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Transparency and Liquidity:
A Controlled Experiment on Corporate Bonds

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Abstract

This paper reports the results of a unique experiment designed to assess the impact of last-sale trade reporting on the liquidity of BBB corporate bonds. We find that increased transparency has either a neutral or positive effect on market liquidity depending on trade size. Measures of trading activity such as daily trading volume and number of transactions per day suggest that increased transparency does not lead to greater trading interest. We find that for all but the smallest trade size group, spreads on bonds whose prices become more transparent decline relative to bonds that experience no transparency change. However, we find no effects of transparency for very infrequently traded bonds. The observed decrease in transactions costs is consistent with investors' ability to negotiate better terms of trade with dealers once the investors have access to broader bond pricing data.

1 Introduction

Although larger than the market for U.S. Government or municipal bonds, the corporate bond market historically has been one of the least transparent securities markets in the U.S, with neither pre-trade nor post-trade transparency. Corporate bonds trade primarily over-the-counter, and until recently, no centralized mechanism existed to collect and disseminate post-transaction information. This structure changed on July 1, 2002, when the National Association of Securities Dealers (NASD) began a program of increased post-trade transparency for corporate bonds, known as the Trade Reporting and Compliance Engine (TRACE) system. As part of this structural change, only a selected subset of bonds initially became subject to public dissemination of trade information. The resulting experiment enables us to observe the effects of increased post-trade transparency on market liquidity in a controlled setting.

With the July 2002 introduction of TRACE, all NASD members were required for the first time to report prices, quantities, and other information for all secondary market transactions in corporate bonds.[1] However, the trade information collected by the NASD was publicly disseminated only for very large (issue size greater than $1 billion) and high credit quality (A-rated and above) bonds. Some market participants and regulators initially were concerned that public dissemination of this data for smaller and lower grade bonds might have an adverse impact on liquidity. Therefore, dissemination of trade information for bonds rated BBB+ and below and for issues sizes under $1 billion was to be phased in later, pending a series of studies of the likely impact of increased transparency.

[1] Prior to TRACE, transaction information for high yield bonds was collected by the NASD under the Fixed Income Pricing System (FIPS), but only hourly trading summaries for a sample of 50 high yield bonds were publicly disseminated. See Hotchkiss and Ronen (2002) and Alexander, et al, (2000) for further description of the FIPS reporting requirements.

The first study, which is the subject of this paper, involved a controlled experiment designed to test the impact of transparency on liquidity for the BBB bond market. Using nonpublic TRACE trade data for all BBB bonds from July 2002 to February 2003, we selected 120 bonds for which the NASD began public dissemination of trade data on a real-time basis.[2] These bonds fell into two groups, 90 more actively traded bonds and 30 relatively inactive bonds, enabling us to examine transparency issues across the liquidity spectrum.[3] We simultaneously identified a control sample of non-disseminated bonds. This provided us the opportunity to conduct a true experiment by altering the transparency properties of these securities on a real-time basis. By inter-temporally comparing the trades of the disseminated bonds to themselves before and after they were made transparent, and by comparing the trades of the disseminated bonds to those of the matching but non-disseminated bonds, our experiment allows us to gauge the effects of transparency on bond liquidity in a systematic and controlled framework.

The NASD began public dissemination of trades in the 120 selected BBB bonds on April 14, 2003. We were provided not only with data for the 120 disseminated bonds, but the entire universe of BBB rated corporate bonds, whether disseminated or not. After applying some filters, the dataset we analyze for our study consists of all trades from July 8, 2002 to February 27, 2004 for 5,503 BBB-rated corporate bonds that have an original issue size between $10 million and $100 million.

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[2] Trade report information is disseminated immediately upon receipt by the NASD. Reporting window requirements are described in the appendix to this paper.

[3] As noted in Federal Register (2002), the NASD was charged with having independent economists (the authors of this paper) design an experiment to test the effects of transparency on corporate liquidity. We were originally mandated to choose only 90 BBB bonds to begin dissemination. However, including too many infrequently traded bonds in our mandated 90 bond sample would potentially compromise the power of our tests. Therefore, we requested that an additional, separate group of 30 thinly traded bonds be made subject to dissemination as well. See Federal Register (2003) for more details.

