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The determinants of trading volume of high-yield corporate bonds☆

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Abstract

This paper examines the trading volume of a sample of high-yield corporate bonds reported on Nasdaq's Fixed Income Pricing System (FIPS). This analysis of volume allows us to better understand the liquidity of debt issues. We demonstrate that the 'mandatory' FIPS issues trade fairly actively. We also conduct tests of the determinants of trading volume and produce evidence that mandatory issues with higher volume tend to be larger, more recently issued, and the obligations of firms without publicly traded equity. © 2000 Published by Elsevier Science B.V. All rights reserved.

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1. Introduction

While much is known about the U.S. equity markets, relatively little research focuses on the secondary corporate bond markets. The primary bound on this research is that the best corporate bond data available were estimates of transaction prices instead of actual market prices, and that data on trading volume figures did not exist. Hence, the existing literature is limited in its ability to accurately measure many aspects of the market. With new data that provides researchers with transaction prices and trading volume, researchers can now delve deeper into these markets just as regulatory interest in bond transparency (e.g., Levitt, 1998; Zuckerman, 1998) is picking up.

This paper examines the determinants of trading volume using data from the Fixed Income Pricing System (FIPS), a trade and quote reporting system for high-yield bonds. Because brokers and dealers are required to report all high-yield transactions to FIPS and no similar system exists for investment-grade debt, FIPS represents the only source of total trading volume in corporate bonds. We also describe the structure and purpose of FIPS and how it fits into the corporate fixed-income market.

Examining the volume of corporate bonds is of interest for many reasons. First, volume is an important component of liquidity, so studying volume can help us better understand the liquidity of high-yield bonds. Given its practical value to issuers, investors, and dealers, liquidity has long been the subject of corporate bond research.[1] Previous research measures liquidity using yield or return spreads and concurrent research measures liquidity using the spread between institutional buy and sell prices.[2]

Using volume, we are able to test new hypotheses and better test existing hypotheses about the determinants of debt liquidity. In particular, we propose that volume should be positively associated with issue size and negatively associated with age and that the debt issues of private firms (i.e., firms without publicly traded equity) should have lower volume. We are able to verify that bonds with higher volume are from larger issues and are seasoned less than two years. The fact that larger issues trade more often supports the arguments that larger issues are more liquid. The age result extends the existing empirical

[1] Papers on the liquidity of debt securities include Fisher (1959), Sarig and Warga (1989), Amihud and Mendelson (1991a), Cornell (1992), Warga (1992), Crabbe and Turner (1995), and Kamara (1994). Liquidity is important because investors in less liquid securities demand higher returns. These higher returns translate into a higher cost of capital (Amihud and Mendelson, 1986, 1991a, b; Datar et al., 1998).

[2] Sarig and Warga (1989), Blume et al. (1991), Warga (1992), and Crabbe and Turner (1995) use yield or return spreads; Hong and Warga (1998), Schultz (1998), and Chakravarty and Sarkar (1999) use bid–ask spreads; Kamara (1994) uses volume.

literature showing that bonds are more liquid for the first few months and supports anecdotal evidence suggesting that many bonds can take as long as two years to settle into portfolios. Contrary to our hypothesis, we find that the bonds issued by public firms trade less often than the bonds issued by private firms. We speculate that this is because the debt of private firms might substitute for equity when equity is not available.

We recognize that volume is not a perfect measure of liquidity. In particular, volume can often be high during periods of low liquidity (e.g., Bamber, 1986; Krinsky and Lee, 1996). This tends to occur during periods of high risk when transaction costs have risen. Therefore, to properly use volume to measure liquidity, we have to control for non-liquidity factors of volume. In particular, we control for default risk, interest rate risk, and return volatility. Not surprisingly, volume is higher for bonds with more default risk and return volatility, and marginally higher for bonds with more interest rate risk.

Finally, describing and analyzing the determinants of volume can serve to support or refute the anecdotal evidence suggesting that corporate bonds do not trade very much, especially relative to equities.[3] We compare the volume of our sample bonds, which are supposedly the most liquid high-yield bonds, to an anecdotal benchmark and to equities. The comparisons show that our sample of bonds exceeded the anecdotal benchmark and that their dollar volume is comparable to the medium to high volume NYSE and Nasdaq stocks. This volume suggests that these bonds are not simply held to maturity, but that some portion of the public float is traded actively. This is important when considering possible transparency increases in corporate bond markets. Foes of transparency (see, e.g., Bourbeau and Vames, 1998; Zwirn, 1998) claim that bond dealers would lose their current informational advantage if transparency became mandatory, and hence would be either unwilling to make markets or would provide quotes with wide spreads while making trades inside their quotes. However, our results suggest that at least some issues trade fairly actively despite the current degree of transparency. While perhaps applying only to those issues that Nasdaq selects for their high volume, these results show that transparency is not invariably hostile to liquidity.

The rest of the paper is organized as follows. The hypotheses are explained in Section 2. Section 3 describes the current structure of the high-yield market with a brief account of its origin, purpose, operations, and rules. Section 4 describes the data and provides statistics about daily trading volume. Section 5 explains tests of the determinants of volume and provides pooled time-series and cross-sectional regression results. A summary appears in Section 6, which also contains some suggestions for future research.

[3] See, for example, SEC (1992).

2. Hypotheses and previous research

2.1. Liquidity hypotheses

We examine the volume of FIPS bonds to learn about the determinants of liquidity for these bonds. A bond's volume is related to its liquidity because its volume directly affects the inventory carrying costs of the dealer, which are passed on to investors in the form of transaction costs.[4] Often required to take large inventory positions to accommodate customer orders, dealers in bonds face considerable risk from adverse price movements. Inventory carrying costs for low-volume bonds are likely to be larger on a per bond basis than for high-volume bonds, as dealers can more easily adjust inventory in high-volume issues. In turn, these larger inventory costs lead to larger transaction costs for investors in low-volume bonds. Thus, low-volume bonds are likely to be less liquid than high-volume bonds.

Due to this connection between volume and liquidity, we are able to apply liquidity hypotheses to explain the determinants of volume. The first two of these hypotheses are well-established yet unresolved in existing literature.

2.1.1. Hypothesis 1: Larger issues have higher volume

Research has long hypothesized that the size of a bond issue is a determinant of a bond's liquidity.[5] Previous studies contend that dealers can more easily manage their inventory in larger issues. Dealers in larger issues should thus have lower inventory holding costs, ultimately leading to lower transaction costs for investors. This idea is motivated by the notion that large issues should trade more often, all else equal (e.g., Fisher, 1959; Crabbe and Turner, 1995), and, therefore, leads to our first hypothesis about trading volume: larger issues have higher volume.

Several existing empirical studies test the hypothesis that larger issues are more liquid (e.g., Warga, 1992; Crabbe and Turner, 1995; Fridson and Garman, 1998). These studies use liquidity premiums (differences in yields or returns relative to a benchmark) to measure liquidity and generally find little or no support for this hypothesis. More recent studies on bid–ask spreads (e.g., Hong and Warga, 1998) find support for the hypothesis by noting that larger issues are associated with smaller bid–ask spreads. Our study differs from these in that we examine volume. Because these studies draw different

[4] See, for example, O'Hara (1995, p. 44), who states that '… inventory imposes some costs on the dealer, and it is this cost that is reflected in market bid and ask prices'. This idea was addressed for equities in Demsetz (1968) and for corporate bonds in Crabbe and Turner (1995).

[5] See, for example, Fisher (1959), Garbade and Silber (1976), Warga (1992), Crabbe and Turner (1995), and Fridson and Garman (1998).

conclusions, studying volume has an additional advantage: it can help to resolve these conflicting conclusions.

2.1.2. Hypothesis 2: Bonds trade less as they become more seasoned

After issuance, a bond issue may begin to settle into the portfolios of investors who intend to hold the issue to maturity. Over time, inactive portfolios absorb more and more of the original float, leaving a smaller portion available to trade. With a smaller portion available for inventory management, dealers will demand a higher spread and the market for the bond becomes less liquid. Therefore, as a bond becomes seasoned, it becomes less liquid.

