 11 terrorist attacks.
9/20/01	-3.10%	September 11 terrorist attacks.
7/10/02	-3.40%	Accounting scandals.
7/19/02	-3.80%	Accounting scandals.
7/22/02	-3.30%	Accounting scandals.
8/5/02	-3.40%	US economic rebound may be weakening.
9/3/02	-4.20%	Weak economic data.
9/27/02	-3.20%	New profit warnings.
3/24/03	-3.50%	Problems with the war on Iraq.

Table 1.4
Rivals' Reaction to Firm-Specific Events in the Corporate Bond Market

I report the rivals' bond reaction to firm-specific events over the period 1995-2003. CCY(S) refers to the cumulated change in basis points in yields (spreads) between the pre- and post-event windows. CCAY(S) refers to the cumulated change in basis points in the adjusted yields (spreads). The adjustment is calculated by subtracting from the raw bond yields (spreads), the yield of an index with rating and maturity characteristics that are similar to the bond of interest. Fifteen adjustment indexes are constructed based on five rating and three maturity categories using the FISD-NAIC database. The pre-event window covers the days (-7,-2) prior to the event, while the post-event window covers the days (-1,+4). One bond/firm implies that yields (spreads) of every issue are averaged first within the firm, and then across firms. All bonds implies that yields (spreads) are averaged across all firms. Panel A shows the effect on the rival portfolios. Panels B and C separate these portfolios into low and high concentration, using the Herfindahl index. Lower value implies a lower level of concentration (or higher degree of competition). The numbers in parentheses are t-statistics and the numbers in square brackets are t-statistics for differences in subsamples. The superscripts ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Section A: Industry Portfolios

	One Bond/Firm	% Positive	All Bonds
Panel A: All Events (N = 76)			
CCY	7.13	45	6.39
	(0.99)		(0.94)
CCAY	-0.01	47	-0.60
	(0.00)		(0.06)
CCS	9.05	51	8.25
	(1.20)		(1.16)
CCAS	0.52	50	-0.70
	(0.05)		(0.07)

Section B: Subsamples of Industry Portfolios

	Low Concentr. Sample (N = 57)	High Concentr. Sample (N = 19)
	One Bond/Firm	
Panel B: All Events (N = 76)		
CCY	8.63	2.61
	(0.93)	(0.35)
		[0.50]
CCAY	-2.62	7.79
	(0.20)	(0.95)
		[0.68]
CCS	10.66	4.20
	(1.09)	(0.56)
		[0.53]
CCAS	-3.66	13.09
	(0.27)	(1.26)
		[0.99]
	All Bonds	
Panel C: All Events (N = 76)		
CCY	7.72	2.41
	(0.88)	(0.32)
		[0.46]
CCAY	-3.66	8.57
	(0.29)	(1.02)
		[0.81]
CCS	9.74	3.79
	(1.06)	(0.51)
		[0.50]
CCAS	-4.81	11.61
	(0.38)	(1.20)
		[1.02]

Table 1.5

Corporate and Treasury Bond Market Reaction to Market-Wide and Firm-Specific Events

I report the corporate and Treasury bond market reaction (in basis points) to market-wide and firm-specific events over the period 1995-2003. Panel A shows the effects on yields and Panel B the effects on spreads. The superscripts ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

	No. of weeks in which an event occurs	No. of weeks in which no event occurs	No. of event weeks exhibiting flight to quality	Changes during weeks when an event occurs	Changes during weeks when no event occurs	Difference in changes	t-test for the difference
				Panel A: Yields			
	I. Corporate Bond Market						
Aggr. Market	98	372		3.31	-1.79	5.10	0.88
IG Market	98	372		-1.26	-0.69	0.56	0.33
HY Market	98	372		17.68	-4.47	22.15	1.64*
	II. Treasury Market						
3-month T Bill	98	372	56	-3.49	-0.42	3.07	2.31**
6-month T Bill	98	372	65	-3.51	-0.58	2.93	2.45**
1-year T Note	98	372	68	-4.25	-0.48	3.76	2.97***
2-year T Note	98	372	65	-4.18	-0.46	3.72	2.55**
3-year T Note	98	372	65	-4.31	-0.33	3.98	3.07***
5-year T Note	98	372	66	-4.16	-0.14	4.02	3.06***
7-year T Note	98	372	62	-3.60	-0.15	3.45	2.70***
10-year T Note	98	372	62	-2.99	-0.18	2.81	2.30**
20-year T Note	98	372	60	-2.39	-0.16	2.24	2.07**
				Panel B: Spreads			
	I. Corporate Bond Market						
Aggr. Market	98	372		7.31	-1.86	9.17	1.50
IG Market	98	372		2.80	-0.80	-3.60	2.13**
HY Market	98	372		20.82	-4.20	25.02	1.82*

Table 1.6
Summary Statistics for Proxies of Liquidity, Information, and Cost of Rebalancing

I report summary statistics for various proxies of liquidity, information, and cost of rebalancing for the corporate and Treasury bond market. The corporate bond market period that I examine is from 1995-2003. For the Treasury market, the sample on bid-ask spreads covers the period January, 1997 to September, 2002, on on-the-run/off-the-run yield spreads from January, 1997 to April, 2000, and on price impact coefficients from January, 1997 to April, 2000. All three samples are at weekly frequency.

Panel A: Corporate Bond Market (Av. Bid-Ask Spreads in cents/$100 par for a 1-day window)

	No. of Bonds	No. of Bond Days	Mean	Median	St. Dev.
Aggr. Market	5,527	19,047	14	0	97
IG Market	4,566	16,150	18	1	88
HY Market	1,232	2,897	-13	0	132

Panel B: Corporate Bond Market (Av. Bid-Ask Spreads in cents/$100 par for a non-overlapping 2-day window)

	No. of Bonds	No. of Bond Days	Mean	Median	St. Dev.
Aggr. Market	5,809	28,145	17	2	101
IG Market	4,800	23,951	18	1	88
HY Market	1,325	4,194	-9	0	133

Panel C: Corporate Bond Market (Av. Daily Trading Volume in million of U.S. dollars)

	No. of Obs.	Mean	Median	St. Dev.
Aggr. Market	2,264	608.59	486.65	398.19
IG Market	2,263	549.52	440.45	362.90
HY Market	2,250	59.68	41.08	57.59

Panel D: Corporate Bond Market (Av. Daily Trading Frequency in number of transactions)

	No. of Obs.	Mean	Median	St. Dev.
Aggr. Market	2,267	201	162	122
IG Market	2,263	165	136	94
HY Market	2,261	37	23	36

Panel E: Corporate Bond Market (Av. Daily Bond Age in years)

	No. of Obs.	Mean	Median	St. Dev.
Aggr. Market	2,264	2.60	2.52	0.75
IG Market	2,267	2.70	2.62	0.83
HY Market	2,250	2.19	2.11	0.99

Panel F: Treasury Bond Market (Av.Weekly Bid-Ask Spreads)

Issue	No. of Obs.	Mean	Median	St. Dev.
three-month bill	300	0.73 bp	0.66 bp	0.34
six-month bill	300	0.78 bp	0.70 bp	0.27
two-year note	300	0.33 32nds	0.25 32nds	0.19
five-year note	299	0.70 32nds	0.54 32nds	0.42
ten-year note	298	1.18 32nds	0.98 32nds	0.58

Panel G: Treasury Bond Market (Av. Weekly On-the-Run/Off-the-Run Yield Spreads in basis points)

Issue	No. of Obs.	Mean	Median	St. Dev.
three-month bill	183	16.85	17.17	5.88
six-month bill	180	13.46	13.36	4.85
two-year note	209	3.89	3.39	3.44
five-year note	209	9.18	7.11	6.69
ten-year note	209	10.73	9.50	5.51
thirty-year note	208	9.51	8.41	4.78

Panel H: Treasury Bond Market (Av. Weekly Price Impact Coefficients)

Issue	No. of Obs.	Mean	Median	St. Dev.
three-month bill	174	0.15 bp	0.14 bp	0.07
six-month bill	174	0.14 bp	0.13 bp	0.05
one-year bill	174	0.12 bp	0.11 bp	0.05
two-year note	174	0.05 32nds	0.04 32nds	0.02
five-year note	174	0.10 32nds	0.09 32nds	0.04
ten-year note	174	0.19 32nds	0.18 32nds	0.07

Table 1.7
Differences in Proxies of Liquidity, Information, and Cost of Rebalancing between Event and Non-Event Weeks

I report differences in levels of proxies of liquidity, information, and cost of rebalancing for the corporate and Treasury bond market between event and non-event weeks. The corporate bond market period that I examine is from 1995-2003. For the Treasury market, the sample on bid-ask spreads covers the period January, 1997 to September, 2002, on on-the-run/off-the-run yield spreads from January, 1997 to April, 2000, and on price impact coefficients from January, 1997 to April, 2000. All three samples are at weekly frequency. The superscripts ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

	No. of weeks in which an event occurs	No. of weeks in which no event occurs	Weeks when an event occurs	Weeks when no event occurs	Differences	t-test for the difference
Panel A: Corporate Bond Market (Mean level of Bid-Ask Spreads for a 1-day window in cents/$100 par)						
Aggr. Market	98	371	16	19	3	1.25
IG Market	98	371	22	22	0	0.24
HY Market	95	300	-7	-1	6	1.00
Panel B: Corporate Bond Market (Mean level of Bid-Ask Spreads for a 2-day non-overlapping window in cents/$100 par)						
Aggr. Market	98	372	20	22	2	0.59
IG Market	98	372	26	25	1	0.58
HY Market	95	322	0	2	2	1.02
Panel C: Corporate Bond Market (Sum of Trading Volume in million of U.S. dollars)						
Aggr. Market	98	372	3,980	2,660	1,320	7.65***
IG Market	98	372	3,590	2,400	1,190	7.72***
HY Market	98	372	390	258	132	5.56***
Panel D: Corporate Bond Market (Sum of Trading Frequency in number of transactions)						
Aggr. Market	98	372	1,330	873	457	8.10***
IG Market	98	372	1,053	724	329	7.87***
HY Market	98	372	273	149	124	7.68***
Panel E: Corporate Bond Market (Mean level of Bond Age in years)						
Aggr. Market	98	372	2.76	2.54	0.22	3.83***
IG Market	98	372	2.91	2.62	0.28	4.40***
HY Market	98	372	2.22	2.10	0.12	1.79*
Panel F: Treasury Bond Market (Bid-Ask Spreads)						
three-month bill	81	219	0.84 bp	0.69 bp	0.15 bp	3.07***
six-month bill	81	219	0.89 bp	0.73 bp	0.16 bp	4.78***
two-year note	81	219	0.47 bp	0.28 bp	0.15 bp	7.04***
five-year note	80	219	0.59 32nds	0.98 32nds	0.39 32nds	7.80***
ten-year note	79	219	1.58 32nds	1.04 32nds	0.44 32nds	7.80***
Panel G: Treasury Bond Market (On-the-Run/Off-the-Run Yield Spreads in basis points)						
three-month bill	26	157	14.78	17.19	2.41	1.95*
six-month bill	26	154	11.56	13.78	2.22	2.19**
two-year note	33	176	3.96	3.87	0.09	0.13
five-year note	33	176	10.78	8.87	1.91	1.51
ten-year note	33	176	12.52	10.40	2.12	2.04**
thirty-year note	33	175	10.71	9.28	1.43	1.59
Panel H: Treasury Bond Market (Price Impact Coefficients)						
three-month bill	25	149	0.17 bp	0.15 bp	0.02 bp	1.65*
six-month bill	25	149	0.14 bp	0.16 bp	0.02 bp	2.37**
one-year bill	25	149	0.12 bp	0.15 bp	0.03 bp	3.39***
two-year note	25	149	0.06 32nds	0.05 32nds	0.01 32nds	2.69***
five-year note	25	149	0.14 32nds	0.10 32nds	0.04 32nds	3.38***
ten-year note	25	149	0.24 32nds	0.18 32nds	0.06 32nds	2.79***

Table 1.8
Further Tests on Rebalancing Channel

Section A reports differences in the trading of liquid and illiquid bonds between event and non-event weeks for years 2001-2003. Bonds with an issuance date prior to the trading year and maturity date after that, are divided into liquid and illiquid based on the total sum of transactions. The superscripts ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Section A: Differences in Trading of Liquid and Illiquid Bonds

	No. of weeks in which an event occurs	No. of weeks in which no event occurs	Differences in Trading Volume (in thousands of U.S. dollars)	t-test for the difference	Differences in Trading Frequency (in number of transactions)	t-test for the difference
	Panel A : 2001					
Liquid Bonds	20	33	-57	0.38	0.04	1.30
Illiquid Bonds	20	33	-281	1.19	-0.01	0.24
	Panel B : 2002					
Liquid Bonds	33	20	232	1.55	0.04	1.00
Illiquid Bonds	33	20	-88	0.44	0.00	0.02
	Panel C : 2003					
Liquid Bonds	11	41	126	0.77	0.01	0.38
Illiquid Bonds	11	41	180	0.80	0.02	0.51

CHAPTER 2

LIQUIDITY RISK IN ASSET PRICING: EVIDENCE FROM THE CORPORATE BOND MARKET

1.1. Introduction

The role of liquidity in asset pricing has attracted considerable attention in recent years. For both equity markets, but particularly for debt markets, liquidity risk has been used to account for the unexplained portion of market prices. In the bond literature, it has long been acknowledged that credit risk alone cannot capture the level of corporate bond spreads, and thus liquidity has been introduced to explain this so-called 'credit spread puzzle'. Investors demand a liquidity premium for holding illiquid securities, thus increasing the level of spreads beyond what is explained by default risk. Yet despite the abundance of papers on the importance of liquidity risk, disentangling the various components of liquidity risk from other sources of risk and capturing the actual level of liquidity premia in corporate bond prices has proven to be a difficult task.

Previous literature has shown that liquidity impacts asset returns due to the individual security characteristics (Amihud and Mendelson (1986, 1989), Brennan and Subrahmanyam (1996), Brennan et al. (1998), Amihud (2002), Chen, Lesmond, and Wei (2005)) or as a systematic risk factor

(Pastor and Stambaugh (2003), Sadka (2005)). Acharya and Pedersen (2005), motivated by previous empirical findings, present an equilibrium model with liquidity risk, the liquidity-adjusted capital asset pricing model (LCAPM) that captures multiple components of liquidity risk, and test the model using U.S. stock market data. Lee (2005) extends this model to international stock data. Although he does not find strong support for the model, liquidity risk that is due to the comovement of individual stocks' return and liquidity with local and global market factors seems to be priced. This paper seeks to extend the LCAPM model to the corporate bond market, and investigate whether these various sources of liquidity risk are priced and help to explain the ‘credit spread puzzle’. Although there has been recently a lot of effort to measure the extend to which liquidity affects corporate bond prices (or spreads), to my knowledge, these multiple forms of liquidity risk have not been addressed in the corporate bond market.