This hypothesis was originally motivated by anecdotal evidence. A common view among professionals is that an issue trades most actively around the start of its life and much less so in later periods (e.g., SEC, 1992; Fabozzi, 1996). Other anecdotal evidence suggests that the process of settling into portfolios takes two years, after which bonds trade sparingly (e.g., Warga, 1992). Existing studies of liquidity premiums generally support this hypothesis by finding that liquidity premiums are lowest for newly issued securities (e.g., Sarig and Warga, 1989; Amihud and Mendelson, 1991a; Warga, 1992; Kamara, 1994). The hypothesis is also supported by recent bid–ask spread studies (e.g., Chakravarty and Sarkar, 1999; Hong and Warga, 1998; Schultz, 1998). However, one study is unable to document a return premium associated with age (Blume et al., 1991).

Our study differs from these not only in our use of volume, but also in our examination of the nature of seasoning. Many earlier studies compare newly issued securities (within a month or two) to much more seasoned issues and the recent effective spread studies assume that liquidity falls linearly. By contrast, our sample does not contain such newly issued bonds so we compare bonds within two years of issuance to bonds seasoned for longer than two years. If a constant percentage of the actively-traded float is absorbed each period, then the decrease in trading volume should not be linear. Our use of the two-year cutoff allows for this nonlinearity.

2.1.3. Hypothesis 3: Bonds issued by private firms should have lower volume

Many privately held companies (i.e., companies without publicly traded equity) have publicly tradable debt. The debt issues of private firms might trade less than the debt issues of otherwise similar public firms because more information is available about public companies. While both public and private firms must file disclosure forms with the SEC and are bound by the rules on releasing material information, it is possible that investors receive far less information about private firms. The disclosure rules for firms with public equity outstanding are more extensive than the rules for firms with only public debt, and the nature of disclosures to analysts and investors might differ for public and private firms (Fenn, 2000). Accordingly, the adverse selection costs of making a market in debt of private firms should be higher, and thus the liquidity should be lower.

Hence, we include a hypothesis predicting lower volume for private firms relative to otherwise similar public firms.

The evidence comparing the debt of private firms to the debt of public firms is sparse. Fenn (2000) tests an inadequate-disclosure-by-private-firms hypothesis and finds weak results that private firms pay a credit premium over public firms. If the credit premium is instead interpreted as a liquidity premium, the Fenn (2000) results are consistent with this hypothesis.

2.2. Limitations of volume as a measure of liquidity

Volume is not a perfect measure of liquidity. Since liquidity is the ability to trade a security quickly with little cost (O'Hara, 1995, p. 216), the primary disadvantage of volume is that is does not incorporate the cost of trading, usually measured by effective or quoted spreads. However, the theory described above, in addition to the theory of Admati and Pfleiderer (1988) and Foster and Viswanathan (1990), predicts that higher volume assets should have smaller bid–ask spreads. Several empirical studies using equity data verify this (e.g., Foster and Viswanathan, 1993), and several other empirical studies use various volume measures as proxies for liquidity (e.g., Datar et al., 1998). We are not the first to suggest or use volume as a measure of liquidity in fixed-income securities, as Kamara (1994) studies the liquidity of Treasury securities using the aggregate Treasury bill and note volumes. Further, a recent study finds that the volume in a subset of large trades in fixed-income securities is negatively associated with effective bid–ask spreads (Chakravarty and Sarkar, 1999).[6]

Despite the general positive relationship, volume can sometimes be high when liquidity is low (i.e., when transaction costs are high). For example, many researchers have noted higher than normal volume and bid–ask spreads around earnings announcements (e.g., Bamber, 1986; and Krinsky and Lee, 1996). Several theoretical papers call this the 'speculative' component of volume and explain that it is due to the difference of opinion about the true value of the financial asset (e.g., Bachelier, 1900; Harris and Raviv, 1993; Kandel and Pearson, 1995; Bamber et al., 1999). Hence, to properly test the liquidity hypotheses, we need to control for determinants of this speculative component. First, we control for return volatility because Harris and Raviv's (1993) Theorem 1 states that volume is positively associated with the absolute value of price changes. This relationship is also well documented in the equity literature (see Karpoff (1987) for a review of the literature). If we think of the return volatility as the realized price changes, then it is also possible that bid–ask spreads and volume are higher for assets with larger expected price changes as well. Therefore,

[6] We estimate that the subset represents about 19% of total volume. We explain how we calculate this number in the data section.

we also control for the level of ex ante risk. Bonds are convenient in this respect because they have two easily measurable ex ante risks: interest rate risk and credit risk.

Instead of volume, liquidity can also be measured with either quoted or effective bid–ask spreads. However, we leave the measurement of bond bid–ask spreads to Schultz (1998), Chakravarty and Sarkar (1999), Hong and Warga (1998), and others, as there are comparative disadvantages to using spread measures based on our data. These include: (1) quoting by FIPS dealers might be done only to satisfy regulatory requirements and not have any relevance for transaction costs; (2) buyer-initiated trades cannot be distinguished from seller-initiated trades in the way suggested by Lee and Ready (1991); and (3) the data contain days that have one or no trades, making it difficult to meaningfully measure the effective spread. On the other hand, Schultz (1998), Chakravarty and Sarkar (1999), and Hong and Warga (1998) use a sample of insurance company trades filed with the National Association of Insurance Commissioners (NAIC) that is better suited to measuring transaction costs. The NAIC data clearly notes the buyer- and seller-initiated trades and contains only trades between dealers and their customers whereas our data does not distinguish these from inter-dealer trades. Instead, our data set is better suited to measuring volume because it contains almost all transactions and because reporting is closely monitored. The liquidity implications drawn from a study of volume provide a valuable complement to those drawn from studies of bid–ask spreads.

Some might argue that the volume of large trades is a better measure of liquidity than total volume. In a liquid market, dealers are willing to take large inventory positions because they can easily manage their inventory. As the markets become less liquid, dealers will charge a higher bid–ask spread for large trades because their inventory management becomes more costly. At some level of liquidity, investors would pay lower costs by breaking up a large order than submitting it all at once. Hence, the presence of a high volume of large trades indicates a liquid market. To see if volume is an appropriate proxy for liquidity, we examine the correlation of volume from just large or small trades to the total volume. For this exercise, we define large trades to be 100 bonds or more (i.e., \$100,000 par value or more). We find that the volume of large trades is positively correlated with total volume and the correlation is economically significant at 0.99 for bond volume and 0.76 for trade volume. Further, the correlation of the volume of small trades and total volume is also positive and economically significant (0.40 and 0.96). Interestingly, the volume of large trades is also positively correlated with the volume of small trades (0.38 and 0.54), suggesting that those bonds with more large trades also have more small trades. Because the volume of large trades is correlated with the volume of small trades, we conclude that the correlations of each to total volume are not economically sensitive to our definition of large trades. In summary, these results show that total volume is a good proxy for liquidity.

3. Institutional background

In the early 1990s, the U.S. Congress and the Securities and Exchange Commission (SEC) became concerned about potential problems associated with a lack of transparency in the corporate debt market, particularly in the segment involving high-yield debt (SEC, 1993). The precipitating factor was the considerable instability that the market experienced in the late 1980s and early 1990s, highlighted by the collapse of the dominant high-yield bond dealer and underwriter, Drexel Burnham Lambert (e.g., Liscio, 1989; Cornell, 1992; Jones, 1998). Subsequently, the SEC encouraged the National Association of Securities Dealers (NASD) to develop an electronic reporting facility that would collect and distribute quotations in actively traded, high-yield corporate bonds and that would require prompt reporting of all trades in these issues. In April 1994, the Nasdaq Stock Market introduced the Fixed Income Pricing System (FIPS). Although restricted to non-convertible issues, FIPS covers every publicly issued corporate debt security that Standard and Poor's rates below investment grade and that is not part of a medium-term note program.[7]

FIPS altered the high-yield debt market in two respects. First, FIPS brought some transparency to the trading of a selected group of the most active high-yield bonds. Before FIPS, few market prices and volume figures were publicly available for corporate bonds in general and high-yield bonds in particular.[8] Now, however, investors and researchers have access to market prices and volume of at least some high-yield bonds. Second, with FIPS, regulators were able to improve their monitoring of trading in high-yield debt. Indeed, regulators are now better able to monitor trading in the high-yield market than in the investment-grade debt market. However, the corporate fixed-income market still falls short of regulators' expectations of a sufficiently transparent market.[9] According to SEC Chairman Arthur Levitt in a speech on September 9, 1998, "the sad truth is that investors in the corporate bond market do not enjoy the same access to information as a car buyer or a homebuyer or, dare I say, a fruit buyer". In fact, the SEC is now committed to improving the transparency for all corporate bond issues and has again called on the NASD to

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[7] Nasdaq Stock Market, Inc. (1997), Rule 6210 (I).