The majority of the studies in the liquidity literature have focused on the U.S. equity market. This is not surprising, given the easy accessibility of reliable, high-frequency data. However, recently researchers have also began to explore the way liquidity affects corporate bond prices. Since the corporate bond market is substantially less liquid than the equity or Treasury markets, it provides a natural setting to examine the impact of liquidity on asset prices. Chen, Lesmond, and Wei (2005) look at the effect of specific bond illiquidity measures on the cross-sectional differences of corporate bond yields. Chacko (2005) constructs a new measure of liquidity based on the bond's accessibility to dealers, and examines how this variable relates to the cross-section of corporate bond prices. De Jong and Driessen (2005), following the lines of Pastor and Stambaugh (2003), examine how liquidity risk affects bond yields. They employ a multifactor model that includes systematic measures of liquidity from the equity and Treasury market, but not from the corporate bond market. Downing, Underwood, and Xing (2005) use corporate bond transactions to show that liquidity is priced in the cross-section of bond returns. Li, Shi, and Wu (2005) develop a reduced-form model that uses information from the spread on on-the-run/off-the-run Treasury securities to extract the liquidity component of corporate bond prices. Longstaff, Mithal, and Neis (2005) use information from credit default swap prices to measure the nondefault component of corporate bond prices and show that it is strongly related to measures of bond-specific illiquidity. My study varies from the above papers in several dimensions. First, I examine various components of liquidity risk, in a manner predicted by Acharya and Pedersen (2005), i.e liquidity risk that arises due to commonality in liquidity, due to the covariation of individual bond's return with a market-wide measure of liquidity, and lastly due to the covariation of individual bond's level of liquidity with market returns. Second, different from other studies but similar to De Jong and Driessen (2005), I use a methodology along the lines of Campello et al. (2004) to construct expected bond returns, a better measure of expected bond returns rather than realized returns. Third, similar only to Downing, Underwood, and Xing (2005), I utilize a new dataset, the TRACE data, that was introduced recently by the National Association of Securities Dealers (NASD) in an effort to bring more transparency to the corporate bond market. An important advantage of this data set, compared to previous sources of bond data, is that it much more comprehensive; all NASD members are required to report every day their transactions on all bonds eligible under TRACE. Fourth, I extend my analysis on the term structure of liquidity spreads.

Despite the very important recent efforts to understand the effect of liquidity on corporate bond prices, still little is known as to how these liquidity premia fluctuate with the term structure of corporate bond spreads. Furthermore, the empirical evidence is mixed. Amihud and Mendelson

(1991a) and Kamara (1994) examine price discrepancies in the Treasury market (bills and notes with the same amount of time remaining to maturity) and attribute the price differential due to the lower level of liquidity of the Treasury notes. This yield differential however increases as we approach the maturity date, suggesting a downward-sloping term structure of liquidity spreads. The reasoning behind this shape is that the further away from maturity, implies that the costs of illiquidity (transaction costs) can be depreciated over a longer horizon. Consistent with the above finding, Ericsson and Renault (2006) develop and test a model that predicts a downward and convex term structure of liquidity spreads. Their reasoning is that there is an upper bound on the dollar losses that can occur due to a liquidity shock. These dollar losses are closer to the upper bound as you approach maturity, and are smaller the further away from maturity date. This finding can help explain the considerable observed spreads for short maturities, which cannot be captured by traditional structural credit risk models.

However Covitz and Downing (2002), in their study of examination of very short-term corporate yield spreads (commercial paper spreads) find that credit risk, and not liquidity risk, is the driving force behind these spreads.

This is somewhat surprising, given the fact that CP is usually issued by large, highly-rated firms. Based on these findings it seems that the CP spread actually proxies for a ‘flight to quality’ (the movement of investors towards safer assets), rather than a ‘flight to liquidity’ (towards more liquid assets).[33] Liquidity risk does not have a significant impact on very short maturities, possibly because as you get closer to maturity there is less chance that you will be forced to liquidate. Then, Chen, Lesmond, and Wei (2005), using three separate liquidity measures, find that liquidity costs are higher for long-maturity bonds. De Jong and Driessen (2005) find that their liquidity risk factors (constructed from the Treasury and equity markets) have a greater impact on long-maturity bond portfolios. Longstaff, Mithal, and Neis (2005), using a number of individual bond-illiquidity proxies, find that longer-maturity bonds are less liquid than shorter-maturity bonds. They argue that there might exist maturity clientele for corporate bonds, making short-maturity corporate bonds more liquid than longer-maturity bonds. Li, Shi, and Wu (2005) show that liquidity spreads increase with maturity.

Based on these results, it seems that the extent to which liquidity affects corporate bond spreads, as well as the fluctuation of liquidity premia with

[33] This was pointed out also by Graveline and McBrady (2005).

the term structure can depend on how well we capture liquidity, as well as on the way that we control for other sources of risk.[34] It is well known in the literature that liquidity is a very elusive concept and has multiple dimensions: depth, tightness, and resiliency.[35] The main objective of course should be to identify the measure of liquidity that has the greatest impact on market prices.

This paper seeks to address all of these issues using a large panel data set of corporate bond market transactions. As mentioned earlier, this is a new, comprehensive database, the Trade Reporting and Compliance Engine (TRACE) system, that includes all transactions by NASD members on all eligible bonds, and covers the period from July 1, 2002 to December 31, 2004. Issue- and issuer-specific variables are then obtained from the Fixed Investment and Securities Database (FISD).

The key findings can be summarized as follows: Contrary to the predictions of the LCAPM, liquidity does not seem to have a big impact on corporate bond prices, especially when it is captured using the trading

[34]Amihud, Mendelson, and Pedersen (2005), in their survey of the liquidity literature, note: 'The results on the effects of liquidity depend, then, on the quality of the model that controls for the bond's risk.'(p. 338, line 8).
[35]A general way of how market participants use to describe liquidity is the ability to trade large quantities quickly, without having to incur large transaction costs, and without making a great impact on the market price.

frequency, trading volume, and turnover. Specifically, after constructing weekly bond portfolios sorted on the above three measures, the more illiquid portfolios do not earn higher expected excess returns than less illiquid portfolios. Furthermore, illiquid portfolios do not have more liquidity risk. After constructing the liquidity betas in a manner shown by Acharya and Pedersen (2005), illiquid portfolios do not have more liquidity covariation with market liquidity, more return covariation with market liquidity, and more liquidity covariation with market returns. Then, in running cross-sectional regressions using a GMM framework, I do not find either strong support for the LCAPM or that liquidity risk has a significant effect on corporate bond prices. When liquidity is measured using two volatility to volume ratios, there is an indication that liquidity risk does matter. However, these two measures can be problematic in the sense that informational effects during the week could be affecting bond prices, for reasons not related to any liquidity considerations.

The remainder of the paper is organized as follows. Section 2.2 discusses the relevant literature, both theoretical and empirical. Section 2.3 describes the data sources utilized in this study, the construction of expected bond returns, as well as the liquidity measures. Section 2.4 presents briefly the LCAPM. Section 2.5 describes the empirical methodology and findings. Section 2.6 concludes.

2.2. Related Literature

Ever since the seminal paper by Amihud and Mendelson (1986) showed that higher bid-ask spreads yield higher expected returns (to compensate investors for the transaction costs they incur), there has been a substantial body of literature (both on an empirical and theoretical level) that addresses the way liquidity risk affects asset returns. Liquidity risk has been shown to affect the pricing of stocks, Treasury bond issues, and more recently corporate bond securities. This paper is largely related to this strand of literature as well as to the literature that examines the determinants of bond spreads and tries to account for the 'credit spread puzzle'.

The majority of the studies in the liquidity literature have focused on the U.S. equity market. To a large extent, this is due to the easy accessibility of reliable, high-frequency data.[36] Recently, there have been a few studies that have examined the effect of liquidity on other international equity markets [Rouwenhorst (1999), Bekaert, Harvey, and Lundblad (2003), Lesmond (2005), Lee (2005)].

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[36]See Amihud and Mendelson (1986, 1989, 1991b), Brennan and Subrahmanyam (1996), Brennan et al. (1998), Chordia, Roll, and Subrahmanyam (2000, 2001), Chordia, Subrahmanyam, and Anshuman (2001), Hasbrouck and Seppi (2001), Huberman and Halka (2001), Jones (2001), Amihud (2002), Pastor and Stambaugh (2003), Wang (2003), Sadka (2005), Acharya and Pedersen (2005) for some related papers. See Amihud, Mendelson, and Pedersen (2005) for a comprehensive review of the theoretical and empirical studies that examine the impact of liquidity on asset prices.

Early work on equity liquidity literature has focused on the implication of the individual asset's liquidity on its market price. For example, Amihud and Mendelson (1986, 1989) show that the level of bid-ask spreads are positively and significantly related to the expected return on a stock. Brennan and Subrahmanyam (1996) and Brennan et al. (1998) reexamine the relationship between return and illiquidity using transactions data and find a significant and negative relation between trading volume and expected returns, after controlling for other traditional sources of risk [Fama and French (1993) and Connor and Korajczyk (1998) factors]. Chordia, Subrahmanyam, and Anshuman (2001) look at the effect of both the level as well as the volatility of trading activity. Surprisingly, they find that the second moment of liquidity has a significant negative coefficient on expected equity returns.

Recent work however has explored other sources of risk that are attributed to liquidity implications. Chordia, Roll, and Subrahmanyam (2000), Hasbrouck and Seppi (2001), and Huberman and Halka (2001)] document a commonality in liquidity, that is, there is significant comovement of individual asset's liquidity with market-wide measures of liquidity. Motivated by the above studies, Pastor and Stambaugh (2003) investigate whether liquidity risk can be a systematic risk factor and find that indeed liquidity risk is priced. Furthermore, Amihud (2002) shows that liquidity can be used to predict future returns and also comoves with contemporaneous returns. Based on the above empirical studies, there has been an attempt to incorporate these liquidity considerations into the traditional asset pricing theory. Jacoby, Fowler, and Gottesman (2000) develop a CAPM-based asset pricing model that accounts for transaction costs, and where the true measure of systematic risk is based on net after-spread returns. Holmstrom and Tirole (2001) develop a model where the corporate demand for liquidity is impacting asset pricing. Finally, Acharya and Pedersen (2005) motivated by previous empirical findings decompose liquidity into three sources of risk : (1) the covariance of individual stock's liquidity with market-wide liquidity (commonality in liquidity), (2) the covariance of individual's stock return with market-wide liquidity, and (3) the covariance of individual stock's liquidity to market returns.[37]

Within the context of the bond market, liquidity has also been used to address pricing anomalies. For example, Sarig and Warga (1989) employ

[37] This third component of liquidity captures the idea that investors will value a liquid security in a down market.

liquidity considerations to explain the price discrepancies between two alternative government bond data sets. Warga (1992), Krishnamurthy (2002), and Goldreich, Hanke, and Nath (2005) use it to address the differential yield between on-the-run/off-the-run Treasuries[38], Longstaff (2004) to explain the differential yield between REFCORP (a U.S. government agency) and comparable Treasury issues, and Amihud and Mendelson (1991a) and Kamara (1994) to justify the differential yield between, otherwise identical, Treasury bills and notes with the same time remaining to maturity.[39] Boudoukh and Whitelaw (1993) address the large price differentials of identical Japanese bonds, using liquidity considerations. Elton and Green (1998), utilizing trading volume as a proxy for liquidity, find evidence of a liquidity effect on the pricing of Treasury bills, notes, and bonds. Liu, Longstaff, and Mandell (2004) find evidence of a liquidity premium in interest rate swap spreads.

More recently, a lot of emphasis has been placed in utilizing liquidity to explain the yield spreads on corporate bonds, as well as the term structure

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[38]This explanation however is contested by Graveline and McBrady (2005). They argue the reason that on-the-run Treasuries are special is due to short-selling demand, rather than a liquidity reason.

[39]Strebulaev (2002) however rejects this illiquidity hypothesis using a sample of matched notes.

of corporate bond spreads. This paper focuses on this last particular aspect of liquidity - the extent to which different components of liquidity risk affect the level and term structure of corporate yield spreads, and how this can help to explain the so-called 'credit spread puzzle'. It is a well known fact that traditional credit risk models, whether structural or reduced-form [Merton (1974), Geske (1977), Leland (1994, 1998), Jarrow and Turnbull(1995), Longstaff and Schwartz(1995), Leland and Toft (1996), Duffie and Singleton(1999)] cannot fully explain the level of corporate bond spreads.[40] Elton et al. (2001) and Delianedis and Geske (2001) analyze the components of credit spreads and show that default risk and recovery risk alone cannot explain the level of these spreads. Collin-Dufresne et al. (2001) investigate the determinants of credit spread changes and show that traditional variables that should help to capture these changes have little explanatory power. Based on the above empirical findings, liquidity and differential taxation between Treasury and corporate bond issues are thought to be the two main reasons that drive these spreads.

Covitz and Downing (2002) investigate the determinants of very short

[40]See Eom, Helwege, and Huang (2003) and Huang and Huang (2003) for some related papers.

corporate yield spreads (CP spreads) and conclude that credit risk is more important than liquidity risk in explaining these spreads. Perraudin and Taylor (2003), Houweling, Mentink, and Vorst (2005) and Chen, Lesmond, and Wei (2005) examine the impact of individual liquidity proxies on the cross-sectional variation of corporate bonds and find evidence of liquidity premia in corporate bond prices. Hund and Lesmond (2006) extend these studies and examine the impact of liquidity on emerging bond markets (corporate and sovereign). Cossin and Lu (2004) and Longstaff, Mithal, and Neis (2005) use information from CDS data to decompose the corporate bond spreads into default and nondefault components. They find evidence that the nondefault component is strongly related to measures of bond-specific illiquidity. Chen, Cheng, and Wu (2005) also use CDS data to investigate how the interaction of default and liquidity risk affects the term structure of credit spreads. Li, Shi, and Wu (2005) use information from the spread between on-the-run/off-the-run Treasury securities as a state variable in a reduced-form model to decompose the liquidity and default component of corporate bond prices. The liquidity component is then shown to be linked to several liquidity proxies. Chacko (2005) using data obtained from one of the world's largest custodians, constructs a new measure of liquidity based on the bond's accessibility to dealers, and examines how this variable is related to corporate bond prices. De Jong and Driessen (2005) employ a multifactor model that includes a systematic measure of liquidity from the equity and Treasury bond market to examine whether liquidity is priced in expected bond returns.[41] Downing, Underwood, and Xing (2005) using the newly formed TRACE database, examine how various proxies of liquidity affect corporate bond prices.

[41]A motivation of using liquidity risk factors from the equity and Treasury bond market is recent works by Chordia, Sarkar, and Subrahmanyam (2005) and Goyenko (2005) that show a cross-market effect of liquidity, i.e. common factors could be driving liquidity and volatility in both equity and bond markets.

2.3. Data and Liquidity Measures

2.3.1. Bond Database

Corporate bond data comes from the Trade Reporting and Compliance Engine (TRACE) system, established by the National Association of Securities Dealers (NASD) on July 1, 2002.[42] In an effort to increase post-trade transparency for corporate bonds, the NASD requires from all its members to report in a relatively short-period of time all transactions on bonds that are eligible under the TRACE system. The original time allowance for reporting a trade was 75 minutes, and since July 1, 2005, has been reduced to 15 minutes.[43] The dissemination of trade information occurred in phases. Initially it included 550 investment-grade bonds, with an originally issue size of at least $1 billion, as well as 50 high-yield bonds. Since October 1, 2004, it includes almost the entire corporate bond market (29,000 corporate bonds). The data set that I utilize in this study covers the period from July 1, 2002 to December 31, 2004, and provides information on transaction dates, prices, as well as quantities traded. As mentioned

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[42]This database was used by Edwards, Harris, and Piwowar (2004), Goldstein, Hotchkiss, and Sirri (2005), Bessembinder, Maxwell, and Venkataraman (2005), and Downing, Underwood, and Xing (2005).

[43]Real-time data is available for a fee at *https://www.nasdtrace.com*, while publicly disseminated data is available (on a delayed basis) at *http://www.nasdbondinfo.com*.

earlier, advantages of using this database compared to other sources of bond data, is that it is much more comprehensive and provides actual transaction prices rather than algorithmically determined `matrix' prices. This data set is then merged with the Fixed Investment Securities Database (FISD) to obtain issue- and issuer-specific variables.

The original transaction file has 7,366,331 observations for 15,650 unique issues. After placing a number of restrictions on the type of bonds, I am left with 1,921,390 transactions for 4,270 issues. Appendix C has a detailed list of the procedure that I used. To get a better sense of the number of observations as well as the level of spreads and expected returns, I group the transactions by year, credit rating, type of market (high-yield or investment-grade), industry (industrial, financial, utility), and maturity.[44]

Table 2.1 reports the number of transactions, issues, and issuers, by year, credit rating, industry, and maturity. Panel A shows that the bulk of the observations, issues, and issuers traded, are in years 2003 and 2004. Furthermore, there are more transactions or issues per month for the above years. This is because the dissemination of trade reports occurred in phases, thus more bonds enter the sample at each phase. Interestingly, the last

[44]FISD includes credit ratings by four agencies (S&P, Moody's, Fitch, and Duff and Phelps). I use the S&P ratings.

column of Panel A indicates that, on average, a bond trades 86 times per month over the entire sample period, whereas this number decreases monotonically between 2002 and 2004. An explanation for this is because originally TRACE included only investment-grade bonds with a very large issue size. These are considered more liquid and trade more frequently than issues with a smaller size [Alexander et al. (2000)]. Gradually smaller issues became subject to dissemination.

Across credit ratings, the bulk of the observations are on bonds with an A rating. 90% of the sample falls under the investment-grade category, and the rest under the high-yield market. This is not surprising since the first two phases of TRACE included mainly investment-grade issues, and only a small sample of high-yield bonds (50) that were carried over from NASD's Fixed Income Pricing System (FIPS). The third phase, that includes almost the entire corporate bond market, started only in October 1, 2004, three months before the end of my sample. The bulk of the observations are in the A rating category (56%). Examining the last column of Panel B indicates that the highest frequency of transactions occurs on issues with a B rating, while the lowest frequency is on issues with a AA rating. Specifically, an issue in the B and AA rating categories trade, on average, 784 and 244 times per month during the time span that I am examining, respectively. Furthermore, high-yield issues trade, on average, more frequently than investment-grade issues; 184 transactions per issue per month for the high-yield sector, compared to 82 transactions for the investment-grade market. The above findings are consistent with Alexander et al. (2000), who find that high-yield bonds reported on FIPS trade fairly frequently.

Across industries, the bulk of the observations, issues, and issuers are in the industrial sector, followed by the financial and utility sectors. Furthermore, the last column of Panel C indicates that, on average, there are more transactions per issue per month on bonds that fall under the industrial sector, followed again by the financial and utility sectors. Across maturity, most of the observations are on bonds with short(zero to seven years) time remaining to maturity (58% of the sample), followed by medium (seven to fifteen years) and long-term (fifteen to thirty years). A very small part of the sample (1%) is on bonds with more than 30 years remaining to maturity. The last column of Panel D indicates that, on average, there are more transactions per issue for bonds with medium time remaining to maturity, compared to bonds with a shorter or longer term remaining. Specifically, a medium-term issue trades on average 115 times per month, compared to 80 and 60 times for a short- and long-term issue, respectively.

Table 2.2 reports statistics on some bond characteristics for the sample. The average issue size is $268 million, whereas the largest issue size is $3 billion. Furthermore, the majority of the sample (81.7%) is on medium-size issues (between $50 million and $500 million dollars), whereas small- and large-size issues constitute 10% and 8.3% of the sample, respectively.[45] In terms of original maturity, the average level is 14.6 years, whereas the maximum is 100 years. For years remaining to maturity, the average level is approximately 8.25 years while the median is 4.94. These numbers are consistent with Table 2.1, where the majority of the transactions is on bonds with a short- or medium-time remaining to maturity. The mean and median age of the bonds in the sample (time that elapsed since the bond started earning interest) is 5.26 and 4.96 years, respectively.

In terms of trade size and daily volume, what is noticeable is that the numbers are highly skewed. The average trade size is $469,000, while the median is only $30,000. The average daily volume per issue is $2.22 million, while the median is only $194 million. The largest trade size is $5

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[45]Small-size are issues of less than $50 million, while large-size issues are more than $500 million. These results are not reported in the table for brevity.

million, while the largest daily volume is approximately $450 million. The average number of daily trades for an issue is 4.7, while the largest number of trades reported for a specific issue is 1,488. Finally, the mean of the average between trades is 3.29 days, while the median is only 1. The skewness exhibited in this bond characteristic is consistent with the findings of Goldstein et al. (2005). They argue that dealers might have incentives to keep low inventory positions in illiquid bonds, and thus sell bonds quickly as soon as they are bought from a customer. In general, the above findings on bond characteristics are fairly consistent with those reported by Downing et al. (2005).

2.3.2. Construction of Expected Bond Returns

In order to construct expected bond returns, I first calculate the yield to maturity and then compute the corporate bond spread which is defined as the difference between the bond's yield to maturity and the interpolated yield to maturity of the benchmark U.S. Treasury. For the benchmark Treasuries, I use linear interpolation to obtain estimates of the yield curve from the Federal Reserve's Constant Maturity Treasury (CMT) daily series.[46]

I then use a methodology in the lines of Campello et al. (2004) to construct expected excess bond returns. This is as follows:

$$R_{Bt}^{i} - r_t^f = YS_{it} - EDL_{it} - ETC_{it} \quad (1)$$

where R_{Bt}^{i} is the expected bond return, r_t^f is the risk-free rate, YS_{it} is the yield spread (or expected bond excess return if there is no change in the bond yield), EDL_{it} is the expected default loss rate (accounts for the fact that default events decrease the bond value), and ETC_{it} is the expected tax compensation (accounts for the fact that Treasury bond investors are exempt from state and local taxes). Appendix D provides a detailed explanation of the empirical procedure.[47]

Panels A and B of Table 2.3 show the average corporate bond spreads (in basis points) and expected excess bond returns (in bp) broken down by year, for all credit ratings as well as for all industry sectors. Not surprisingly,

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[46]From the information provided by the CMT daily series, I do not use the 7-year yield since it is not auctioned. Furthermore, beginning Feb.18, 2004, the Treasury ceased publication of the 30-year CMT yield. Instead, they provide an extrapolation factor that can be added to the 20-year yield, to get the 30-year level. I use this extrapolation factor. For any observation above the 30-year level, I compute the spread based on the 30-year yield.

[47]Similar methodology is used by Elton et al. (2001) and De Jong and Driessen (2005).

spreads increase with credit risk. Specifically, average spreads are 173 and 821 bp for the investment-grade and high-yield market, respectively. Expected excess bond returns are 144 and 493 bp for the investment-grade and high-yield market, respectively. Furthermore, both spreads and expected excess returns decrease with time (between 2002 and 2004). This is expected as during the years 2001-2002 the markets experienced a significant large number of firm-specific financial shocks, but started recovering after that. Across industries, the utility sector has the highest spreads or returns, followed by the industrial and financial sectors. Panels C and D show the average spreads and expected excess returns broken down by maturity, for all credit ratings as well as for all industry sectors. Both variables increase as we move from bonds with a short time remaining to maturity to longer terms.

2.3.3. Liquidity Measures

Liquidity is hard to define, let alone capture. It has several dimensions: depth, tightness, and resiliency. Since it is a variable that has multiple dimensions, researchers have used a number of different proxies in order to measure liquidity. These measures can differ whether someone wants to capture liquidity in the equity, Treasury, or corporate bond market. They could also differ whether the aim is to capture the bond-specific illiquidity (or liquidity) or the market-wide illiquidity. Popular measures are quoted and effective bid-ask spreads (Amihud and Mendelson (1986, 1989)), bond age, i.e. difference between the issue date and transaction date of a bond (Sarig and Warga (1989)), amount of bond outstanding (Sarig and Warga (1989), Longstaff, Mithal, and Neis (2005)), trading volume (Brennan and Subrahmanyam (1996), Brennan et al. (1998), Elton and Green (1998), Chordia, Subrahmanyam, and Anshuman (2001)), quoted depth, i.e. sum of bid and ask sizes divided by the number of trades (Chordia et al. (2000), Chordia, Roll, and Subrahmanyam (2001), Chordia et al. (2005)), quote and trade size (Hasbrouck and Seppi (2001), Fleming (2003)), quote and trade frequency (Perraudin and Taylor (2003), Fleming (2003)), turnover, i.e. volume divided by issue size (Downing, Underwood, and Xing (2005)), on-the-run/off-the-run spreads (Warga (1992), Collin-Dufresne et al. (2001)), price impact of a trade (Hasbrouck and Seppi (2001), Sadka (2004)), yield dispersion (Houweling, Mentink, and Vorst (2005)), number of contributors (Houweling, Mentink, and Vorst (2005)), time to maturity of an issue (Longstaff, Mithal, and Neis (2005)), as well as order imbalance, i.e. buy orders minus sell orders in dollars divided by the dollar value of buys and sells (Chordia et al. (2005)).

Recently, a number of other variables have been proposed to capture liquidity. Amihud (2002) proposes a measure that calculates the daily ratio of absolute stock returns to dollar volume. Collin-Dufresne et al. (2001) introduce swap spreads, as well as the frequency of quotes versus matrix prices in the Warga database. Krishnamurthy (2002) uses the spread between 3-month Commercial Paper and T-bill, whereas Longstaff (2004) proposes the spread between comparable REFCORP and Treasury issues. Longstaff, Mithal, and Neis (2005) use dummy variables for bonds issued by financial firms, as well as for bonds issued by highly-rated firms, as some of their measures of bond-specific illiquidity. Chen, Lesmond, and Wei (2005) use a measure (known as the LOT measure) that captures the bound around the bond price within which new information would not induce a transaction (variant of the limited dependent variable model of Lesmond et al. (1999)), as well as a measure that is related to the percentage of zero returns. Pastor and Stambaugh (2003) employ a volume-related return reversal measure of liquidity (the extent to which order flow on day x affects the return on day $x+1$, with a stronger return reversal on day $x+1$ implying a lower level of liquidity). Wang (2003) uses the institutional equity acquisition as a proxy for liquidity (institutions provide liquidity to the market), Chacko (2005) develops a liquidity measure that is based on the bond accessibility to dealers, and Downing, Underwood, and Xing (2005) use the ratio of price volatility to volume. Table 2.4 presents the above liquidity measures, as well as an explanation as to how they capture liquidity.

I utilize five different measures to capture liquidity in the corporate bond market, for robustness of my results. First, I employ two modified measures from the one adopted by Amihud (2002) that capture the price impact of trades. These measures are the price volatility to volume ratio, where price volatility is measured in two different ways. The first measure is calculated as follows:

$$Volatility / Volume_{i,t} = \frac{St.Dev.of\ \mathrm{Pr}ices_{i,t}}{Volume_{i,t}} \tag{2}$$

where $St.Dev.of\ \mathrm{Pr}ices_{i,t}$ is the volatility of prices for bond *i* during week *t* and $Volume_{i,t}$ is the total amount traded for this bond during the same week. The second measure that captures the price volatility to volume ratio is computed in the following way:

$$Volatility / Volume_{i,t} = \frac{(P_{i,t}^{\max} - P_{i,t}^{\min}) / P_{i,t}^{median}}{Volume_{i,t}} \quad (3)$$

where $P_{i,t}^{\max}$, $P_{i,t}^{\min}$, and $P_{i,t}^{median}$ represent the maximum, minimum, and median prices for bond *i* during week *t*.[48]

A problem that can arise with the above two measures, is that arrival of information during the week can impact bond prices for reasons unrelated to any liquidity considerations. Thus I utilize another three different measures. These are the total dollar volume traded for bond *i* during the week *t* ($volume_{i,t}$), the total number of transactions during the week ($frequency_{i,t}$), as well as the turnover ($turnover_{i,t}$). Turnover is measured in the following way:

$$Turnover_{i,t} = \frac{Volume_{i,t}}{IssueSize_{i}} \quad (4)$$

where $IssueSize_{i}$ refers to the face value of the bond *i* initially issued.

I construct all five measures for every issue that has available information during week *t*.[49] Table 2.5 reports the correlation between the

[48]Both measures are scaled for presentation purposes.
[49]In empirically constructing the first two measures, the price volatility to volume ratios, I delete issues that have five or less observations during a specific week. This is needed in order to capture the volatility of prices during the week and deletes 186,541 observations from the sample (approximately 10%).

above five liquidity measures. The correlation matrices are computed in 2 different ways; Panel A is first a time-series average of the correlation between any two measures, and then a cross-sectional average for the sample. Panel B on the other hand is first a cross-sectional average for every trading week, and then a time-series average for all trading weeks. As expected, the two volatility to volume ratios are highly correlated whereas they are both negatively correlated with the other three measures (the volatility to volume ratios can be considered illiquidity measures, whereas the other three are liquidity measures). Furthermore, their correlation is higher with trading volume and turnover, rather than the number of transactions. Not surprisingly, trading volume and turnover are also highly correlated, and to a lesser extent trading frequency with trading volume and turnover.

2.4. LCAPM

Acharya and Pedersen (2005) propose a liquidity-adjusted capital asset pricing model (LCAPM) to capture various components of liquidity risk. The LCAPM adds three liquidity betas, β^{L1}, β^{L2}, and β^{L3}, to the market beta, β. The LCAPM can be represented by the following equation:

$$E_t(r_{t+1}^i - c_{t+1}^i) = r^f + \lambda_t \frac{\text{cov}_t(r_{t+1}^i - c_{t+1}^i, r_{t+1}^M - c_{t+1}^M)}{\text{var}_t(r_{t+1}^M - c_{t+1}^M)} \tag{5}$$

where r_t^i is the gross return of asset i, r^f is the gross risk-free rate, r_t^M is the market return, c_t^i is the relative illiquidity cost (illiquidity cost per price at time t), c_t^M is the relative market illiquidity, and $\lambda_t = E_t(r_{t+1}^M - c_{t+1}^M - r^f)$ is the risk premium. Based on the assumption of constant conditional variance of innovations in illiquidity and returns (since illiquidity is persistent), the unconditional version of the model can be written as:

$$E(r_t^i) = r_t^f + E(c_t^i) + \lambda(\beta_i + \beta_i^{L1} - \beta_i^{L2} - \beta_i^{L3}) \tag{6}$$

where

$$\beta_i = \frac{\text{cov}(r_t^i, r_t^M - E_{t-1}(r_t^M))}{\text{var}(r_t^M - E_{t-1}(r_t^M) - [c_t^M - E_{t-1}(c_t^M)])}, \tag{7}$$

$$\beta_i^{L1} = \frac{\text{cov}(c_t^i - E_{t-1}(c_t^M), c_t^M - E_{t-1}(c_t^M))}{\text{var}(r_t^M - E_{t-1}(r_t^M) - [c_t^M - E_{t-1}(c_t^M)])}, \tag{8}$$

$$\beta_i^{L2} = \frac{\text{cov}(r_t^i, c_t^M - E_{t-1}(c_t^M))}{\text{var}(r_t^M - E_{t-1}(r_t^M) - [c_t^M - E_{t-1}(c_t^M)])}, \tag{9}$$

$$\beta_i^{L3} = \frac{\text{cov}(c_t^i - E_{t-1}(c_t^i), r_t^M - E_{t-1}(r_t^M))}{\text{var}(r_t^M - E_{t-1}(r_t^M) - [c_t^M - E_{t-1}(c_t^M)])}. \tag{10}$$

Equation (6) states that the required excess return is composed of the following terms:

(1) The relative illiquidity cost, $E(c_t^i)$.[50]

(2) A component that is due to the covariation of individual asset return with the market return, i.e. the standard market beta, β_i.

(3) A component that arises due to the covariation of individual asset liquidity with market liquidity, β_i^{L1}. It captures the commonality in liquidity [See Chordia, Roll, and Subrahmanyam (2000), Hasbrouck and Seppi (2001), and Huberman and Halka (2001)]. This risk factor is expected to load positively with the expected excess return (irrespective of whether I am using a liquidity or illiquidity measure), since investors need to be compensated for holding stocks whose liquidity drops when the market liquidity diminishes.

[50]The way illiquidity costs affect required returns has been shown originally by Amihud and Mendelson (1986, 1989), and then later documented by a number of other researchers.