[8] Daily prices for NYSE-listed bonds are disseminated and are more widely available than FIPS, but the volume figures that the NYSE also disseminates are not aggregate.

[9] The NYSE's Automated Bond System (ABS), inter-dealer brokers, and alternative trading systems allow for some trade and quote transparency of investment-grade bonds. However, because corporate bonds are not National Market System securities, there is no requirement that trades in these securities be reported to a central facility. For high-yield bonds, only exchange trading (i.e., ABS and Amex) is exempt from reporting to FIPS. See Dueweke et al. (1992) for documentation of the approximate market share of ABS.

create the infrastructure for collecting and distributing price information on corporate bond transactions.[10]

FIPS operates much like Nasdaq but is considerably less transparent. In both markets, quotes and trade reports are posted electronically, with executions being negotiated on the telephone. The most significant difference is that FIPS rules for trade reporting and quoting partition bond issues into 'mandatory' and 'non-mandatory' groups, and only mandatory issues have any notable transparency. The mandatory issues are a set of 50 of the most actively traded securities. (Initially, the number was 35, but it was increased to 50 in early 1995.) A committee of Nasdaq officials and dealers meets every six months to review the mandatory bond list and to alter it, if necessary. While an issue's volume is one criterion for inclusion in the mandatory set, the committee also considers a security's price, the issuer's name recognition and industry group, and the number of dealers and researchers a bond has attracted.[11]

Trades in mandatory securities must be reported to FIPS within five minutes of execution, and summaries of prices and volume are distributed hourly to FIPS participants and information vendors. Actual transactions are never disseminated to participants, information vendors, or the public. A FIPS dealer must continuously post a firm one-sided quote (but may post a two-sided quote) either in its own name or through an inter-dealer broker. (An inter-dealer broker, also known as a 'broker's broker', is an agent that negotiates trades between dealers.) These quotes, including those of inter-dealer brokers, are available in real-time to FIPS participants only (i.e., brokers and dealers).[12] Although NASD has been persuading more major broker-dealers to become active in the market, participation in the quoting of FIPS bonds is not a strict requirement. Further, the current NASD proposal for a transparent corporate bond market does not include any quoting requirements.[13]

Trades in the 1,400-plus non-mandatory issues must be reported by 5:00 p.m. on the day of the transaction, but no information regarding prices and volume is publicly disseminated. Instead, only regulators have access to such data. In addition, FIPS does not require dealers to post quotes (firm or otherwise) in non-mandatory bonds and provides no mechanism for disseminating voluntarily posted dealer quotes in these bonds. Thus, the benefit that investors derive

[10] Examples of press articles on the recent bond market transparency issue include Bourbeau and Vames (1998), Wyatt (1998), Zuckerman (1998), and Zwirn (1998). Also see the NASD proposal for a new transaction reporting system.

[11] Nasdaq Stock Market, Inc. (1997), Rule 6220(a).

[12] The hourly summaries disseminated to information vendors and participants contain the prevailing quotes.

[13] See SEC Release No. 34-42201. File No. SR-NASD-99-65, 64 *Federal Register* 69305, December 10, 1999.

from the non-mandatory portion of FIPS is simply the regulators' ability to monitor trading, as trading in non-mandatory issues is not transparent to either investors or dealers.

4. Data and daily volume in FIPS issues

We analyze data from NASD Regulation's (NASDR) record of transactions in 60 of the issues that were mandatory over all or a substantial part of the interval between October 1, 1994 and July 1, 1997. The data include the price, volume, and time of each transaction in the sampled issues. Our analysis concentrates on daily aggregates of these individual transactions.[14] While 67 issues were mandatory at some point during this period, we excluded five because they were mandatory for only six or fewer months and two other issues because we could not be confident, after conversations with NASDR officials, that the data files contain all the transactions that should have been reported.

Some of the sampled issues had a small number of clerical errors that appear to have resulted from the similarity in ticker symbols for bonds of the same issuing firm. We identified and deleted suspect transaction reports by means of an algorithm (discussed in Appendix A) that uses NASDR data on the bid and ask prices. In sum, this filtering algorithm deleted less than 1,000 of the more than 283,000 transaction reports in the data set.

Some transactions were executed through inter-dealer brokers who report both sides of a trade (buy and sell). This practice generates double-reported volume for some trades.[15] In an effort to correct this problem, we separately sum up buy and sell trades that have the same price and time stamp. We then compare the total volume of buy trades to the total volume of sell trades that have the same price and time stamp. Finally, we delete the buy trades if the volume of buys is less than or equal to the volume of the sells. Likewise, we delete the sell trades if they have lower volume than the buys.

The FIPS data contains additional limitations because it contains only 60 bonds and those bonds are only high-yield corporate bonds. Unfortunately, a broader analysis cannot be conducted until better data becomes available. The institutional NAIC data used in studies by Hong and Warga (1998), Schultz (1998), and Chakravarty and Sarkar (1999) is not well suited to this type of analysis. While the NAIC data contains a larger number of bond issues as well as investment-grade corporate and municipal bonds, the transactions included in it are far from comprehensive. According to Hong and Warga (1998), the

[14] Aggregated volume and price data can be downloaded from the information disseminated to information vendors. See Hotchkiss and Ronen (1999, p. 5) for a discussion on obtaining FIPS data.

[15] This is different from the double-counting phenomenon in the Nasdaq market, which is also a feature of our data.

NAIC data contains 25% of the volume of FIPS bonds as reported by Hotchkiss and Ronen (1999). However, our data produced volume figures that are roughly 31% higher than those reported in Hotchkiss and Ronen (1999) for the same bonds over the same period. Therefore, the NAIC data in fact contains less than 19% of actual FIPS volume. Two reasons may account for the discrepancy between our volume and that reported by Hotchkiss and Ronen (1999): (1) Hotchkiss and Ronen use the hourly volume summaries, which do not contain system corrections; and (2) we apply a different filtering technique because we have the actual transactions.

The characteristics of the 60 bond issues in the sample appear in Table 1. The issues represent 47 different corporations, only 37 of which had publicly traded equity during the entire period that their bonds were mandatory. Eight issuers were privately held firms throughout the period that their bonds were mandatory, illustrating the fact that NASDR does not require mandatory issues to be obligations of corporations having public equity.[16] Table 1 suggests that the issues were sizable, averaging $396 million in par value, and that they tended to be relatively new because the average time since issuance was only 2.7 years. The average time to maturity was 7.3 years.[17] More than 70% of the issues were initially listed within two years of issuance, but very few within the first six months.

Table 1 also gives the end-of-year credit ratings and shows that the majority of bonds have a single-B rating (B + , B, or B −). While the number of bonds rated higher than B + remains steady from year to year, the number of bonds rated B or lower increased each year. This fact is partially explained by revisions in ratings, which had this distribution: 34 bonds changed within their rating grade (e.g., B to B +); 19 changed rating grades (e.g., B to BB); and 4 were moved from one category to another (e.g., any B grade to any C grade). The 19 bonds that changed rating grade underwent 8 upgrades and 14 downgrades (a few bonds had more than one change).

We calculate four different volume measures in order to gain a thorough perspective on the frequency and quantity of trading in FIPS mandatory issues and report these in Table 2. The average number of trades per day is an indicator of the frequency of trading, as is the percentage of days on which at least one trade occurs. The average number of bonds traded per day and the turnover ratio convey the level (or amount) of trading volume.[18] The turnover

[16] Five issuers were public for a portion of the mandatory period and private for another. Three issuers fall into more than one category because each was private for part of the time that one bond issue was mandatory and public for the entire time that another issue was mandatory.

[17] We report time-weighted averages of these figures.

[18] The turnover ratio is defined as an issue's average daily number of bonds traded divided by the issue's number of bonds outstanding. In order to identify a representative number of bonds outstanding, we simply divided the outstanding par value by $1,000. See the description of the Issue Size variable in Section 5.2. Annualized volume equals the average daily volume times 250 days.

Table 1
A description of the sample of FIPS mandatory issues

The sample contains bonds that were mandatory on the FIPS system for at least a portion of October 1, 1994 to July 1, 1997 time period. Out of a total of 67 issues, we discarded five because they were mandatory for six or fewer months and two others because of a lack of confidence that the data files contained all transactions. Reported are the number of bond issues whose issuers had public or private equity while the issue was mandatory, and the number of issuers that had public or private equity while their bonds were mandatory on FIPS. The par value outstanding is the average value while the issue was mandatory, correcting for any repurchases and refundings. Average time to maturity and average time since issuance are measured from the mid-point of the period when the bond issue was mandatory in our sample period. We also report the seasoning of the bond issues as of the first trading day after being classified as mandatory. The bond ratings are from Standard and Poor's. We report the bond rating for each bond that was mandatory at the time indicated.

Total number of bond issues		60	
Bonds of issuers with public equity during the entire period the bond was on FIPS		47	
Bonds of issuers with private equity during the entire period the bond was on FIPS		8	
Bonds of issuers with private equity for a portion of the time the bond was on FIPS		5	
Number of issuers		47	
Issuers with public equity during the entire period the bond was on FIPS		37[a]	
Issuers with private equity during the entire period the bond was on FIPS		8[a]	
Issuers that had private equity for a portion of the time the bond was on FIPS		5[a]	
Average par value outstanding		\$396 million	
Average time to maturity		7.3 years	
Average time since issuance		2.7 years	
Seasoning (Age) as of listing date	Listed on 4/11/94		Listed after 4/11/94
Bonds listed within six months of issuance	7 (22%)		1 (4%)
Bonds listed within one year of issuance	13 (41%)		9 (32%)
Bonds listed within two years of issuance	24 (75%)		20 (71%)
Bonds listed more than two years after issuance	8 (25%)		8 (29%)
Number of bonds rated	December 1994	December 1995	December 1996
Above B +	13	15	14
B +	8	16	9
B	6	8	12
B −	2	3	5
Below B −	4	6	7
NR	0	1	1

[a] Three issuers fall into more than one category.

Table 2
Daily trading activity of FIPS bonds

The data contain daily volume measures for 60 mandatory FIPS issues over the time period of October 1, 1994 to July 1, 1997. We calculate the number of trades, the number of bonds traded, and trade size by finding the average for each bond issue and then computing the mean over all bonds. The percentage of days that bond trades is found by dividing the total number of days that a bond trades at least once by the total number of days that the bond is mandatory. The annual turnover is calculated for each bond by multiplying the daily number of bonds traded by 250 and dividing by the number of bonds outstanding.

	Number of trades	Number of bonds traded	Annual turnover	Trade size	Percentage of days that bond trades
Mean (standard deviation)	7.79 (7.50)	3,207 (3,693)	176% (126%)	529 (492)	83 (20)
Highest value	41.16	19,758	619	1952	100
Cutoff for highest 25%	11.07	4,126	237	801	98
Cutoff for highest 50%	5.46	1,771	143	401	93
Cutoff for highest 75%	1.99	861	86	135	68
Lowest value	0.45	119	28	45	25

ratio also gauges whether or not an issue tends to be bought and held because a high turnover implies significant trading interest on the part of short-term investors.

Table 2 shows that the typical mandatory FIPS issue trades rather frequently and in decent quantities. According to a report on bond market transparency prepared by the SEC's Division of Market Regulation, an 'actively traded' issue posts at least two trades a week (SEC, 1991). Table 2 reveals that all sampled bonds exceeded this criterion between 1994 and 1997 because the minimum of 0.45 trades per day implies 2.25 trades per week. In fact, the average is 7.79 trades per day, which amounts to 38.90 trades in an average week. The other measure of frequency uncovered similar evidence: over half the issues traded on at least 90% of possible days, and the average issue in the sample had at least one trade on 83% of possible days. The quantity measures suggest a market of some size: half of the issues had an average daily volume of 1,771 bonds or more (at least \$1.771 million, in par value); the average issue had an annual turnover of 176%, with a quarter of the issues having turnover ratios above 237%.

It is worthy of note that the typical trade size has not been as large as the SEC might once have expected: FIPS bonds have an average trade size across issues of 529 bonds (or \$529,000 in par value). This amount is much less than the \$1–3 million predicted in SEC (1992). Further, the average trade size across trades is

399 bonds, the median is 25 bonds, the mode is 10 bonds, and more than 70% of trades are for fewer than 100 bonds (not shown). These trade sizes represent the trading interest of not only institutions, but also dealers and possibly retail investors. As such, these figures are much less than the median institutional trade size reported by Schultz (1998) for a sample of both investment-grade and high-yield corporate bonds, suggesting, not surprisingly, that institutions trade in much larger sizes than dealers and individuals. While these trade sizes seem small relative to anecdotal evidence, they are large relative to equities. Schultz (1998) also shows that the median trade size in his institutional fixed-income data set is several times larger than the median institutional equity trade sizes reported in Keim and Madhavan (1995). Our trade sizes are also large relative to trade sizes reported in equities. According to the NYSE, the average trade size in NYSE equities in 1996 was $54,135 (NYSE, 1997).

Table 2 also indicates that mandatory FIPS issues exhibit substantial cross-sectional variation in trading volumes and average trade size. The range of the average trades per day was a notable 40.71 (or 41.16 − 0.45). While the top quartile posted average daily volumes of at least 4,126 bonds, the bottom 25% averaged 861 or fewer bonds. The turnover ratio also ranged widely, between 28% and 619%. Average trade size varies quite a bit with several bonds averaging more than 1,000 bonds per trade (i.e., $1 million in par value) and others averaging less than 100 bonds per trade. Relatively less variation appears in the percentage of days measure: 45 of the 60 mandatory issues traded on more than two of every three days. In summary, Table 2 indicates that most FIPS mandatory issues trade fairly regularly and that most of them trade in quantities in excess of $1 million of par value per day.

We also examined the daily distribution of total volume in the sampled FIPS issues in order to assess how much activity this market handles each day and how much variability the total volume might exhibit. Fig. 1 plots the distribution of the market's total daily volume between October 1994 and July 1997. That volume primarily fell within the range of 50,000–150,000 bonds. On approximately 60% of the days, the volume on the mandatory portion of FIPS exceeded 100,000 bonds, but it also occasionally (specifically, on 3% of the days) fell below 25,000.

The volume of trading recorded in Table 2 and Fig. 1 may seem large in light of the widely held view that 'the high-yield debt market is relatively illiquid and is characterized by sporadic transactions' (SEC, 1991, p. 10). Nonetheless, the documented volume level is understandable. Mandatory issues are those that, in Nasdaq's view, have recognizable names, a following among analysts, and a history of being actively traded. Thus, it is only to be expected that mandatory issues post trading volumes larger than that expected of the average high-yield bond.

A good way to assess the relative volume on this market is to compare the trading of FIPS securities to the volumes recorded on more familiar venues, like

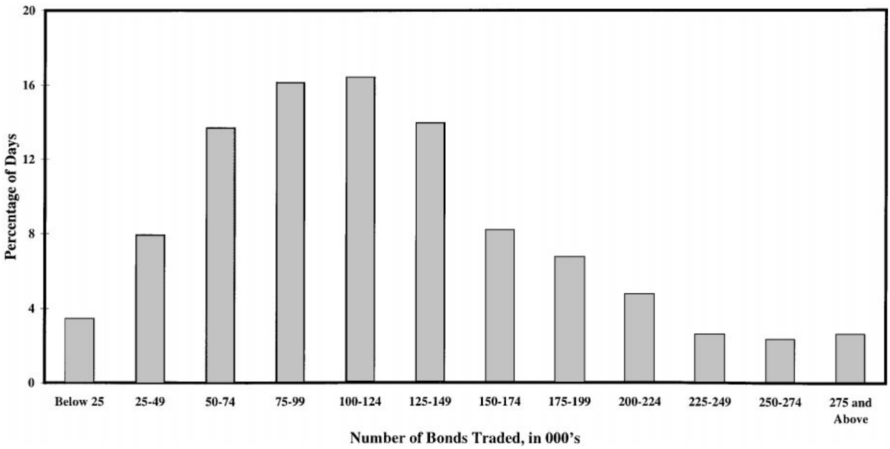

Fig. 1. Frequency distribution of volume on FIPS market. The data contain the daily volume for 60 mandatory FIPS issues over the period of October 1994 to July 1997.

equity trading on NYSE and Nasdaq. This exercise is not intended to determine the relative importance of these markets, but rather to provide a better understanding of the volume on FIPS. We chose to compare the market value of volume (dollar volume) to avoid an 'apples and oranges' type of comparison that would result if other volume measures were used. Table 3 reports this comparison for the most recent six months of our FIPS data (January to July 1, 1997).[19] The average daily volume across the mandatory FIPS issues was \$3,705,128. To form a standard for comparison, we divided the equities of NYSE and Nasdaq into deciles according to average daily dollar volume. It can be argued that a comparison with the NYSE is misleading because trades on the NYSE often do not involve the use of a specialist, whereas all FIPS trades involve a dealer. The NYSE (1997, p. 18) reports that, in 1996, the specialist was either the buyer or seller for 18% of all share volume. Thus, a fair comparison involves dividing the volume of the FIPS issues in half and comparing the resulting amount (\$1,852,564) with 0.91 times the NYSE decile volumes.[20] No adjustments are necessary to compare the FIPS volume to that of Nasdaq equities.