(4) A component that arises due to the covariation of returns of asset *i* with marketwide liquidity/illiquidity, β_i^{L2} [See Pastor and Stambaugh (2003) and Sadka (2005)]. Investors are willing to accept low returns on an asset that provides high returns during periods of market illiquidity. Thus, this risk factor is expected to load negatively with required excess returns if an illiquidity measure is utilized, and positively in the case of a liquidity measure.

(5) The final component of expected excess returns arises due to the comovement of individual asset liquidity with market returns, β_i^{L3}. It is expected to also load negatively for illiquidity measures and positively for liquidity measures; investors are willing to accept lower returns on assets that are liquid in down markets.

2.5. Empirical Methodology and Findings

The empirical procedure follows the lines of Acharya and Pedersen (2005) and is as follows:

(i) I first construct portfolios to be used as test assets in my analysis, sorted on maturity, credit rating, and liquidity/illiquidity. This is similar to Acharya and Pedersen (2005) and Downing et al. (2005), and helps to reduce the noise that is embedded in tests on individual assets. I also construct market-wide portfolios. I then compute the return and liquidity of each portfolio in each trading week.

(ii) Due to the documented persistence in liquidity, I form innovations in liquidity, $c_t^p - E_{t-1}(c_t^p)$, for each portfolio.

(iii) I estimate the liquidity betas using the liquidity innovations and returns.

(iv) I run cross-sectional regressions using a GMM framework to test the fit of the LCAPM.

5.1. Formation of portfolios

The return of each portfolio (test and market portfolios) in week t is computed as follows:

$$r_t^{p} = \sum_i w_t^{ip} r_t^{i}, \tag{11}$$

where i represents all the bond issues that are part of portfolio p in week t, and w_t^{ip} are equal-weights. Table 2.6 displays characteristics of portfolios formed after sorting using the five liquidity/illiquidity measures. Interestingly, the expected excess returns increase monotonically as illiquidity is increasing in panels A and B. Illiquidity here is sorted by using the two variables that capture the price impact of trades, the volatility to volume ratio #1 and #2, as described earlier. The same monotonic increase as illiquidity is increasing is observed also in the standard deviation of portfolio returns. All illiquid portfolios exhibit a high degree of persistence. Furthermore, the return difference between the most and least illiquid portfolio is statistically significant at the 1% level. These results suggest that liquidity might actually be priced and thus investors require higher expected returns in order to hold illiquid assets. However, more tests are needed to arrive to such a conclusion.

As it was pointed out earlier, I am also considering three other measures of liquidity in addition to the ones above that capture the price impact of trades. These are the trading frequency (number of transactions), dollar trading volume, as well as turnover. Panel C shows that the returns of portfolios sorted on trading frequency seem to fall as liquidity is increasing (as expected), but then rise for the most liquid portfolio. Thus, contrary to my expectation, the return difference between the most liquid and least liquid portfolio is positive and significant. The same pattern is observed for portfolios sorted on trading volume (panel D) and turnover (panel E). Again, all portfolios in these three panels exhibit high autocorrelations.[51] A plausible reason for the above findings could be due to the fact that bonds were gradually disseminated, with the first phase of TRACE consisting of large issue size bonds that are more active, while in later phases, smaller issue size (and less actively traded) bonds were added. To address this issue, I recalculate the portfolio characteristics sorting on the last three measures of liquidity and restricting the sample to the period from Oct.1, 2004 to Dec.31, 2004. This is the period after the initiation of the third phase of TRACE where almost all corporate bonds became subject to dissemination. In terms of portfolios sorted on trading frequency, the return difference between the

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[51]All the above results regarding portfolio characteristics are fairly consistent with the findings of Downing et al. (2005), using similar liquidity measures and data. However the way that they calculate returns differs from this paper. In their study, total return for bond i during week t is given by first taking the difference between the price of the last and first transaction during the week, adding the accrued interest that accumulated during the week, and then dividing by the price of the first transaction.

high and low frequency portfolios remains significant. For portfolios sorted on dollar volume and turnover, the return difference now between the most liquid and least liquid portfolio becomes insignificant.

Table 2.7 reports characteristics of portfolios sorted on maturity, credit rating, and liquidity/illiquidity. Panel A represents five equal-weighted bond portfolios sorted every week on time remaining to maturity. The first quintile is the portfolio that includes bonds with the shortest time to maturity, while the fifth quintile includes bonds with the longest time to maturity. Average expected excess returns seem to increase as time to maturity increases. Furthermore, all portfolios exhibit high persistence in returns, indicative by the high degree of first-order autocorrelation. The difference in returns between the longest and shortest maturity portfolios is 194 bp, and is significant at the 1% level.

Panel B reports characteristics for portfolios sorted on credit rating class. As we move then from the AAA-rated portfolio to lower credit rating levels, returns increase monotonically, a probable outcome due to the higher credit and liquidity risk of lower-rated bonds. All portfolios exhibit high persistence in returns, while the difference in returns between the junk- and AAA-rated portfolios is 283 bp and significant at the 1% level.

Test assets are also constructed by sorting bonds first on maturity and then on liquidity/illiquidity, as well as on credit rating and then on liquidity/illiquidity. Panels C and D report portfolio characteristics for these test assets, using the volatility to volume ratio #1 as the illiquidity measure; panels E and F report the same characteristics, using the volatility to volume ratio #2 to capture illiquidity. The column labeled portfolio 5-1 represents the difference in returns between the most illiquid and least illiquid portfolio, for each maturity and rating class. For portfolios with a short time remaining to maturity, there is a positive and significant difference in returns between the most illiquid and least illiquid portfolio. This is not the case however for portfolios with a longer time remaining to maturity. Furthermore, for investment-grade bonds, there is a also a positive and significant difference in returns between the most illiquid and least illiquid portfolio. Interestingly however, this pattern is not observed for high-yield bonds, using the volatility to volume ratio #1 as the illiquidity measure (panel D). There is actually a negative and significant difference in returns between the most illiquid and least illiquid portfolios.

Panels G and H report the same characteristics of test portfolios sorted on maturity/credit rating and liquidity, using trading frequency as the liquidity measure; panels I and J using trading volume, and panels K and L using turnover. Examining these panels, what is observed is that similar to the findings from the two illiquidity measures, liquidity seems to have a bigger impact on portfolios with a short time remaining to maturity, as well as on portfolios with highly-rated issues (rating levels of AAA, AA, and A). For these cases, more liquid portfolios seem to exhibit lower expected bond returns than less liquid portfolios.

5.2. Innovations in Liquidity/Illiquidity

The next step is to compute the liquidity/illiquidity of each portfolio (test and market portfolio). This is done as follows:

$$c_t^p = \sum_i w_t^{ip} c_t^i, \tag{12}$$

where i represents all the bond issues that are part of portfolio p in week t, w_t^{ip} are equal-weights, and c_t^i is the liquidity/illiquidity level for each issue during week t. As it was pointed out by Acharya and Pedersen (2005), liquidity/illiquidity is very persistent. This is also evident from Figure 2.1, where it exhibits the variation of market liquidity/illiquidity through time. For example, the first- and second-order autocorrelation of the market illiquidity (formed using the volatility to volume ratio #1) is 0.87 and 0.81, respectively, at a weekly frequency. For that reason, and similar to previous studies [Pastor and Stambaugh (2003), Acharya and Pedersen (2005)], I form innovations in illiquidity, $c_t^p - E_{t-1}(c_t^p)$, to compute the liquidity betas using an AR(2) specification. These innovations are formed for both the market portfolio as well as all the test portfolios (utilizing all liquidity/illiquidity measures). The residual from the AR(2) specification captures these innovations.

To demonstrate the reasons for choosing an AR(2), this specification for market illiquidity (formed using the volatility to volume ratio #1) has an R^2 of 78%, and the standard deviation of residuals is at 0.44%. Furthermore, the autocorrelation of these residuals is very low (-0.05). An AR(1) specification results in a much higher autocorrelation (-0.24), whereas an AR(3) specification produces the same explanatory power (an R^2 of 78%). Figure 2.2 exhibits the innovations in market liquidity/illiquidity for all liquidity/illiquidity measures, each series scaled by its standard deviation.

5.3. Estimation of Betas

The next step is to compute the four betas for all test portfolios, according to Eqs. (7)-(10). To calculate the four betas, I am utilizing the liquidity/illiquidity innovations of all test portfolios as well as the market portfolio. Furthermore, I am employing an AR(2) specification to calculate innovations in market portfolio returns. Table 2.8 reports descriptive statistics for the five test portfolios sorted on liquidity/illiquidity (Panel A), as well as for a selected group from the 50 portfolios sorted on maturity and liquidity/illiquidity (Panel B) and credit rating and liquidity/illiquidity (Panel C).

Sections A and B display the results for the illiquidity measures, whereas sections C, D, and E report the results for the three liquidity measures. The first two sections seem to indicate that illiquid portfolios tend to have high liquidity risk, evidenced by large positive values of β^{L1}, as well as large negative values of β^{L2} and β^{L3}. Specifically, panel A displays the results for five portfolios sorted on illiquidity, whereas panels B and C display descriptive statistics for the most illiquid and least illiquid portfolios for each maturity group and credit rating category, respectively. Furthermore, illiquid bonds tend to have volatile illiquidity innovations,

$\sigma(\Delta c^P)$. These results are consistent with Acharya and Pedersen (2005). However, the other three sections seem to contradict the above findings. When liquidity is captured using the trading frequency, trading volume, and turnover, it seems that the more liquid portfolios have the larger positive values of β^{L1}, β^{L2}, and β^{L3}. This is contrary to the LCAPM where it states that the more illiquid portfolios should have the higher level of liquidity risk.

5.4. Cross-Sectional Regressions

In this section and following the methodology of Acharya and Pedersen (2005), I am running cross-sectional regressions on all test portfolios (for all five liquidity measures) using a GMM framework. The betas are pre-estimated using eqs. (7)-(10), whereas the standard errors are computed using the Newey and West (1987) method with two lags. Table 2.9 displays the results. For each test portfolio, I run six different cross-sectional regressions. Line 1 is a regression using only the standard market beta; line 2 represents the results for a regression that includes the relative liquidity/illiqudity cost, $E(c^P)$, as well as a net liquidity beta. For illiqudity measures, the net liquidity beta is computed as follows:

$$\beta^{L4} = \beta^{L1} - \beta^{L2} - \beta^{L3}, \tag{13}$$

whereas as for liquidity measures,

$$\beta^{L4} = \beta^{L1} + \beta^{L2} + \beta^{L3}. \tag{14}$$

Line 3 is a cross-sectional regression that includes the relative liquidity/illiquidity cost, the market beta, as well as the net liqudity beta. In sections A and B, β^{L4} is positive and significant in most cases indicating that liquidity risk does matter. In the above two sections, liquidity is captured using the volatility to volume ratios #1 & #2. In the remaining three sections, the three liquidity measures are utilized. Contrary to the previous findings, in a number of cases here, the liquidity beta is negative and significant.

In line 4, I run a cross-sectional regression that includes the relative liquidity/illiquidity cost, as well as a net beta, β^{NET}. This net beta is formed by adding the market beta to the net liquidity beta, β^{L4}. Line 5 includes the market beta as well as the net beta. Again, for the first two sections, the net beta is positive and significant. However, in a number of cases for the remaining three sections, it becomes negative and significant.

In all the previous specifications, there is only one liquidity risk premium. In the last specification (line 6), I allow each beta to have a different risk premium. The coefficients on the betas become insignificant now for a number of cases, most probably due to the high collinearity among the different liquidity betas. This is consistent with the findings of Acharya and Pedersen (2005). In other cases, the coefficients have the opposite sign of what is predicted.

Overall, the results do not exhibit strong support that liquidity risk does matter, especially when the three liquidity measures are used (trading frequency, trading volume, and turnover). When the two illiquidity measures are used, the support for liquidity is stronger, however as it was pointed out earlier the two measures might actually be capturing information that impacts the bond's price during the week, that is unrelated to any liquidity considerations. Furthermore, looking at the intercept, in all cases is positive and highly significant, a result that does not lend support for the validity of the LCAPM in the bond market.

2.6. Conclusions

This study examines the effect of liquidity on corporate bond prices in the spirit of Acharya and Pedersen's (2005) liquidity-adjusted capital asset pricing model. According to the LCAPM, liquidity risk can affect expected returns in various ways: due to the commonality in liquidity with the market, due to the covariation of individual asset's return with the market liquidity, and lastly due to the covariation of individual asset's level of liquidity with market returns. Using a large panel data set of corporate bond market transactions that cover the period from July 1, 2002 to December 31, 2004 (TRACE data), I examine whether these various sources of liquidity risk are priced in corporate bonds.

My main findings are as follows: The various sources of liquidity risk, as defined in the liquidity-adjusted capital asset pricing model of Acharya and Pedersen (2005), do not seem to have a great effect on corporate bond prices. Specifically, after sorting bonds into weekly portfolios based on liquidity (measured using the trading frequency, trading volume, and turnover), as well as maturity/credit rating and liquidity, I do not find that illiquid portfolios have higher levels of liquidity risk than more liquid portfolios. The liquidity risk is measured by constructing three liquidity betas that capture the commonality in liquidity with the market, the sensitivity in returns with the market liquidity, and the liquidity sensitivity with the market returns. Furthermore, cross-sectional regressions using a GMM framework do not lend support either for the LCAPM or that the above sources of liquidity risk strongly matter for corporate bond prices. There is an indication that liquidity risk does matter if liquidity is captured using the two volatility to volume ratio measures. However these measures, as it was explained earlier, can be biased since they can be capturing information unrelated to any liquidity considerations.