[19] We used Securities Industry Automation Corporation (SIAC) data to calculate equity volume. Although 50 issues were mandatory at that time, our sample contains only 48, as two issues had private equity.

[20] The results are similar if we compare half of the debt issue volume with 100% of NYSE decile volume.

Table 3
A comparison of the volume on FIPS to the volume of equities

This table examines the daily volume for 48 mandatory FIPS bonds over the time period of January 1, 1997 to July 1, 1997. The average daily market volume, in dollars, of the typical issue is $3,705,128. This amount is compared to the volume of the typical Nasdaq-listed stock, while half of this amount, $1,852,564, is used to compare to the adjusted volume of the typical NYSE-listed stock. The NYSE volume is adjusted to reflect 91% of the average to take into consideration the participation of specialists. The data for the stocks comes from the Securities Industry Automation Corporation (SIAC) for the same period. Reported are the average daily dollar volume per bond on FIPS and the average daily dollar volume within each of ten volume deciles of NYSE stocks and Nasdaq stocks. The *** denotes the location of the FIPS *average* within the two sets of deciles. The ** denotes the location of the FIPS *median* within the two sets of deciles. Also reported are the number of FIPS bonds that would qualify for each volume decile on NYSE and Nasdaq.

Decile of equity volume	New York Stock Exchange (n = 3,991)		Nasdaq Stock Market (n = 7,192)	
	Adjusted average daily volume of decile ($)*	Number of FIPS issues in decile range	Average daily volume of decile ($)	Number of FIPS issues in decile range
1	4584	0	925	0
2	38,500	3	7,180	0
3	95,184	2	21,703	0
4	172,460	3	47,735	2
5	311,104	8	88,486	1
6	581,517	9**	161,136	1
7	1,103,904***	4	302,954	3
8	2,406,130	12	606,590	9
9	6,223,434	6	1,495,918***	11**
10	38,196,719	1	21,231,098	21

According to the table, the average volume of a FIPS bond falls between the averages for the third and fourth highest volume deciles of NYSE stocks and between the highest and second highest volume deciles of Nasdaq stocks. Moreover, the average volumes of 32 of 48 FIPS issues were large enough to rank among the top 50% of all NYSE stocks. And these 32 FIPS issues had sufficient trading volume to rank in the top 20% of Nasdaq stocks. Hence, the volume in mandatory FIPS issues is comparable to that of medium- and higher-volume stocks on the NYSE and Nasdaq.

While this comparison analyzes only the most liquid bonds, it does allow us to speculate on the volume of other high-yield bonds. If we assume that our sample comes from the absolute highest volume FIPS bonds, then examination of the lowest volume mandatory bond indicates that the volume of each of the non-mandatory bonds would be comparable or less than the bottom two NYSE deciles and the bottom four Nasdaq deciles. We cannot, however, tell how many more bonds trade regularly or whether volume drops off abruptly for other

Table 4
Growth in daily FIPS volume across time

The data contain daily volume measures for 60 mandatory FIPS issues over the time period of October 1, 1994 to July 1, 1997. The table reports the average volume per bond in each year of operation. Note that the year 1994 includes only October 1 to December 31, and the year 1997 contains only January 1 to July 1. These averages allow for a change in the number of mandatory issues from 35 to 50 in 1995 because we focus on average volume per issue instead of total volume over all issues.

Year of operation	Average number of trades (standard error)	Average number of bonds traded (standard error)
1994	4.97	2,108
	(0.20)	(162)
1995	7.39	2,562
	(0.10)	(64)
1996	7.29	2,440
	(0.09)	(57)
1997	8.97	4,123
	(0.17)	(144)

issues. Our overall conclusion, therefore, is that there exists a set of bonds that have fairly high volume, but most high-yield bonds probably do not trade as much as this set.

Table 4 contains statistics regarding the growth of the FIPS market during the time covered by our data. Two measures of daily volume, average trades and average number of bonds traded, are reported for each year. As mentioned previously, note that: (1) the data from 1994 cover only the last three months; (2) FIPS increased the number of mandatory issues from 35 to 50 in April 1995; and (3) the data from 1997 extend over just the first six months. Overall, the table shows that the daily trading volume in FIPS bonds has nearly doubled in the 1994–1997 period. This was largely because of substantial growth in both the average number of trades per day and the average number of bonds traded daily from 1994 to 1995 and from 1996 to 1997. On the other hand, little growth appeared in either measure between 1995 and 1996. This result is not surprising in that it may indicate that when FIPS increased the number of mandatory bonds, the new bonds added were not as heavily traded as the incumbent bonds.

The 1996–1997 growth spurt in both daily averages is curious. It could be due to increased participation in FIPS by broker-dealers or increased interest in debt issues by investors, or both. It could also be due to a shift in the characteristics of the 50 mandatory bonds when Nasdaq revised the list in November 1996 by replacing 10 issues. As a result, the typical mandatory bond tended to have a higher average par value, be more recently issued, be more likely to be from a private company, and to have lower credit ratings in 1997 than in 1996. (The typical bond's average duration decreased slightly, but that variable, as the tests in this paper will show, is less important to trading volume than the others.) Some of the growth in trading, however, was independent of the change in the sample. In analyzing the volume of issues that were mandatory in both 1996 and 1997, we found a modest increase in the average number of trades and a somewhat larger rise in the average number of bonds traded. Consequently, we can explain only part of the 1996–1997 growth spurt.

5. Tests of the determinants of volume

5.1. Methodology

We examine the determinants of volume through regression analysis of the relationships between three measures of trading volume and key attributes of the issue and issuer. The model, which has a pooled time-series and cross-sectional structure, takes the following functional form, where the subscript i refers to an individual bond issue and the subscript t refers to a month:

$$\text{Trading Volume}_{it} = f(\text{Size}_{it}, \text{Age}_{it}, \text{Private Equity}_{it}, \text{Control Variables}_{it}). \tag{1}$$

The specification of the independent variables appears below. The methodology is the one that Greene (1993) and Kmenta (1986) recommend for pooling data when the data set is not 'short and wide', or when the number of cross-sectional cases (here, 57 bond issues) is not 'large' by comparison to a 'few' time-periods (the data span up to 24 months per issue).[21] The specific adjustments for the effects of pooling are explained below.

We perform tests for several versions of Eq. (1) that differ only in the dependent variable. In one version, the dependent variable reflects the frequency of trading and is the natural log of an issue's average daily number of trades over the month. (The choice of the log of trades, as opposed to the simple trade number itself, reflects the wide dispersion of the trade volume over the various bonds.) In two other versions, the dependent variable gauges the relative quantity of trading as measured by the natural log of the average daily number of bonds traded and by the average daily turnover during the month. By applying the tests to monthly time intervals, we limit the effect of possibly

[21] See Greene (1993, p. 465).

imprecise timing in some of the independent variables. For example, the par value outstanding changed for two issues (because of an open market repurchase and the use of sinking funds). However, the exact date of the change cannot be determined. Thus, the monthly aggregation limits the error due to this imprecision. One consequence of focusing on monthly values is that it becomes prudent to exclude a bond in any month in which it is mandatory for only part of the month, either at the beginning or at the end of its mandatory interval. Such an exclusion affects one month for each of 19 bonds that were either added to the FIPS list after the start of the test period or removed before the end of the test period. Four firms announced calls of their bonds during the test interval. The test data omit these bonds from the announcement months on, but this exclusion affects only 15 monthly observations.[22]

The regressions include only data from the interval of July 1995 to June 1997. Because Nasdaq changed the number of mandatory FIPS issues from 35 to 50 in April 1995, focusing on the period that started shortly after the change should protect the test results from any regime shift within the data. (Data from July 1, 1997, are excluded by the decision to concentrate on full months.) The data set, accordingly, consists of trades over 24 months, during which a total of 57 bond issues were mandatory, eight for fewer than ten months but 31 issues for the full 24 months. The total number of pooled observations is 1,120. Because some of the bonds are not part of the sample in every month, the pooled data constitute an unbalanced panel.

The appropriate pooling methodology requires testing the data for autocorrelation, cross-sectional heteroscedasticity, and cross-sectional correlation. Specifically, for all versions of Eq. (1), a White test of the residuals from a simple OLS regression applied to the pooled data indicates the presence of heteroscedasticity for 23–30% of the issues, depending on the particular dependent variable. Further, the residuals from those regressions produced evidence of first-order autocorrelation for 20–44% of the bonds, with no indication of higher-order autoregressive tendencies.[23] The tests for cross-sectional correlation consisted of computing the pairwise correlations among all the values of each of the dependent variables. Fewer than 10% of the correlations were statistically meaningful. Accordingly, we opted to use the pooling technique

[22] Four bonds remained listed as mandatory for one to six months after Standard and Poor's had raised their ratings and they no longer qualified as FIPS issues. Our data contain trade reports in these issues for those months, but we cannot be confident that we have all trades. Hence, the transactions in these bonds over a total of 15 months are not part of the data set for the regressions.

[23] The presence of autocorrelation would seem to be related to a bond's liquidity, as it would tend to make it easier for a dealer to manage his or her inventory than if it were absent. However, this does not detract from the central purpose of this paper, which is to analyze other potential determinants of liquidity.

appropriate for time-series autoregression and cross-sectional heteroscedasticity, but not cross-sectional autocorrelation.

Implementing this methodology requires five steps for each version of Eq. (1).[24] The first step is to apply OLS to the pooled data in order to estimate the monthly residuals associated with each bond issue. Second, for each individual issue, first-order autocorrelation is estimated and evaluated for statistical significance. If an issue posts a significant autocorrelation coefficient, its data are transformed according to a first-order autoregressive scheme. The third step is to apply OLS once more to the data that is now free of autoregressive properties. The fourth step is to eliminate heteroscedasticity by dividing the standard deviation of the residuals for each bond into its already once-transformed data. With autocorrelation and heteroscedasticity removed from the data, we re-estimate the model's parameters with OLS regression, resulting in estimates that have desirable statistical properties for inference and hypothesis testing.[25]

5.2. Independent variables

5.2.1. Issue size

To test the impact of size on trading volume (Hypothesis 1), we include the natural log of the issue's par value in millions of dollars, labeled Ln(Size), in the regressions.[26] *Standard & Poor's Monthly Bond Report* and Bloomberg's information service are the sources of outstanding par values. Because the size of only two securities fell during the sample period (through repurchases), the monthly size of most issues is their par value outstanding as of the later of July 1995 or the month when they became mandatory FIPS bonds.

5.2.2. Age

To test Hypothesis 2, we include a variable to measure the seasoning of the issues. While there are many ways to specify a variable based on age, our heuristic analysis suggested that the typical relationship between age and volume is non-linear because trading appears to decline throughout an issue's first two years and then to become stable at a low level.[27] Such a pattern

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[24] We prefer our approach to the Newey–West method because it allows us to estimate a separate autocorrelation coefficient for each bond and to adjust the data of only those bonds whose autocorrelation coefficients are statistically different from zero.

[25] Tests with a random effects model for the effect of time were also performed; the coefficients and t-statistics were very similar to the OLS results reported here.

[26] Like Crabbe and Turner (1995), we experimented with both the natural logs of size and size itself. The statistical results were similar.

[27] Other research that justifies a two-year cutoff include Blume et al. (1991), who use two years as a major cutoff point for analyzing a bond's age, and Hong and Warga (1998), who state that 'bonds that trade are likely to have been issued within the past year or two'.

probably reflects the tendency of a bond to settle in investors' portfolios over the first two years of its life and to trade somewhat sparingly after that time (Warga, 1992). Accordingly, the independent variable denoted Age is a dummy that takes the value of one if the bond has been outstanding for two years or less and the value of zero if the bond has been outstanding longer.

5.2.3. Private equity

To test Hypotheses 3, we add a dummy variable that takes on a value of one if the issuer's equity was privately held at any time in a month, and a value of zero if the firm was a public corporation during the entire month. The sign of the coefficient should be negative if private firms are less liquid because of a lack of information. As noted in connection with Table 1, 13 bonds were issued by firms that had no public equity during at least a portion of the interval when their bonds were mandatory. A total of 100 of our 1,120 monthly observations contain a dummy value of one for this variable. Thus, almost 9% of our observations are cases of privately held equity.

5.3. Control variables

As indicated in Section 2.2, we control for non-liquidity-related determinants of volume. This involves adding control variables for default risk, interest rate risk, and price volatility.

5.3.1. Default risk

The variable that represents default risk, labeled Credit Rating, is a monthly dummy variable that takes on a value of zero if the rating was in any B-category (that is, BB or B) during the entire month, and a value of one if the bond was in a C-category at any time in the month. This specification allows for ratings changes between the two broad categories. The coefficient of this variable gauges the difference in trading activity between issues rated B-minus or better and securities with any lower rating. The source of information is *Standard & Poor's Monthly Bond Report*. If bonds with higher ex ante risk have higher volume, then the coefficient on Credit Rating should be positive.

5.3.2. Interest rate risk

The measure of interest rate risk is an issue's duration, which depends on the issue's price and the details of its call provision, if any. Like the coefficient on credit rating, the coefficient on duration should be positive. If an issue is selling at or below par, whether it has a call provision or not, then its 'modified duration', computed on the basis of its maturity and maturity value, is used.[28] If

[28] See, for example, Fabozzi (1996, p. 60.)

an issue is selling above par and does not have a call provision, then we also use modified duration. However, if an issue is selling above par and has a call provision, then we use the following procedure. First, if it is not yet callable, then we use its 'duration to call', which equals its modified duration computed on the basis of its call date and call price. Second, if it is callable during the month, then we use its 'effective duration', computed for upward and downward shifts of 25 basis points in its yield-to-maturity.[29]

5.3.3. Price Variability

Price Variability is defined, for each security in each month, as the average absolute value of the daily percentage change in volume-weighted price.[30] We use volume-weighted average price to minimize any bid–ask bounce effects in this variable. Price Variability should be positively linked with trading volume.[31]

5.4. Results

Adding the independent variables to Eq. (1) results in the following linear specification:

$$\begin{aligned}\text{Trading Volume}_{it} = {} & \beta_0 + \beta_1 \,\text{Ln}(\text{Size}_{it}) + \beta_2 \,\text{Age}_{it} + \beta_3 \,\text{Private Equity}_{it} \\ & + \beta_4 \,\text{Credit Rating}_{it} + \beta_5 \,\text{Duration}_{it} \\ & + \beta_6 \,\text{Price Variability}_{it} + \varepsilon_{it}. \end{aligned} \tag{2}$$

Table 5 reports the results of the pooled time-series and cross-sectional regressions of Eq. (2) with the three monthly measures of trading volume – natural log of the average daily number of trades, the natural log of the average daily number of bonds traded, and average daily turnover.[32] The fit between the dependent and independent variables is good, as the values of R^2 (adjusted for degrees of freedom) and the F-statistics suggest that a significant relationship

[29] See, for example, Fabozzi (1996, p. 344). Three issues were callable during our sample period, but the prices of only two of them rose briefly above par. For them, when we calculated the effective duration, we used the call price as a cap on the rise in the price for a decline in the yield.

[30] Karpoff (1987) reports that many researchers use the absolute value of the change in price, but that raises the specter of heteroscedasticity with this data set.

[31] At first it might seem that the measures of duration and price variability might create a problem of multicollinearity. However, the correlation between these two variables was, at 0.02, not significantly different from zero.