Figure 2.1: Systematic Measures of Liquidity/Illiquidity

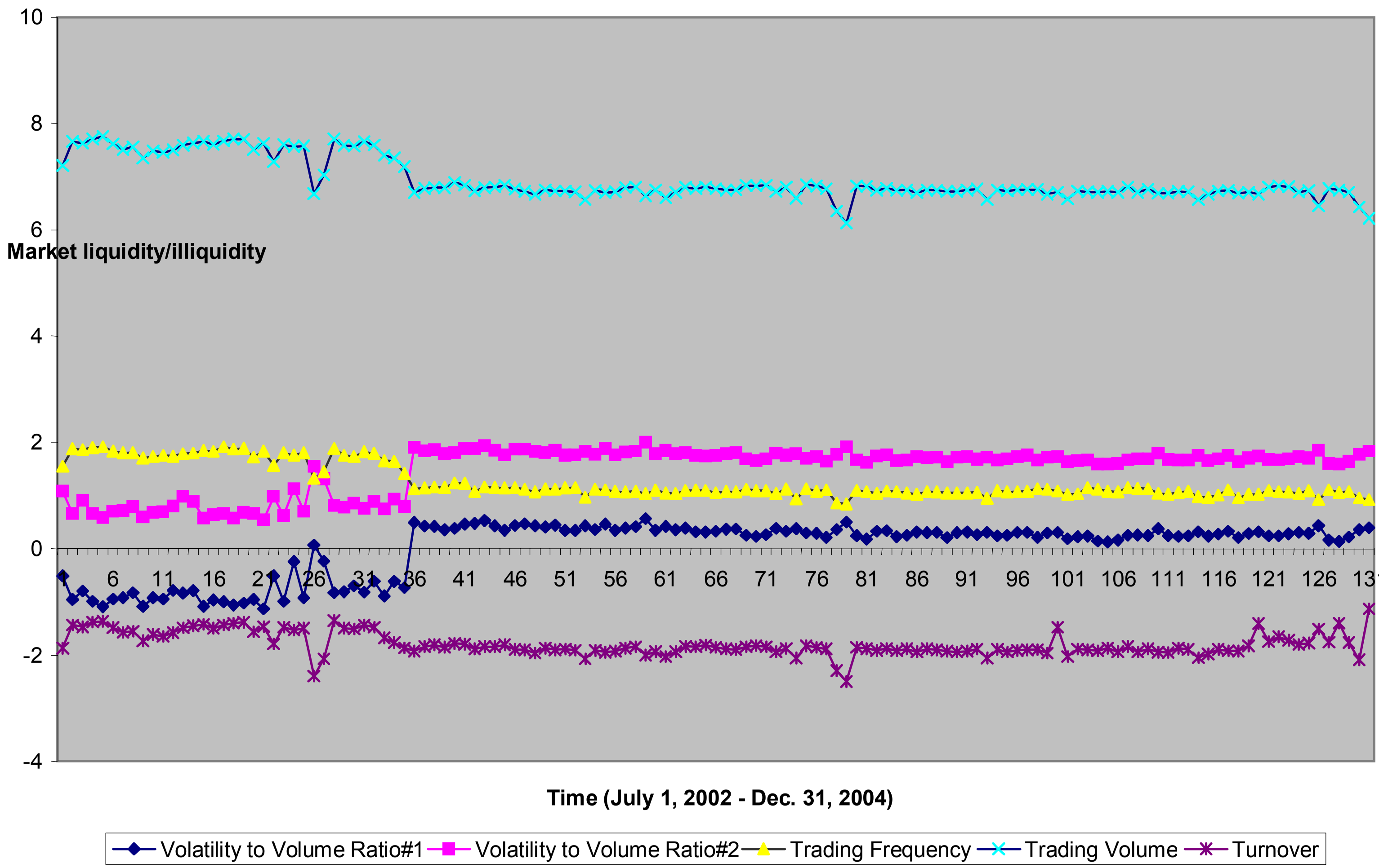

Figure 2.2: Standardized Innovations in Market Liquidity/Illiquidity

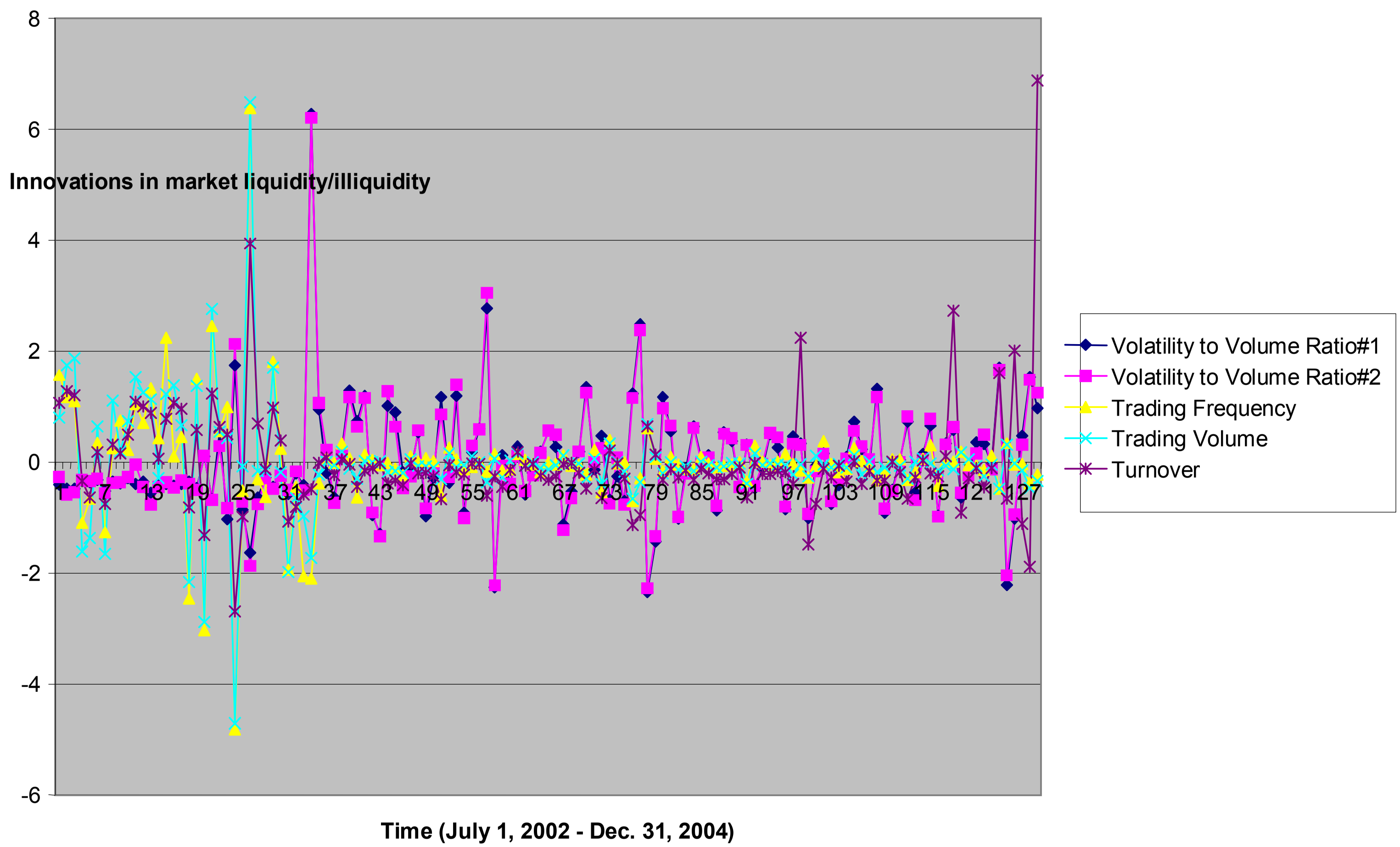

Table 2.1
Number of Transactions, Issues, and Issuers

I include corporate bonds with a fixed rate, credit rating, from U.S. issuers, with semi-annual coupons, nonputtable, and nonconvertible. I exclude asset-backed securities, credit enhancements, yankees, Canadian, bonds in foreign currencies, issues offered globally, bonds with announced calls, perpetual, exchangeable, and preferred securities. The industry groups include the industrial, financial, and utility sectors.

Panel A: No. of trans. by year			**No. of issues**		**No. of issuers**		**No. of trans./month**	**No. of issues/month**	**No. of trans./issue/month**
	N	**%**	**N**		**N**		**N**	**N**	**N**
2002-2004	1,921,390	100.0	4,270		1,139		64,046	1,407	86
2002	179,617	9.3	296		162		29,936	140	222
2003	798,552	41.6	1,992		584		66,546	1,414	64
2004	943,221	49.1	4,002		1,103		78,602	2,035	40
Panel B: No. of trans. by rating			**No. of issues/rating**		**No. of issuers/rating**		**No. of trans./month**	**No. of issues/month**	**No. of trans./issue/month**
	N	**%**	**N**		**N**		**N**	**N**	**N**
AAA	67,915	3.5	119		32		2,264	56	84
AA	164,081	8.5	406		96		5,469	160	53
A	1,079,381	56.2	1,930		456		35,979	900	72
BBB	412,560	21.5	1,698		501		13,752	244	132
BB	77,298	9.7	195		85		2,577	28	143
B	103,847	13.0	156		86		3,462	23	222
CCC	9,459	0.5	16		12		473	3	175
Below CCC	6,849	0.4	16		6		527	4	140
Inv-Gr.	1,723,937	89.7	3,953		992		57,465	1,355	82
High-Yield	197,453	10.3	355		166		6,582	54	184
Panel C: No. of trans. by industry			**No. of issues/industry**		**No. of issuers/industry**		**No. of trans./month**	**No. of issues/month**	**No. of trans./issue/month**
	N	**%**	**N**	**%**	**N**	**%**	**N**	**N**	**N**
Industrial	1,083,990	56.4	2,088	48.9	599	52.6	36,133	714	94
Financial	678,868	35.3	1,457	34.1	349	30.6	22,629	521	80
Utility	158,532	8.3	725	17.0	191	16.8	5,284	172	57
Panel D: No. of trans. by maturity			**No. of issues/maturity**		**No. of issuers/maturity**		**No. of trans./month**	**No. of issues/month**	**No. of trans./issue/month**
	N	**%**	**N**		**N**		**N**	**N**	**N**
Short (0-7 yrs)	1,111,083	57.8	2,711		954		37,036	868	80
Medium (7-15 yrs)	494,216	25.7	925		546		16,474	258	115
Long (15 yrs-30 yrs)	297,945	15.5	760		400		9,932	256	60
V. Long (30 yrs-onwards)	18,146	0.9	103		77		672	32	18

Table 2.2
Bond Characteristics

I report bond characteristics for the TRACE sample for the period July 1, 2002 to December 31, 2004. These are the issue size (in million of U.S. dollars), the original maturity (in years), the years remaining to maturity, the age of the bond (time that elapsed since the bond started earning interest), the trade size (in thousand of U.S. dollars), the daily volume (in thousand of U.S. dollars), the number of daily trades, and the number of days between trades.

	Mean	Median	25% quantile	75% quantile	Max
Issue size ($million)	268	200	120	300	3,000
Original maturity (years)	14.6	10	10	20	100
Years to maturity	8.25	4.94	2.48	9.28	95.19
Age (years)	5.26	4.96	2.05	7.81	67.60
Trade size ($K)	469	30	10	200	5,000
Daily volume ($K)	2,219	194	40	1,391	450,080
Number of daily trades	4.7	3.0	1.0	5.0	1,488.0
Days between trades	3.29	1.00	1.00	3.00	826.00

Table 2.3
Average Corporate Bond Spreads and Expected Excess Bond Returns

Using panel data between July 1, 2002 to December 31, 2004, I report corporate bond spreads (in basis points) and expected excess bond returns (in basis points). For the benchmark Treasuries, I use linear interpolation to obtain estimates of the yield curve from the Federal Reserve's Constant Maturity Treasury (CMT) series. I include bonds with a fixed rate, credit rating, from U.S. issuers, with semi-annual coupons, nonputtable, and nonconvertible. I exclude asset-backed securities, credit enhancements, yankees, Canadian, bonds in foreign currencies, issues offered globally, bonds with announced calls, perpetual, exchangeable, and preferred securities. The industry groups include the industrial, financial, and utility sectors.

	AAA	AA	A	BBB	BB	B	CCC	Below CCC	IG	HY	Total Market	Industrial Total	Financial Total	Utility Total
Panel A: Breakdown by Year, All Maturities (Spreads)														
2002-2004	97	119	144	284	440	952	1,813	1,751	173	821	240	284	116	468
2002	105	126	235	497	822	1389	1,898	1,925	349	1,277	551	643	188	1,143
2003	106	133	156	283	550	999	1,949	1,862	176	910	235	266	119	512
2004	89	105	122	212	297	655	1,621	1,693	141	574	184	213	103	350
Panel B: Breakdown by Year, All Maturities (Expected Excess Bond Returns)														
2002-2004	77	97	119	239	345	641	206	303	144	493	179	205	89	392
2002	84	104	208	445	705	932	153	180	311	785	414	468	159	986
2003	85	110	130	237	425	663	166	80	147	559	180	198	93	419
2004	69	83	99	170	220	452	283	351	113	329	135	148	77	299
Panel C: Breakdown by Maturity, 2002-2004 (Spreads)														
Short (0-7 yrs)	70	82	95	243	401	906	1,823	1,753	121	862	191	256	96	375
Medium (7-15 yrs)	492	466	508	611	856	1,395	1,848	2,237	147	799	250	248	117	568
Long (15-30 yrs)	221	295	340	451	478	499	1,864	1,735	364	636	377	373	336	453
V. Long (30 yrs-onwards)	596	632	640	742	804	N/A	N/A	N/A	656	804	657	668	602	571
Panel D: Breakdown by Maturity, 2002-2004 (Expected Excess Bond Returns)														
Short (0-7 yrs)	50	60	70	198	306	552	209	262	93	429	125	154	71	300
Medium (7-15 yrs)	86	68	114	228	468	1,032	1,453	1,805	116	599	193	184	91	469
Long (15-30 yrs)	196	269	312	404	400	237	507	388	331	375	333	326	303	412
V. Long (30 yrs-onwards)	572	607	613	688	730	N/A	N/A	N/A	625	730	625	635	577	543

Table 2.4
Historical Measures of Liquidity/Illiquidity

I report measures of liquidity/illiquidity that have been previously used in the liquidity literature, together with an explanation as to how they capture and measure liquidity. These include measures for both equity and debt markets.

Measure	Justification/Effect on Liquidity
Bid-Ask Spread (Quoted and Effective)	Higher bid-ask spreads increase the cost of acquiring an asset
Bond Age	Over time, bonds become part of investors' portfolios, become inactive, and thus illiquid
Amount of Bond Outstanding	The larger the amount of of bond outstanding, the higher the liquidity
Trading Volume	Higher level of trading volume impies a more liquid asset or market
Quoted Depth	Higher level of depth implies a more liquid asset or market
Quote and Trade Size	Larger size implies a more liquid asset or market
Quote and Trade Frequency	Higher frequency of trades implies a more liquid asset or market
Turnover	Higher turnover implies a more liquid asset or market
On-the-run/Off-the-run Spread	When liquidity is low, the spread between on-the-run/off-the-run securities increases
Price Impact of a Trade	Higher price impact of a trade implies a lower level of liquidity
Yield Dispersion	Higher yield dispersion implies a lower level of liquidity for a bond issue
Number of Contributors	A larger number of contributors following a bond, implies a higher level of liquidity
Time to Maturity	Shorter-maturity bonds can be more liquid than longer-maturity bonds
Order Imbalance	Higher order imbalance implies a lower level of liquidity

Table 2.4…*continued*
Historical Measures of Liquidity/Illiquidity

I report measures of liquidity that have been previously used in the liquidity literature, together with an explanation as to how they capture and measure liquidity. These include measures for both equity and debt markets.

Measure	Justification/Effect on Liquidity
Daily Ratio of Absolute Stock Return to Dollar Volume	Similar to price impact of a trade. Higher ratio implies lower liquidity
Swap Spreads	The higher the spread, implies a less liquid market
Frequency of Quotes Vs. Matrix Prices in the Warga Database	Matrix prices are created when there are no quotes. The higher this ratio, implies a more liquid asset or market
3-month CP/T-Bill Spread	CP have similar default risk to Treasury Bills, but are less liquid. Higher spread implies lower liquidity
REFCORP/T-Bill Spread	REFCORP issues are backed by the U.S. government, but are less liquid.
Dummy Variable for Bonds Issued by Financial Firms	Securities of financial firms have higher liquidity, since these firms are more connected to capital markets
Dummy Variable for Bonds Issued by Highly-Rated Firms	Securities of highly-rated firms enjoy similar liquidity to Treasury issues
Percentage of Zero Returns	Informed traders would not trade on a day, when transaction costs are high enough to erase any gains
Bound around Bond Price within New Info would not induce a transaction	The higher the bound, implies transaction costs are too high to create any gains from the new info
Volume-Related Return Reversal	Stronger volume-related return reversal implies a lower level of liquidity
Institutional Equity Acquisition	Institutions can provide liquidity to the market
Bond Accessibility	If the bond is owned by buy and hold investors (e.g. insurance companies) is less accessible to dealers and is considered less liquid. If it's owned by more active investors (e.g. hedge funds) is considered more liquid
Ratio of Price Volatility to Volume	Higher price volatility/volume ratio implies a less liquid asset or market

Table 2.5
Correlation of Bond Liquidity/Illiquidity Measures

I report the correlation between five different bond liquidity measures for the period July 1, 2002, to December 31, 2004; volatility to volume ratio #1, volatility to volume ratio #2, trading frequency, trading volume, and turnover. The volatility to volume ratio #1 is calculated by dividing the standard deviation of prices for bond *i* during week *t* with the total amount transacted for the bond during the same week. The volatility to volume ratio #2 is calculated by first dividing the difference between the maximum and minimum price of bond *i* during week *t* with the median price to get a measure of volatility of prices, and then dividing by the volume transacted during the week. Trading frequency is the number of transactions for bond *i* during week *t*, trading volume is the dollar amount transacted, and turnover is the dollar volume divided by the original issue size. Panel A is constructed by first taking a time-series average of the correlation between any two measures, and then a cross-sectional average for the sample. Panel B on the other hand is first a cross-sectional average for every trading week, and then a time-series average for all trading weeks. P-values are in parentheses.