[32] We also estimated the model for a sample that did not include bonds for which the credit rating dummy variable changed during the period. The results were similar.

Table 5
Pooled time-series and cross-sectional regressions of the determinants of volume in high-yield bonds

$$\text{TradingVolume}_{it} = \beta_0 + \beta_1\ \text{Ln}(\text{Size}_{it}) + \beta_2\ \text{Age}_{it} + \beta_3\ \text{PrivateEquity}_{it} + \beta_4\ \text{CreditRating}_{it} + \beta_5\ \text{Duration}_{it} + \beta_6\ \text{PriceVariability}_{it} + \varepsilon_{it}$$

The data contain monthly measures of trading activity for the July 1, 1995 to June 30, 1997 time period. The dependent variables are the natural log of the number of trades per day [Ln(Trades)], the natural log of the number of bonds traded per day [Ln(Bonds)], and the daily turnover, all averaged over the month. The turnover is measured by dividing the average daily number of bonds traded during a month by the number of bonds outstanding in that month. The regression model adjusts for first-order autoregressive and cross-sectionally heteroscedastic disturbances. Size is the issue's par value outstanding. Age is a dummy variable equal to one if the issue has been outstanding for less than two years. Private Equity is a dummy variable equal to one if the issuer has no public equity outstanding in any part of the month. Credit Rating is a dummy variable equal to one if the issue is rated below B-minus by Standard and Poor's at any point in the month. Duration is a bond's modified duration if the issue is selling at or below par. If the issue is selling above par and is not callable, then we also use modified duration. However, if the issue is selling above par and has a call provision, then we measure its duration as its modified duration to call. Lastly, if it is callable, then we represent its duration as its effective duration. Price Variability is the monthly average absolute value of the daily percentage change in volume-weighted price. The number in parentheses below the coefficient is the p-value, which is the level of confidence at which the hypothesis of a zero coefficient can be rejected in a one-tailed test.

Variable (expected sign)	Ln(Trades)	Ln(Bonds)	Turnover
Intercept	− 0.14	− 0.32	0.52
	(0.02)	(< 0.01)	(< 0.01)
Ln(Size, in \$ millions Par) (+)	0.12	1.20	0.01
	(< 0.01)	(< 0.01)	(0.07)
Age, Dummy (+)	0.16	0.44	0.18
	(0.01)	(< 0.01)	(< 0.01)
PrivateEquity, Dummy (−)	0.21	0.84	0.20
	(< 0.01)	(< 0.01)	(0.01)
CreditRating, Dummy (+)	0.77	0.74	0.30
	(< 0.01)	(< 0.01)	(< 0.01)
Duration (+)	0.18	0.03	0.01
	(< 0.01)	(0.12)	(0.07)
PriceVariability, in % (+)	0.24	0.21	0.08
	(< 0.01)	(< 0.01)	(0.02)
R^2 (adjusted)	0.72	0.93	0.07
F-statistic	475.60	2,320.90	14.12
	(< 0.01)	(< 0.01)	(< 0.01)

exists between the regressors and the measures of trading volume, particularly for the number of bonds and number of trades. Further, the coefficients for all but one of the independent variables are statistically significant in all regressions, with the expected signs, at the 95% level of confidence.

The coefficient for Ln(Size) strongly indicates that, ceteris paribus, larger mandatory FIPS issues trade more frequently and in greater quantities than smaller issues when trades and number of bonds traded are used as dependent variables. Interestingly, the relationship is even marginally statistically significant when turnover is the dependent variable. Our analysis of trading volume produces statistical results consistent with the idea that smaller issues, all else equal, are less liquid and should therefore offer liquidity premiums over larger issues.

The positive coefficients on the dummy variable, Age, support the hypothesis that a mandatory bond issue is more actively traded within the first two years after issuance than later. Because the sample does not include any observations of a bond's trading volume immediately after issuance (see Table 1), the results suggest that many bonds might require up to two years to settle into portfolios. This supports our proposition that the volume decline in bond issues lasts much longer than the initial few months.

The positive coefficients for the Private Equity dummy variable in Table 5 do not support the hypothesis that, ceteris paribus, mandatory FIPS issues of private equity firms trade less actively than otherwise similar securities of public firms. This is possibly because our set of private firms might release as much information as the public firms despite their private firm status. The higher volume is also possibly due to the role of this debt as the only vehicle for investing in a firm that has no publicly traded equity. Because equity is not available, more investors may choose to invest in the debt of a private firm than an otherwise similar public firm. This increased supply of investors might outweigh the effect of less information and lead to higher trading volume for private firms relative to public firms.

Each of the control variables seems to behave as expected with the marginal exception of interest rate risk ('Duration'). Both default risk ('Credit Rating') and return volatility ('Price Variability') appear to be determinants of the speculative component of volume. For duration, the significantly positive coefficient in the Trades regression and marginally significant positive coefficient in the Turnover regression seem to confirm that an issue's volume can also reflect interest rate risk.[33] However, the insignificant coefficient in the Number of Bonds regression and the small size of the coefficient in the Turnover regression indicate that the relationship is fairly weak. Indeed, such a result gets support from the results of Fama and French (1993) and Kwan (1996) that high-yield bond prices are not very sensitive to changes in interest rates. If the prices are not very sensitive to interest rate changes, then volume should not be very sensitive to interest rate risk.

[33] When Ln(Duration) was used instead of Duration in the Ln(Bonds) regression, its coefficient was significantly positive, but the coefficients for Duration in the other two regressions were insignificant.

6. Summary and conclusions

This paper describes the structure of the corporate fixed-income market, focusing on the Fixed Income Pricing System. We describe the intricacies of the trading and quoting rules on the FIPS system, and we document that the volume of mandatory FIPS bonds is comparable to that of the medium- to high-volume NYSE and Nasdaq equities. This description is useful to future researchers who may consider using FIPS data because FIPS operates in a market with limited transparency and lenient quoting rules. Further, the status of corporate bonds as non-National Market System securities, when considered in light of previous research highlighting the equity characteristics of high-yield bonds (e.g., Blume et al., 1991; Cornell and Green, 1991; Fridson, 1994), raises the question of whether high-yield bonds should be regulated more like equities. Indeed, this question is relevant to the SEC's current re-evaluation of regulation and transparency in bond markets.

After introducing FIPS, we examine the volume of individual high-yield bond issues and offer implications for the liquidity of these issues. Results of existing studies on the liquidity of fixed-income securities disagree about the effects of issue size and aging on liquidity, yet our volume results suggest that larger issues and issues less than two years old are indeed more heavily traded, and by implication, more liquid. The age result, in particular, extends earlier empirical results that found that the liquidity of Treasury securities drops off after an initial trading period of a few months. After suggesting that age and issue size are associated with liquidity, it is interesting to note that recent working papers by Hong and Warga (1998), and Chakravarty and Sarkar (1999) generally found that these characteristics are similarly associated with bid–ask spreads.

We also introduce and examine the idea that secondary market activity in debt issues can be affected by the status of the underlying firm's equity. Our findings show that the debt of firms without public equity trades more actively than the debt of firms with public equity. This contradicts the hypothesis that the debt of private firms should be less liquid because of more relaxed disclosure rules. We postulate that this result is driven by the fact that debt is the only way to invest in a firm's economic development if that firm does not have public equity. In other words, high-yield debt of private firms seems to attract some of the volume that otherwise would have occurred in the equity. Future research is needed to explore this substitution effect further.

Appendix A. The algorithm to filter erroneous trade records

We applied a filtering algorithm to delete erroneous trades that deleted less than 0.5% of the trade reports. This technique relies on both recorded prices and quoted prices and allows for a significant price change in the bond. We set the price limits heuristically to try to delete as many transactions with price errors as possible without deleting many legitimate transactions. We used the dealer bid and ask prices because their firm nature makes posting erroneous quotes costly. However, because the quotes seemed to lag big intraday price changes, we use bounds based on the highest ask and lowest bid prices in a day. If the ask price was greater than \$60 per \$100 of par value, the algorithm deleted any transactions with prices greater than 107% of the maximum ask on the day. If the ask price was less than \$60, the algorithm deleted transactions with prices greater than the maximum ask plus \$4. Similarly, the algorithm rejected transactions with prices less than 93% of the day's minimum bid for bids greater than \$60, and transactions with prices less than the minimum bid minus \$4 whenever the bid was less than \$60.