	Volatility to Volume Ratio #1	Volatility to Volume Ratio #2	Trading Frequency	Trading Volume	Turnover
Panel A: Time-series average, followed by a cross-sectional average					
Volatility to Volume Ratio #1	1.00	0.98	-0.26	-0.49	-0.49
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
Volatility to Volume Ratio #2	0.98	1.00	-0.22	-0.49	-0.49
	(<.0001)		(<.0001)	(<.0001)	(<.0001)
Trading Frequency	-0.26	-0.22	1.00	0.37	0.37
	(<.0001)	(<.0001)		(<.0001)	(<.0001)
Trading Volume	-0.49	-0.49	0.37	1.00	1.00
	(<.0001)	(<.0001)	(<.0001)		(<.0001)
Turnover	-0.49	-0.49	0.37	1.00	1.00
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	
Panel B: Cross-sectional average, followed by a time-series average					
Volatility to Volume Ratio #1	1.00	0.98	-0.15	-0.19	-0.21
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
Volatility to Volume Ratio #2	0.98	1.00	-0.13	-0.19	-0.22
	(<.0001)		(<.0001)	(<.0001)	(<.0001)
Trading Frequency	-0.18	-0.16	1.00	0.23	0.13
	(<.0001)	(<.0001)		(<.0001)	(<.0001)
Trading Volume	-0.19	-0.19	0.23	1.00	0.72
	(<.0001)	(<.0001)	(<.0001)		(<.0001)
Turnover	-0.22	-0.22	0.13	0.72	1.00
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	

Table 2.6
Portfolio Characteristics Sorted on Liquidity/Illiquidity

I report characteristics of equal-weighted portfolios formed each trading week during July 1, 2002 and December 31, 2004, sorted using various liquidity (illiquidity) measures. Panel A consists of 5 portfolios sorted on volatility to volume ratio #1, panel B of 5 portfolios sorted on volatility to volume ratio #2, panel C of 5 portfolios sorted on trading frequency, panel D of 5 portfolios sorted on trading volume, and panel E of 5 portfolios sorted on turnover. The superscripts ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Portf. sorted on Volat. to Volume Ratio #1

Sort Order	Quintile	Mean	Std. Dev.	Autocorr.
Illiquidity	1	143.95	72.83	0.81
Increasing	2	171.81	113.25	0.90
	3	177.59	124.63	0.90
	4	187.11	143.72	0.85
	5	221.77	125.26	0.92
High - Low		77.82		
t-stat.		11.46***		

Panel B: Portf. sorted on Volatility to Volume Ratio #2

Sort Order	Quintile	Mean	Std. Dev.	Autocorr.
Illiquidity	1	133.61	55.61	0.82
Increasing	2	162.59	102.45	0.87
	3	178.32	125.08	0.88
	4	191.24	147.43	0.88
	5	236.63	147.39	0.89
High - Low		103.02		
t-stat.		11.05***		

Panel C: Portf. sorted onTrading Frequency

Sort Order	Quintile	Mean	Std. Dev.	Autocorr.
Liquidity	1	176.33	105.92	0.89
Increasing	2	178.88	112.88	0.90
	3	173.84	115.16	0.91
	4	161.34	94.62	0.92
	5	202.04	129.35	0.95
High - Low		25.71		
t-stat.		3.67***		

Panel D: Portf. sorted on Trading Volume

Sort Order	Quintile	Mean	Std. Dev.	Autocorr.
Liquidity	1	186.59	95.49	0.87
Increasing	2	178.16	110.28	0.92
	3	164.35	116.75	0.91
	4	164.11	104.37	0.92
	5	200.43	131.19	0.93
High - Low		13.84		
t-stat.		2.00**		

Panel E: Portf. sorted on Turnover

Sort Order	Quintile	Mean	Std. Dev.	Autocorr.
Liquidity	1	177.07	76.27	0.77
Increasing	2	168.43	97.15	0.86
	3	163.22	113.57	0.90
	4	181.87	133.21	0.91
	5	202.62	140.82	0.94
High - Low		25.55		
t-stat.		3.01***		

Table 2.7
Portfolio Characteristics Sorted on Maturity, Credit Rating, and Liquidity/Illiquidity

I report characteristics of equal-weighted portfolios formed each trading week during July 1, 2002 and December 31, 2004, sorted on maturity, credit rating, and liquidity/illiquidity. Panel A consists of 5 portfolios sorted on maturity, panel B of 5 portfolios sorted on credit rating class, panel C of 25 portfolios sorted on maturity and then on illiquidity (measured using the volatility to volume ratio #1), and panel D of 25 portfolios sorted on credit rating class and then on illiquidity (measured using the volatility to volume ratio #1); standard deviations of the portfolios in panels C and D are reported in parentheses. The superscripts ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Portf. sorted on Maturity | **Panel B: Portf. sorted on Credit Rating**

Sort Order	Quintile	Mean	Std. Dev.	Autocorr.	Rating	Quintile	Mean	Std. Dev.	Autocorr.
Maturity	1	111.24	58.08	0.93	**AAA**	1	99.40	27.41	0.53
Increasing	2	121.64	104.52	0.96	**AA**	2	104.16	33.09	0.49
	3	206.74	233.93	0.97	**A**	3	131.88	37.82	0.96
	4	169.88	150.26	0.96	**BBB**	4	215.44	100.49	0.97
	5	305.33	57.55	0.90	**JUNK**	5	382.50	223.58	0.97
Long-Short		194.10			**Junk - AAA**		283.10		
t-stat.		80.09***			**t-stat.**		15.08***		

Panel C: Portf. sorted by Maturity and Illiquidity (Volatility to Volume Ratio #1)

		Illiquidity Increasing						
		1	2	3	4	5	Portf. 5 - 1	t-stat.
Maturity	**1**	78.75	97.30	117.16	121.44	140.96	62.21	10.62***
Increasing		(49.38)	(69.66)	(88.06)	(87.69)	(80.19)	(67.06)	
	2	86.16	118.65	135.33	148.24	136.43	50.27	5.28***
		(83.29)	(115.87)	(139.25)	(168.90)	(128.45)	(108.97)	
	3	177.99	197.13	218.53	216.89	240.64	62.65	3.67***
		(198.12)	(258.63)	(311.09)	(290.43)	(293.81)	(195.40)	
	4	173.69	159.38	163.47	176.98	186.89	13.20	0.75
		(179.67)	(146.24)	(145.98)	(195.20)	(198.50)	(200.48)	
	5	325.55	327.70	307.99	298.04	299.00	-26.55	-2.47**
		(74.48)	(96.23)	(111.28)	(101.22)	(83.57)	(123..23)	

Panel D: Portf. sorted on Credit Rating and Illiquidity (Volatility to Volume Ratio #1)

	Illiquidity Increasing						
Rating	1	2	3	4	5	Portf. 5 - 1	t-stat.
AAA	65.49	75.79	92.94	98.06	119.03	53.54	8.60***
	(40.51)	(72.58)	(53.99)	(61.44)	(50.05)	(61.02)	
AA	62.32	75.60	75.70	100.35	149.93	75.24	10.43***
	'(27.52)	(62.37)	(44.80)	(86.98)	(97.43)	(78.03)	
A	100.40	115.23	124.09	130.22	165.38	64.99	23.90***
	(39.03)	(44.83)	(53.20)	(57.76)	(44.82)	(31.11)	
BBB	195.72	230.96	231.36	224.92	253.49	57.78	7.95***
	(78.01)	(127.84)	(127.95)	(111.19)	(93.21)	(83.18)	
JUNK	422.52	374.42	393.40	376.20	372.58	-49.94	2.80**
	(252.03)	(244.68)	(258.62)	(247.32)	(250.62)	(204.34)	

Table 2.7…*Continued*

Portfolio Characteristics Sorted on Maturity, Credit Rating, and Liquidity/Illiquidity

Panel E consists of 25 portfolios sorted on maturity and then on illiquidity (measured using the volatility to volume ratio #2), panel F of 25 portfolios sorted on credit rating class and then on illiquidity (measured using the volatility to volume ratio #2), Panel G consists of 25 portfolios sorted on maturity and then on liquidity (measured using the trading frequency), and panel H of 25 portfolios sorted on credit rating class and then on liquidity (measured using the trading frequency); standard deviations of the portfolios are reported in parentheses. The superscripts ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel E: Portf. sorted by Maturity and Illiquidity (Volatility to Volume Ratio#2)

		Illiquidity Increasing						
		1	2	3	4	5	Portf. 5 - 1	t-stat.
Maturity Increasing	1	74.78	90.99	114.41	126.22	150.37	75.60	10.47***
		(43.55)	(59.75)	(82.55)	(87.38)	(99.24)	(82.62)	
	2	74.47	108.59	130.54	163.71	146.75	72.28	7.73***
		(55.52)	(104.31)	(124.13)	(195.99)	(141.28)	(107.01)	
	3	156.63	187.76	201.43	241.52	257.23	100.60	5.19***
		(158.56)	(239.45)	(247.62)	(334.79)	(323.84)	(221.84)	
	4	137.30	152.53	164.10	182.48	220.90	83.60	5.12***
		(104.18)	(122.87)	(155.76)	(201.97)	(249.50)	(186.81)	
	5	318.18	331.05	301.14	306.26	301.08	-17.10	1.52
		(74.83)	(96.73)	(94.73)	(103.97)	(83.58)	(128.85)	

Panel F: Portf. sorted on Credit Rating and Illiquidity (Volatility to Volume Ratio#2)

	Illiquidity Increasing						
Rating	1	2	3	4	5	Portf. 5 -	t-stat.
AAA	64.03	75.18	95.22	96.99	119.37	55.34	9.08***
	(38.07)	(54.15)	(73.41)	(61.82)	(47.76)	(59.73)	
AA	63.24	74.08	83.56	100.56	142.61	69.26	10.32***
	(31.14)	(60.97)	(61.93)	(88.79)	(91.13)	(72.57)	
A	100.86	117.25	123.10	131.14	162.55	61.70	19.69***
	(39.75)	(47.74)	(52.17)	(57.44)	(39.57)	(35.87)	
BBB	184.78	223.30	232.24	229.26	266.40	81.62	8.92***
	(72.13)	(118.98)	(130.24)	(126.33)	(112.67)	(104.71)	
JUNK	364.10	383.47	398.19	376.98	412.27	48.17	2.47**
	(187.95)	(270.45)	(264.63)	(252.21)	(270.84)	(223.17)	

Panel G: Portf. sorted by Maturity and Liquidity (Trading Frequency)

		Liquidity Increasing						
		1	2	3	4	5	Portf. 5 - 1	t-stat.
Maturity Increasing	1	111.25	109.54	95.03	96.18	145.65	34.40	4.46***
		(73.94)	(66.15)	(50.63)	(53.62)	(113.47)	(88.18)	
	2	116.30	116.52	116.72	109.79	149.96	33.27	2.87***
		(121.64)	(106.80)	(110.55)	(99.01)	(163.22)	(132.11)	
	3	208.09	238.85	228.74	172.40	187.68	-20.41	0.94
		(309.63)	(327.00)	(318.22)	(199.90)	(185.82)	(248.32)	
	4	182.69	156.06	132.55	157.93	226.23	43.54	2.25**
		(247.51)	(179.17)	(119.27)	(144.94)	(215.25)	(221.90)	
	5	295.65	313.11	301.01	302.03	312.48	16.83	3.42***
		(62.63)	(88.01)	(89.60)	(96.84)	(53.14)	(56.41)	

Panel H: Portf. sorted on Credit Rating and Liquidity (Trading Frequency)

	Liquidity Increasing						
Rating	1	2	3	4	5	Portf. 5 -	t-stat.
AAA	102.94	121.40	103.46	83.45	69.92	-15.13	5.46***
	(41.06)	(86.12)	(49.35)	(33.57)	(21.94)	(31.70)	
AA	131.49	109.68	115.20	83.47	79.98	-51.76	4.19***
	(137.22)	(60.19)	(82.80)	(37.77)	(42.27)	(140.76)	
A	143.19	135.19	126.38	127.05	128.06	-31.71	6.92***
	(47.01)	(47.63)	(38.86)	(46.56)	(45.09)	(44.90)	
BBB	179.39	191.27	206.82	239.85	259.38	79.99	12.90***
	(85.16)	(99.62)	(109.70)	(136.89)	(119.62)	(70.96)	
JUNK	343.11	356.49	383.46	371.75	455.35	112.24	4.85***
	(291.94)	(237.22)	(247.24)	(226.57)	(277.70)	(264.96)	

Table 2.7…*Continued*

Portfolio Characteristics Sorted on Maturity, Credit Rating, and Liquidity/Illiquidity

Panel I consists of 25 portfolios sorted on maturity and then on liquidity (measured using the trading volume), panel J of 25 portfolios sorted on credit rating class and then on liquidity (measured using the trading volume), Panel K consists of 25 portfolios sorted on maturity and then on liquidity (measured using the turnover), and panel L of 25 portfolios sorted on credit rating class and then on liquidity (measured using the turnover); standard deviations of the portfolios are reported in parentheses. The superscripts ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel I: Portf. sorted by Maturity and Liquidity (Trading Volume)

		Liquidity Increasing						
		1	2	3	4	5	Portf. 5 - 1	t-stat.
Maturity	**1**	137.00	118.41	99.82	89.43	112.35	-24.65	2.97***
Increasing		(65.16)	(80.19)	(72.68)	(63.25)	(92.98)	(94.95)	
	2	119.89	115.90	117.33	125.44	129.40	9.51	2.87***
		(102.79)	(110.71)	(122.26)	(132.06)	(130.58)	(112.77)	
	3	210.03	222.09	213.19	186.11	201.70	-8.33	0.38
		(296.57)	(312.34)	(293.76)	(236.54)	(228.43)	(251.88)	
	4	189.61	164.32	143.24	147.38	209.17	19.56	1.28
		(225.74)	(195.88)	(148.46)	(135.75)	(203.00)	(175.28)	
	5	276.03	293.85	303.07	310.59	342.22	66.19	10.07***
		(53.91)	(79.97)	(75.77)	(86.66)	(79.66)	(75.25)	

Panel J: Portf. sorted on Credit Rating and Liquidity (Trading Volume)

	Liquidity Increasing						
Rating	1	2	3	4	5	Portf. 5 - 1	t-stat.
AAA	115.26	113.32	102.15	78.12	79.37	-34.83	7.00***
	(41.13)	(84.88)	(55.32)	(40.00)	(31.47)	(49.00)	
AA	143.45	111.87	84.17	87.77	101.09	-42.35	3.54***
	(135.40)	(69.06)	(56.41)	(62.64)	(84.97)	(136.95)	
A	148.37	134.51	124.18	118.73	133.60	-14.77	3.27***
	(37.27)	(47.15)	(46.96)	(44.50)	(49.58)	(51.69)	
BBB	207.04	192.94	193.78	224.61	259.40	52.35	5.84***
	(74.94)	(89.78)	(107.65)	(143.86)	(144.92)	(102.63)	
JUNK	337.53	351.76	381.86	389.15	447.77	110.24	5.32***
	(273.71)	(222.69)	(248.55)	(283.07)	(285.38)	(237.24)	

Panel K: Portf. sorted by Maturity and Liquidity (Turnover)