This example illustrates the procedure. For bond A on day X, the minimum dealer bid was \$89.6875 and the maximum dealer ask was \$106. Thus, the filter would keep only trades occurring at prices greater than \$83.40 [$0.93 \times \$89.6875$] and less than \$113.40 [$1.07 \times \$106.00$]. For the trades reported for bond A on day X, and the filter deletes trades numbered 2, 3, 11, and 15:

No.	Time	Direction	Price	Size (par)
1	9:41	S	104.25	10,000
2	9:50	S	75.50	1,000,000
3	9:50	B	75.50	1,000,000
4	10:19	S	104.00	5,000
5	12:07	S	104.50	50,000
6	12:24	S	104.50	50,000
7	12:56	S	104.25	2,000
8	1:28	S	104.25	11,000
9	1:38	S	104.00	15,000
10	1:53	S	104.25	10.000
11	1:54	S	76.00	13,000
12	3:10	S	104.00	25,000
13	3:15	S	103.75	50,000
14	3:16	B	103.75	50,000
15	3:53	S	76.00	20,000

References

Admati, A.R., Pfleiderer, P., 1988. A theory of intraday patterns: volume and price variability. Review of Financial Studies 1, 3–40.

Amihud, Y., Mendelson, H., 1986. Asset pricing and the bid–ask spread. Journal of Financial Economics 17, 223–249.

Amihud, Y., Mendelson, H., 1991a. Liquidity, maturity, and yields on U.S. Treasury securities. Journal of Finance 46, 1411–1425.

Amihud, Y., Mendelson, H., 1991b. Liquidity, asset prices, and financial policy. Financial Analysts Journal 47, 56–66.

Bachelier, L., 1900. Theory of speculation. Reprinted in: P.H. Cootner (Ed.), The Random Character of Stock Prices. The MIT Press, Cambridge, MA, 1964, pp. 17–78.

Bamber, L.S., 1986. The information content of annual earnings releases: a trading volume approach. Journal of Accounting Research 24, 40–56.

Bamber, L.S., Barron, O.E., Stober, T.L., 1999. Differential interpretations and trading volume. Journal of Financial and Quantitative Analysis 34, 369–386.

Blume, M., Keim, D., Patel, S., 1991. Returns and volatility of low-grade bonds, 1977–1981. Journal of Finance 46, 49–74.

Bourbeau, H., Vames, S., 1998. Experts express skepticism about Levitt impact. The Wall Street Journal, September 10, C21.

Chakravarty, S., Sarkar, A., 1999. Liquidity in U.S. fixed income markets: a comparison of the bid–ask spread in corporate, government and municipal bond markets. Staff Report Number 73, Federal Reserve Bank of New York.

Cornell, B., 1992. Liquidity and the pricing of low-grade bonds. Financial Analysts Journal 48, 63–74.

Cornell, B., Green, K., 1991. The investment performance of low-grade bond funds. Journal of Finance 46, 29–48.

Crabbe, L.E., Turner, C.M., 1995. Does the liquidity of a debt issue increase with its size? Evidence from the corporate bond and medium-term note market. Journal of Finance 50, 1719–1734.

Datar, V.T., Naik, N., Radcliffe, R., 1998. Liquidity and stock returns: an alternative test. Journal of Financial Markets 1, 203–219.

Demsetz, H., 1968. The cost of transacting. Quarterly Journal of Economics 82, 33–53.

Dueweke, D.G., Hyland, M.J., Siesel, F., 1992. Measuring the New York Stock Exchange's share of corporate trading volume. Journal of High Yield Bond Research, Merrill Lynch Extra Credit, September/October 4, 9–16.

Fabozzi, F.J., 1996. Bond Markets, Analysis and Strategies. Prentice-Hall, Upper Saddle River, NJ.

Fama, E.F., French, K.R., 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics 33, 3–56.

Fenn, G., 2000. Speed of issuance and the adequacy of disclosure in the 144A high-yield debt market. Journal of Financial Economics, forthcoming.

Fisher, L., 1959. Determinants of risk premiums on corporate bonds. Journal of Political Economy 67, 217–237.

Foster, F.D., Viswanathan, S., 1990. A theory of the intraday variations in volume, variance, and trading costs in securities markets. Review of Financial Studies 3, 593–624.

Foster, F.D., Viswanathan, S., 1993. Variations in trading volume, return volatility, and trading costs: evidence on recent price formation models. Journal of Finance 48, 187–212.

Fridson, M., 1994. Do high-yield bonds have an equity component? Financial Management 23, 83-85.

Fridson, M., Garman, C., 1998. Determinants of spreads on new high-yield bonds. Financial Analysts Journal 52, 28–39.

Garbade, K.D., Silber, W.L., 1976. Price dispersion in the government securities market. Journal of Political Economy 84, 721–740.

Greene, W.H., 1993. Econometric Analysis. Prentice-Hall, Upper Saddle River, NJ.

Harris, M., Raviv, A., 1993. Differences of opinion make a horse race. Review of Financial Studies 6, 473–506.

Hong, G., Warga, A., 1998. An empirical study of bond market transactions. Working Paper, University of Houston.

Hotchkiss, E.S., Ronen, T., 1999. Information links between bond and stock markets: an intraday analysis. Working Paper, Boston College.

Jones, C.L., 1998. Evidence of the importance of market making: Drexel's failure and the junk bond market. Working Paper, George Washington University.

Kamara, A., 1994. Liquidity, taxes, and short-term Treasury yields. Journal of Financial and Quantitative Analysis 29, 403–417.

Kandel, E., Pearson, N., 1995. Differential interpretation of public information and trade in speculative markets. Journal of Political Economy 103, 831–872.

Karpoff, J.M, 1987. The relationship between price changes and trading volume: a survey. Journal of Financial and Quantitative Analysis 22, 109–126.

Keim, D., Madhavan, A., 1995. Anatomy of the trading process: empirical evidence on the behavior of institutional traders. Journal of Financial Economics 37, 371–398.

Kmenta, J., 1986. Elements of Econometrics. Macmillan, New York.

Kwan, S., 1996. Firm-specific information and the correlation between individual stocks and bonds. Journal of Financial Economics 40, 63–80.

Krinsky, I., Lee, J., 1996. Earnings announcements and the components of the bid–ask spread. Journal of Finance 51, 1523–1535.

Lee, C.M.C., Ready, M.A., 1991. Inferring trade direction from intraday data. Journal of Finance 46, 733–746.

Levitt, A., 1998. The importance of transparency in America's debt market. Speech given at the Media Studies Center, New York, NY, September 9.

Liscio, J., 1989. Inflated junk: the pricing scandal in the high-yield bond market. Barron's, May 22, 15.

Nasdaq Stock Market, Inc., 1997. The Handbook of the Fixed Income Pricing System. April.

New York Stock Exchange, Inc. (NYSE), 1997. Fact Book 1996 Data.

O'Hara, M., 1995. Market Microstructure Theory. Blackwell, Cambridge, MA.

Sarig, O., Warga, A., 1989. Bond price data and bond market liquidity. Journal of Financial and Quantitative Analysis 24, 367–378.

Schultz, P., 1998. Corporate bond trading costs and practices: a peek behind the curtain. Working Paper, University of Notre Dame.

U.S. Securities and Exchange Commission (SEC), 1991. A Report by the Division of Market Regulation on Transparency in the Market for High-Yield Debt Securities. September 6.

U.S. Securities and Exchange Commission (SEC), 1992. The Corporate Bond Markets: Structure, Pricing, and Trading.

U.S. Securities and Exchange Commission (SEC), 1993. Order Approving Proposed Rule Change and Amendment No. 1 Relating to the Proposed Operation of a Pricing System for Certain High Yield Fixed Income Securities. Release No. 34-32019, March 19.

Warga, A., 1992. Bond returns, liquidity, and missing data. Journal of Financial and Quantitative Analysis 27, 605–617.

Wyatt, E., 1998. N.A.S.D. to set up network to report data on bonds. New York Times, September 10, C8.

Zuckerman, G., 1998. In the dark: the pricing of bonds, long a mystery, gets some scrutiny. The Wall Street Journal, September 10, A1.

Zwirn, Ed, 1998. SEC's bond-trading plan is lacking, critic says. The Wall Street Journal, September 14, B11.