		Liquidity Increasing						
		1	2	3	4	5	Portf. 5 - 1	t-stat.
Maturity	**1**	135.36	115.37	98.20	98.29	109.73	-25.63	3.26***
Increasing		(72.80)	(68.67)	(66.29)	(75.14)	(89.61)	(89.99)	
	2	110.53	97.58	113.66	133.99	153.43	42.90	3.64***
		(89.17)	(79.42)	(114.94)	(149.90)	(167.03)	(134.72)	
	3	191.85	193.10	221.39	199.25	232.83	40.98	1.62
		(275.46)	(249.96)	(307.91)	(250.14)	(288.34)	(289.30)	
	4	167.75	164.92	150.41	155.63	214.61	46.86	2.72***
		(201.86)	(179.38)	(141.09)	(142.04)	(231.99)	(197.13)	
	5	284.90	298.60	300.39	327.57	313.52	28.62	4.90***
		(61.15)	(77.09)	(76.84)	(102.60)	(65.90)	(66.79)	

Panel L: Portf. sorted on Credit Rating and Liquidity (Turnover)

	Liquidity Increasing						
Rating	1	2	3	4	5	Portf. 5 - 1	t-stat.
AAA	110.38	114.66	101.58	80.78	79.33	-29.99	6.18***
	(41.83)	(85.28)	(54.04)	(39.39)	(31.90)	(47.81)	
AA	140.89	100.49	93.79	82.46	110.48	-30.41	2.34***
	(138.61)	(52.93)	(63.16)	(47.00)	(93.18)	(148.99)	
A	148.83	137.34	121.57	125.30	125.63	-23.20	6.14***
	(39.34)	(46.59)	(48.49)	(51.91)	(40.87)	(43.22)	
BBB	213.03	194.84	200.45	231.33	238.33	25.30	3.11***
	(79.75)	(95.29)	(113.84)	(145.22)	(131.03)	(93.03)	
JUNK	327.92	329.11	396.43	393.57	460.74	132.81	6.02**
	(270.16)	(201.74)	(288.91)	(249.25)	(270.32)	(252.40)	

Table 2.8

Descriptive Statistics of Test Portfolios

I report descriptive statistics of the five portfolios sorted on liquidity/illiquidity (using all the five liquidity/illiquidity measures), as well as for a selected group from the portfolios sorted on maturity and liquidity/illiquidity and credit rating and liquidity/illiquidity (for example, in Panel B, portfolio 1, 1 represents the portfolio with the lowest maturity and lowest liquidity/illiquidity level; in Panel C, portfolio AAA, 1 represents the portfolio with a AAA credit rating level and lowest liquidity/illiquidity level). The market beta is represented by β, while the three liquidity betas are represented by β^{L1}, β^{L2}, and β^{L3}, respectively. All betas are scaled to facilitate presentational purposes. $E(c^P)$ represents the average weekly liquidity/illiquidity of the test portfolios, while $\sigma(\Delta c^P)$ represents the standard deviation of a portfolio's liquidity/illiquidity innovations.

	Section A: Volatility to Volume Ratio#1						Section B: Volatility to Volume Ratio#2						Section C: Trading Frequency					
Portfolios	β	β^{L1}	β^{L2}	β^{L3}	$E(c^P)$	$\sigma(\Delta c^P)$	β	β^{L1}	β^{L2}	β^{L3}	$E(c^P)$	$\sigma(\Delta c^P)$	β	β^{L1}	β^{L2}	β^{L3}	$E(c^P)$	$\sigma(\Delta c^P)$
	Panel A: Portfolios sorted on liquidity/illiquidity																	
1	12.15	0.00	-2.01	0.00	0.02	0.01	7.75	0.50	-19.04	-0.08	0.72	0.28	119.50	3.30	40.84	2.59	2.43	1.71
2	60.60	0.00	-3.99	-0.02	0.08	0.03	31.86	1.86	-50.75	-0.31	2.61	0.90	157.07	11.29	87.55	9.19	7.13	4.01
3	100.56	0.01	-4.57	-0.04	0.24	0.08	56.02	5.81	-71.45	-0.75	7.65	2.52	76.20	17.32	45.80	14.33	13.39	5.82
4	96.07	0.05	-4.44	-0.14	0.87	0.29	64.48	19.56	-76.22	-2.69	25.83	8.21	36.72	26.48	31.26	18.74	24.38	8.48
5	113.55	0.37	-3.79	-1.42	7.01	1.93	63.71	135.11	-61.47	-19.92	184.08	47.78	82.55	75.25	77.62	4.49	73.92	23.77
	Panel B: Portfolios sorted on maturity and liquidity/illiquidity																	
1,1	24.00	0.00	0.45	0.00	0.02	0.01	6.98	0.21	2.11	-0.03	0.56	0.20	89.31	2.08	66.43	0.66	2.03	1.56
1,5	43.21	0.24	-1.50	-0.06	3.94	2.25	64.97	80.49	-56.27	-0.07	101.67	50.26	19.20	65.22	88.10	17.80	70.11	38.61
2,1	-23.05	0.00	-2.35	-0.01	0.02	0.01	-18.56	0.39	-39.65	-0.15	0.84	0.30	151.05	3.70	46.20	4.68	2.35	2.45
2,5	238.46	0.17	-4.33	-0.98	4.61	2.01	130.40	56.92	-139.83	-17.63	121.36	45.72	131.93	90.84	124.93	3.87	69.37	36.31
3,1	167.50	0.00	-5.23	-0.01	0.03	0.01	33.88	0.78	-110.99	-0.20	1.02	0.49	138.83	9.37	66.46	9.68	3.45	4.49
3,5	257.57	0.21	-9.91	-0.34	5.26	2.38	187.11	82.30	-262.25	-10.00	141.19	60.66	217.55	212.00	84.79	11.40	130.96	85.54
4,1	242.81	0.00	-4.40	0.00	0.01	0.01	102.92	0.51	-66.52	-0.04	0.57	0.41	309.19	5.37	123.24	0.28	4.21	4.02
4,5	222.00	0.22	-6.78	-1.56	5.12	2.95	140.07	78.26	-216.30	-14.87	133.40	71.96	79.68	82.78	45.85	15.30	95.85	43.54
5,1	6.89	0.00	0.87	-0.01	0.03	0.02	-6.03	1.10	44.08	-0.11	1.14	0.67	120.41	5.70	14.06	7.97	2.60	3.43
5,5	73.76	0.79	-1.95	-2.76	14.26	5.08	52.54	293.33	-46.83	-40.24	369.14	127.90	-11.26	59.60	42.89	-16.27	61.01	22.27
	Panel C: Portfolios sorted on credit rating and liquidity/illiquidity																	
AAA,1	12.42	0.00	-0.65	-0.01	0.03	0.02	17.72	1.14	-19.12	-0.1	1.11	0.72	68.79	0.2	18.92	0.22	1.36	0.41
AAA,5	2.88	0.59	0.20	-1.75	10.36	7.36	1.07	149.33	15.03	-28.1	263.05	201.6	4.89	6.03	19.5	-1.5	33.53	7.12
AA,1	6.1	0.00	1.15	0.01	0.03	0.12	-10.79	1.91	23.92	0.17	0.84	3.71	97.42	0.26	3.1	0.06	1.65	3.05
AA,5	70.18	0.16	0.43	-0.18	6.62	3.35	24.9	48.32	8.44	-2	166.39	77.33	5.4	25.88	-9.98	-18.6	41.32	16.12
A,1	30.55	0.00	-1.24	0.01	0.02	0.06	7.81	1.74	-29.53	0.18	0.83	1.81	51.6	4.14	6	8.62	2.48	3.67
A,5	-168.55	0.25	1.05	-0.51	7.41	1.91	-91.88	90.28	29.3	-8.82	188.92	46.89	-77.86	37.05	-8.19	15.01	59.14	15.35
BBB,1	-28.22	0.00	-3.01	0.00	0.01	0.02	-10.88	0.67	-77.88	-0.1	0.40	0.58	78.49	3.07	18.88	-2.12	3.23	2.85
BBB,5	-58.99	0.19	-5.75	0.68	5.07	3.16	-6.62	70.96	-110.45	9.77	133.50	80.45	99.08	101.9	53.47	-32.2	111.88	52.15
JUNK,1	-51.66	0.00	-0.08	-0.04	0.03	0.07	-9.68	1.91	-212.19	-0.78	1.11	2.37	77.35	3.63	32	-1.91	4.92	3.67
JUNK,5	334.24	0.07	-3.91	0.54	2.07	2.90	115.76	40.32	-97.82	12.82	59.93	74.31	62.93	99.09	74.21	-37.1	146.81	54.67

Table 2.8…*Continued*
Descriptive Statistics of Test Portfolios

Portfolios	Section D: Trading Volume						Section E: Turnover					
	β	β^{L1}	β^{L2}	β^{L3}	$E(c^P)(k)$	$\sigma(\Delta c^P)(k)$	β	β^{L1}	β^{L2}	β^{L3}	$E(c^P)$	$\sigma(\Delta c^P)$
Panel A: Portfolios sorted on liquidity/illiquidity												
1	6.57	6.84	2.89	0.07	505	718	66.19	1.08	4.63	0.17	0.001	0.001
2	7.32	28.08	3.25	0.33	2,448	2,163	160.07	4.41	5.78	0.61	0.003	0.002
3	7.16	58.08	3.65	0.55	5,898	4,109	146.55	8.41	8.81	0.79	0.008	0.004
4	1.07	113.39	2.37	0.71	12,824	7,782	48.81	14.96	11.43	0.83	0.017	0.007
5	5.37	294.68	3.71	1.51	44,440	19,465	76.08	14.21	9.69	1.20	0.063	0.039
Panel B: Portfolios sorted on maturity and liquidity/illiquidity												
1,1	2.35	3.32	2.05	0.02	226	470	53.61	0.43	4.13	0.04	0.000	0.000
1,5	-0.03	154.29	4.08	1.39	24,754	14,357	-46.84	16.65	7.01	1.88	0.043	0.010
2,1	7.05	6.21	1.97	0.11	460	1,001	37.48	1.06	6.34	0.27	0.001	0.000
2,5	-1.05	229.31	4.73	0.66	30,517	17,934	32.33	537.18	12.51	-2.22	0.079	0.170
3,1	14.50	17.21	9.24	0.21	893	2,082	-16.31	4.22	12.69	0.58	0.001	0.000
3,5	13.94	504.88	3.66	1.42	58,581	42,963	270.37	36.53	18.13	2.24	0.058	0.020
4,1	19.54	14.73	10.83	0.22	1,404	2,065	266.23	3.29	19.84	0.39	0.002	0.000
4,5	9.76	330.63	6.57	1.38	69,917	28,297	121.54	33.30	11.12	1.53	0.077	0.020
5,1	1.10	9.54	0.16	0.13	1,042	1,587	34.50	1.88	0.99	0.27	0.001	0.000
5,5	4.67	383.46	1.50	2.04	53,882	31,430	69.52	39.15	0.33	2.44	0.063	0.030
Panel C: Portfolios sorted on credit rating and liquidity/illiquidity												
AAA,1	-0.18	0.03	0.26	0.00	28	14	-13.29	-0.08	0.12	0.00	0.000	0.000
AAA,5	1.06	21.48	1.22	0.28	15,902	7,767	1.94	8565.00	1.63	-31.77	0.499	1.590
AA,1	5.38	1.66	1.39	-0.04	372	1,716	55.13	0.38	4.00	-0.10	0.000	0.000
AA,5	-3.43	133.70	0.79	0.42	24,499	17,738	-80.33	13.74	0.40	1.50	0.041	0.020
A,1	8.77	6.11	-1.58	0.07	503	1,115	48.99	1.24	13.05	0.15	0.001	0.000
A,5	5.52	203.22	1.36	1.73	36,678	15,992	52.37	22.14	1.32	1.87	0.051	0.010
BBB,1	-0.08	10.99	1.63	0.02	1,153	1,197	19.82	1.72	2.05	0.05	0.001	0.000
BBB,5	7.65	409.47	3.41	1.45	82,031	32,232	61.10	34.40	5.08	1.57	0.080	0.030
JUNK,1	10.57	6.64	5.22	0.00	1,501	1,656	174.65	1.61	13.30	0.17	0.003	0.000
JUNK,5	5.99	254.95	6.08	0.26	57,964	30,905	138.66	34.23	13.99	0.51	0.068	0.030

Table 2.9
GMM Estimation of LCAPM

I report results from cross-sectional regressions using a GMM framework of the LCAPM using alternative cases of the following equation:

$$E(r_t^p - r_t^f) = \alpha + \xi E(c_t^p) + \lambda^1 \beta + \lambda^2 \beta^{L1} + \lambda^3 \beta^{L2} + \lambda^4 \beta^{L3} + \lambda^5 \beta^{L4} + \lambda^6 \beta^{NET},$$

where β represents the market beta, β^{L1}, β^{L2}, and β^{L3} represent the three liquidity betas, respectively. For the two illiquidity measures (volatility to volume ratio#1 & #2), $\beta^{L4} = \beta^{L1} - \beta^{L2} - \beta^{L3}$, and $\beta^{NET} = \beta + \beta^{L1} - \beta^{L2} - \beta^{L3}$, whereas for the three liquidity measures (trading frequency, trading volume, and turnover), $\beta^{L4} = \beta^{L1} + \beta^{L2} + \beta^{L3}$, and $\beta^{NET} = \beta + \beta^{L1} + \beta^{L2} + \beta^{L3}$. The betas are pre-estimated using equations (7) – (10). t-statistics are in parentheses. The superscripts ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Section A: Volatility to Volume Ratio#1

	Intercept	E(c^p)	β	β^L1	β^L2	β^L3	B^L4	β^NET
Panel A: Portfolios sorted on illiquidity								
1	13.40		6.06					
	(18.12)***		(6.37)***					
2	6.47	-0.80					3.16	
	(5.26)***	(4.85)***					(7.09)***	
3	7.79	-0.80	2.36				2.39	
	(3.58)***	(4.83)***	(0.51)				(1.77)*	
4	7.81	-0.80						2.39
	(7.10)***	(4.85)***						(6.98)***
5	10.01		-1.28					1.86
	(4.67)***		(0.22)					(1.39)
6	10.74	-2.78	-2.29	13852.14	-1.96	17.62		
	(5.43)***	(11.29)***	(0.57)	(1.13)	(1.64)*	(0.56)		
Panel B: Portfolios sorted on maturity and illiquidity								
1	17.80		0.87					
	(40.90)***		(2.28)**					
2	17.42	-0.13					0.31	
	(25.46)***	(1.70)*					(1.67)*	
3	17.42	-0.14	0.66				0.18	
	(25.51)***	(1.80)*	(2.01)**				(0.97)	
4	17.30	-0.14						0.29
	(26.11)***	(1.77)*						(1.88)*
5	17.31		0.46					0.16
	(25.00)***		(1.12)					(0.88)
6	16.16	-1.83	0.84	5367.62	-0.14	1.18		
	(22.99)***	(11.59)***	(2.52)***	(10.56)***	(0.76)	(0.96)		
Panel C: Portfolios sorted on credit rating and illiquidity								
1	17.56		5.34					
	(42.96)***		(11.98)***					
2	12.76	-0.14					3.28	
	(32.31)***	(2.49)***					(18.18)***	
3	12.69	0.01	3.45				2.72	
	(32.52)***	(0.10)	(7.81)***				(16.18)***	
4	12.50	-0.01						2.91
	(31.45)***	(0.20)						(17.99)***
5	12.70		0.72					2.72
	(37.21)***		(1.50)					(16.13)***
6	12.69	-0.54	2.81	3164.41	-2.73	4.04		
	(30.48)***	(5.26)***	(6.10)***	(8.60)***	(15.74)***	'(6.92)***		

Section B: Volatility to Volume Ratio#2

	Intercept	E(c^p)	β	β^L1	β^L2	β^L3	B^L4	β^NET
Panel A: Portfolios sorted on illiquidity								
1	12.07		13.34					
	(18.77)***		(7.12)***					
2	8.57	-0.03					0.18	
	(10.27)***	(4.66)***					(7.26)***	
3	3.76	-0.03	-40.23				0.56	
	(2.47)***	(4.96)***	(2.73)***				(4.12)***	
4	8.59	-0.03						0.18
	(10.32)***	(4.66)***						(7.25)***
5	8.10		-19.37					0.30
	(6.26)***		(1.36)					(2.48)***
6	9.35	-0.13	-32.83	204.21	-0.35	11.933		
	(1.38)	(11.59)***	(0.34)	(0.33)	(0.45)	(0.29)		
Panel B: Portfolios sorted on maturity and illiquidity								
1	16.98		3.08					
	(37.82)***		(3.69)***					
2	16.63	0.00					0.02	
	(26.58)***	(1.02)					(2.64)***	
3	16.64	-0.01	2.57				0.01	
	(26.68)***	(1.65)*	(3.43)***				(1.08)	
4	16.62	0.00						0.02
	(26.56)***	(1.02)						(2.64)***
5	16.52		2.25					0.01
	(26.08)***		(3.23)***					(1.11)
6	15.20	-0.08	1.84	16.27	-0.01	0.050		
	(24.14)***	(10.67)***	(2.63)***	(11.52)***	(1.55)	(0.58)		
Panel C: Portfolios sorted on credit rating and illiquidity								
1	18.16		11.78					
	(43.40)***		(12.88)***					
2	10.24	0.01					0.17	
	(35.03)***	(4.58)***					(22.29)***	
3	10.14	0.01	7.08				0.15	
	(35.66)***	(6.68)***	(8.51)***				(21.66)***	
4	10.22	0.01						0.17
	(35.05)***	(4.66)***						(22.31)***
5	10.82		6.58					0.15
	(44.15)***		(8.02)***					(21.33)***
6	9.70	-0.01	2.75	12.71	-0.15	0.360		
	(31.96)***	(2.62)***	(6.46)***	(9.04)***	(20.94)***	'(8.67)***		

Table 2.9…*Continued*
GMM Estimation of LCAPM

Section C: Trading Frequency

	Intercept	$E(c^P)$	β	β^{L1}	β^{L2}	β^{L3}	B^{L4}	β^{NET}
	Panel A: Portfolios sorted on liquidity							
1	169.85		9.15					
	(15.27)***		(0.98)					
2	160.19	1.59					-0.30	
	(16.53)***	(17.36)***					(2.36)**	
3	140.74	1.93	93.04				-1.45	
	(14.88)***	(18.19)***	(8.93)***				(8.67)***	
4	158.73	1.59						-0.27
	(16.39)***	(17.33)***						(2.17)**
5	153.77		-1.19					0.38
	(14.65)***		(0.10)					(2.36)**
6	445.09	2.33	-375.35	-637.54	5.47	-10.91		
	(2.65)***	(16.77)***	(1.62)	(2.38)**	(1.70)*	(1.80)**		
	Panel B: Portfolios sorted on maturity and liquidity							
1	176.14		7.54					
	(38.34)***		(1.66)*					
2	617.34	-1358.94					11.81	
	(4.13)***	(3.06)***					(3.08)***	
3	156.00	1.12	13.85				-0.23	
	(24.42)***	(12.06)***	(3.91)***				(2.71)***	
4	160.44	1.11						-0.11
	(26.01)***	(12.24)***						(1.17)
5	180.63		10.07					-0.09
	(26.74)***		(2.71)***					(0.98)
6	171.28	1.53	14.20	-96.55	-0.06	-0.60		
	(28.59)***	(11.05)***	(4.13)***	(10.35)***	(0.68)	(4.49)***		
	Panel C: Portfolios sorted on credit rating and liquidity							
1	181.18		39.44					
	(39.68)***		(8.68)***					
2	127.26	1.50					0.74	
	(34.38)***	(16.36)***					(12.50)***	
3	122.33	1.48	32.05				0.71	
	(33.51)***	(16.06)***	(7.40)***				(12.46)***	
4	126.86	1.50						0.75
	(34.40)***	(16.37)***						(12.64)***
5	163.33		36.46					0.68
	(42.26)***		(8.03)***					(11.47)***
6	161.13	1.44	6.65	-159.24	1.00	-2.94		
	(29.05)***	(14.59)***	(1.56)	(9.28)***	(15.37)***	'(12.94)***		

Section D: Trading Volume

	Intercept	$E(c^P)$	β	β^{L1}	β^{L2}	β^{L3}	B^{L4}	β^{NET}
	Panel A: Portfolios sorted on liquidity							
1	169426.30		1691.33					
	(15.75)***		(1.16)					
2	256548.70	0.00					-25483.70	
	(21.65)***	(14.99)***					(12.68)***	
3	221066.10	0.00	6403.03				-25688.20	
	(22.45)***	(14.80)***	(5.62)***				(12.56)***	
4	174449.20	0.00						-2733.22
	(19.27)***	(15.13)***						(3.64)***
5	146062.30		-2604.42					4558.22
	(14.83)***		(0.91)					(2.33)**
6	228703.30	0.00	7465.64	-29386.20	-31082.90	-14064.90		
	(4.50)***	(14.44)***	(1.03)	(1.07)	(0.90)	(0.19)		
	Panel B: Portfolios sorted on maturity and liquidity							
1	177714.20		907.52					
	(38.40)***		(1.28)					
2	165145.70	0.00					-2832.19	
	(32.79)***	(16.11)***					(2.79)***	
3	160988.40	0.00	2015.74				-4417.97	
	(30.63)***	(15.99)***	(2.86)***				(4.18)***	
4	153677.40	0.00						-213.23
	(29.88)***	(16.30)***						(0.43)
5	168073.10		-2662.24					2728.90
	(29.50)***		(1.81)**					(2.42)**
6	163272.80	0.00	1956.06	-22611.40	-3826.27	14971.35		
	(31.51)***	(14.53)***	(2.94)***	(6.76)***	(2.79)***	(2.61)***		
	Panel C: Portfolios sorted on credit rating and liquidity							
1	152670.70		12518.96					
	(44.89)***		(15.52)***					
2	97305.84	0.00					21950.86	
	(31.87)***	(7.68)***					(13.44)***	
3	94914.57	0.00	7584.27				15362.29	
	(32.02)***	(9.22)***	(11.37)***				(10.92)***	
4	103613.60	0.00						9834.97
	(37.11)***	(10.71)***						(15.24)***
5	91341.20		-17583.30					23872.25
	(28.70)***		(10.27)***					(15.86)***
6	127413.40	0.00	1027.10	-25331.80	28608.01	-33926.50		
	(38.33)***	(13.45)***	(1.40)	(5.68)***	(13.63)***	'(9.43)***		

Table 2.9…*Continued*
GMM Estimation of LCAPM

Section E: Turnover

	Intercept	$E(c^p)$	β	β^{L1}	β^{L2}	β^{L3}	B^{L4}	β^{NET}
	Panel A: Portfolios sorted on liquidity							
1	198.50		-19.95					
	(16.52)***		(2.34)**					
2	169.28	1075.85					-0.26	
	(26.07)***	(1.64)*					(1.04)	
3	179.94	1066.69	-9.72				-0.28	
	(19.21)***	(1.63)	(1.33)				(1.14)	
4	169.59	1076.83						-0.26
	(26.01)***	(1.64)*						(1.04)
5	183.72		-13.36					0.19
	(18.91)***		(1.80)*					(2.80)***
6	221.79	1076.54	-30.05	-0.49	-7.70	62.40		
	(5.22)***	(1.62)	(1.11)	(1.36)	(0.93)	(0.72)		
	Panel B: Portfolios sorted on maturity and liquidity							
1	183.27		0.04					
	(38.64)***		(0.01)					
2	179.53	393.52					-0.09	
	(33.02)***	(1.78)*					(2.75)***	
3	179.40	393.56	0.12				-0.09	
	(31.69)***	(1.78)*	(0.03)				(2.74)***	
4	179.64	393.47						-0.09
	(33.11)***	(1.78)*						(2.75)***
5	184.55		-0.16					-0.02
	(37.89)***		(0.05)					(0.87)
6	163.56	300.38	1.86	0.07	-1.19	26.96		
	(19.79)***	(1.61)	(0.60)	(1.57)	(1.33)	(4.97)***		
	Panel C: Portfolios sorted on credit rating and liquidity							
1	152.16		76.11					
	(40.62)***		(16.04)***					
2	191.87	1.70					-0.01	
	(40.90)***	(1.51)					(19.28)***	
3	155.86	1.67	76.49				-0.01	
	(40.78)***	(1.53)	(16.05)***				(21.11)***	
4	191.87	1.68						-0.01
	(40.90)***	(1.50)						(19.27)***
5	155.88		76.50					-0.01
	(40.77)***		(16.06)***					(21.94)***
6	108.82	1.22	-11.24	-0.02	16.81	-3.43		
	(26.69)***	(1.27)	(1.64)*	(3.69)***	(12.40)***	'(2.74)***		

APPENDIX A

SCREENS USED FOR ELIMINATING UNDESIRABLE OBSERVATIONS FROM THE NAIC DATABASE

I first impose the following restrictions on the type of bonds: (1) I include corporate debentures, corporate issues backed by letter-of-credit, corporate medium-term notes, corporate medium-term notes zero, corporate zeros, and corporate insured debentures, (2) I include only fixed-rate bonds, with a credit rating, from U.S. issuers, with semi-annual coupons (2) the industry groups include the industrial, financial, and utility sectors, (3) I exclude bonds that are puttable, convertible, perpetual, exchangeable, and have announced calls, and (4) I exclude asset-backed issues, credit enhancements, yankees, canadian, issues denominated in foreign-currency, as well as issues offered globally. These screens reduce the sample to 506,406 transactions. I then eliminate transactions in which the dealer description has the following label: maturity, direct, transfer, exchange of securities, transferred from michigan, called, tender, redemption, merger, tax

free exchange, issuer, conversion, exchanged, matured, put, redeemed, sinking fund, no broker, tender offer.

This process eliminates 21,533 observations, leaving 484,873 transactions. I then compress the dealer description label to capture suspicious data that are not removed by the above process. I use the following compressed names: sinking, sink, exchange, tender, securitycalled, intercompany, internal, transfer, taxable, redemption, partial, voluntary, principalpay, principalred, special, installment, original, scheduled, issue, sinkpmt, direct, fullcall, restructured, inexchange, issuing, purchase/ten, bondtender, bondcalled, interestrec, bondmove, redeem, principalpr, tsfr, affiliated, reversal, reinsurance.

This action eliminates another 22,491 observations, leaving a sample of 462,382 transactions. I then eliminate observations that fall under non-trading days (weekends or holidays). I also eliminate the observations on December 31 for years 1996, 1997, 1998 as too many observations were recorded on these dates (they were probably transacted on different dates). This process eliminates 7,215 transactions and leaves me with a sample of 455, 167 observations.

APPENDIX B

CONSTRUCTION OF CCY/S AND CCAY/S

In the spirit of the methodologies used by Warga and Welch (1993) and Jorion and Zhang (2005), I employ CCY/S and CCAY/S as the two measures to examine changes in the level of the yields/spreads. CCY/S refers to the cumulated change in raw yields/spreads, whereas CCAY/S refers to the cumulated change in adjusted yields/spreads. The second measure is constructed by subtracting from the raw bond yields/spreads, the yield/spread of an index with similar rating and maturity characteristics as the bond of interest. Specifically, I construct 15 equal-weighted adjustment indexes in the dimensions of risk and maturity using the FISD-NAIC database. These indexes do not include the event or rival firms. The rating categories are AAA, AA, A, BBB, and Below BBB (junk). Each rating category is then subdivided into a short-term (1 to 7 years left to maturity), intermediate (7 to 15 years), and long-term category (15 years onwards).

Thus the rating-adjusted spread for issue j at time t (AS_{jt}) is given by:

$$AS_{jt} = S_{jt} - I_{rt}$$

(15)

where S_{jt} is the spread of issue j at time t, and I_{rt} is the spread of the adjustment index. The change in adjusted spread during the event window is given by:

$$CAS_j(t_1, t_2) = AS_{jt_2} - AS_{jt_1}$$

(16)

My analysis then proceeds in 2 ways; I first average this measure within a firm (one bond/firm), and then across all firms in order to get CCAY/S. I then calculate the cross-sectional mean of the full sample as well as t-statistics. I also calculate CCAY/S assuming that different bonds of a company are considered to be independent observations (all bonds).[52]

[52]CCY/S is calculated in the same fashion, but without any adjustment.

APPENDIX C

SCREENS USED FOR ELIMINATING UNDESIRABLE OBSERVATIONS FROM THE TRACE DATABASE

I impose the following restrictions on the type of bonds: (1) I include corporate debentures, corporate issues backed by letter-of-credit, corporate medium-term notes, corporate medium-term notes zero, corporate zeros, and corporate insured debentures, (2) I include only fixed-rate bonds, with a credit rating, from U.S. issuers, with semi-annual coupons, (2) the industry groups include the industrial, financial, and utility sectors, (3) I exclude bonds that are puttable, convertible, perpetual, exchangeable, and have announced calls, and (4) I exclude asset-backed issues, credit enhancements, yankees, canadian, issues denominated in foreign-currency, as well as issues offered globally. A small number of observations are also excluded where spreads or expected excess bond returns turn out to be negative. Furthermore, to eliminate any outliers, I remove observations with spreads that fall in the top and bottom 1% of my sample. These screens reduce the sample to 1,921,390 transactions.

APPENDIX D

EMPIRICAL METHODOLOGY TO COMPUTE EXPECTED EXCESS BOND RETURNS

In the lines of Campello et al. (2004), I use the following expression for the expected excess bond returns:

$$R_{Bt}^{i} - r_t^{f} = YS_{it} - EDL_{it} - ETC_{it}$$

(17)

where

$$EDL_{it} = \pi_{it} * \theta_t / dt$$

(18)

$$ETC_{it} = ((1-\pi_{it}) * \frac{C_i}{B_{it}} \frac{1}{dt} - EDL_{it})\tau$$

(19)

R_{Bt}^{i} is the expected bond return of bond *i* at time *t*, r_t^{f} is the risk-free rate, YS_{it} is the yield spread, EDL_{it} is the expected default loss rate, and ETC_{it} is the expected tax compensation. EDL_{it} is given by multiplying the default probability, π_{it}, by the default loss rate (θ_t) and then scaling by the time period (dt = one year). ETC_{it} is given by first multiplying the probability of no default, (1 - π_{it}), with the coupon payment (C_i) dividing by the bond price (B_{it}) and scaling by the time period *dt*. Then, the expected default loss, EDL_{it} is subtracted from this term. Finally, the difference obtained is multiplied by the tax rate (τ).

I follow Campello et al. (2004) in constructing the above terms. Starting from the yield spread (excess of bond yield over the treasury yield of similar maturity), I first subtract the expected default loss term. To compute this latter term, I utilize first the Moody's default reports to compute default probabilities for the years that I examine. These are annual issuer-weighted corporate default rates by alphanumeric rating.[53] Similar to Campello et al. (2004), since default probabilities are time-varying, I use the three-year moving average default probability (from year *t-2* to *t*) to replace the one-year expected default probability for year *t*. I then multiply the default probability with the default loss rates (or 1 - recovery rate) provided by Altman and Kishore (1998) to get the expected default loss rate. The recovery rates provided by these authors for bonds rated by S&P

[53]Default & recovery rates of corporate bond issuers: 1920 - 2005, Moody's Investors Service, March 2006, Exhibit 32.

are the following: 68.34% (for AAA bonds), 59.59% (for AA), 60.63% (for A), 49.42% (for BBB), 39.05% (for BB), 37.54% (for B), and 38.02% (for CCC). Similar to previous studies, I assume an equivalence between ratings by S&P and Moody's (Aaa = AAA, Aa2 = AA, A2 = A, Baa = BBB, and so on).

The last term needed to compute the expected excess bond returns is the ETC_{it}, the expected tax compensation. Following Elton et al. (2001) and Campello et al. (2004), I use an effective tax differential rate of 4% for all bonds. In computing this term, a very small part of my sample produces a negative value (less than 3%). I replace those negative numbers with a zero value for this term.

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