We find that depending on trade size, increased transparency has either a neutral or positive effect on market liquidity, as measured by trading volume or estimated bid-ask spreads. Measures of trading activity, such as daily trading volume and number of transactions per day, show no relative increase, indicating that increased transparency does not lead to greater trading interest in our sample period. The relatively long (10 months) post-transparency period suggests that this lack of increased trading volume is not due to the newness of the market changes. For all but the smallest trade size group, spreads decrease for bonds whose prices become transparent by more than the amount that spreads decline for our control bonds. This effect is strongest for intermediate trade sizes: for trades between 51 and 100 bonds, relative to their controls, spreads on the 90 disseminated bonds fall by either 21 or 42 basis points (per $100 face value) more, depending on the spread estimation method. The decrease in transaction costs for such trades is consistent with investors' ability to negotiate better terms of trade with dealers once the investors have access to broader bond pricing data. We do not find any change for very thinly-traded bonds. Thus, overall, we find that increased transparency has a neutral or positive effect on liquidity.

Since pre-trade quote data does not exist for this market, we estimate the impact of transparency on spreads using two different techniques. Our dataset identifies trades by individual dealers, which allows us to first measure spreads directly by measuring the round-trip cost of a dealer purchase from a customer followed by a sale of that bond by the same dealer to another customer (a dealer round-trip or DRT) within a specified time period. This DRT method is similar to that used by Green, Hollifield and Schurhoff (2004) and Biais and Green (2005) in their studies of municipal bonds, except that we use additional information on the identity of the dealer. A distinct advantage of this approach is that it provides a measure of bond spreads that is simple to interpret and is not dependent on assumptions used to model spreads.

Using this method, for all BBB bonds we find that for round-trips that occur within one day, spreads average \$2.37 (median \$2.25) per \$100 face value for trades up to 10 bonds. These costs fall monotonically to \$0.47 (median \$0.25) per \$100 for trades of 1000 bonds or more. For both the 90 disseminated bonds and their non-disseminated controls, we find for all trade size groups that customer transactions costs fall from the pre- to post-dissemination time period.[4] However, our cross-sectional analysis, which controls for additional bond characteristics affecting spreads, shows that spreads are lower when the bonds are disseminated, reaching a maximum decline of over 45 basis points for intermediate size trades.

We also estimate spreads using a second methodology similar to that in Warga (1991) and Schultz (2001), based on regression estimates of the difference between transaction prices and the previous day's estimated bid price as reported by Reuters. The regression-based results, which utilize *all* trading data over this time period, support the results found using the more direct DRT method. For the more actively traded bonds, transparency is associated with an additional decrease, over and above market wide changes in costs, of between 21 and 29 basis points per \$100 face value for disseminated bonds for trade sizes less than 250 bonds. This effect diminishes to 14 basis points for trade sizes from 250 to 1000 bonds, and becomes insignificant for trade sizes greater than 1000 bonds. However, for the additional disseminated sample of 30 less active BBB bonds, we find no significant effect of transparency either overall or for any trade size group.

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[4] We do not include the additional 30 less active disseminated BBB bonds (and their controls) in these comparisons because of the relatively small number of observations of DRTs.

Our analyses are related to those in two other recent working papers. Using the TRACE data for 2003, Edwards, Harris, and Piwowar (2004) fit a time-series model of transactions costs for individual bonds. They then use this model in a cross-sectional regression to explain determinants of transactions costs, and find that transparency is associated with about a 10 basis point drop in spreads. More directly comparable to our results, for intermediate sized trades in BBB bonds relative to all non-disseminated BBB bonds, they also find a drop of about 10 basis points. Bessembinder, Maxwell, and Venkataraman (2005) estimate the impact of TRACE on trading costs using insurance company trades reported at the daily level to the National Association of Insurance Company (NAIC). The NAIC dataset permits the authors to evaluate the impact of transparency by examining costs relative to those estimated before the July 2002 start of TRACE.[5] For the large institutional trades included in their dataset, they conclude that there is a 12 to 14 basis point reduction in round-trip trade execution costs for bonds that become disseminated on TRACE.

An important difference of our work is that rather than focusing on the cross sectional determinants of trading costs, we focus on the BBB transparency experiment. For all other credit ratings besides BBB, all bonds of a given rating and issue size are either subject to dissemination under TRACE at that time or not. The BBB market is the only case in which we can *simultaneously* observe bonds of the same credit rating and matched on characteristics such as issue size and trading activity, some of which are disseminated and some of which are not. Further, both regulators and market participants believed the market for the highest rated and very large issues, which are less information sensitive and also have more close substitutes,

[5] Hong and Warga (2000) and Chakravarty and Sarkar (1999) provide estimates of trading costs from the NAIC dataset for an earlier time period. See also Chen, Lesmond and Wei (2005) for discussion of liquidity measures for corporate bonds.

would not behave in the same manner as lower rated or smaller issues (hence the willingness to begin dissemination for bonds rated above BBB sooner).[6]

Our paper also differs from these working papers in the methods used to estimate trading costs. Our regression-based estimates are broadly similar to the approaches used in these papers and used by Schultz, and the magnitude of the trading cost estimates we find for the largest trades (greater than 1000 bonds) in the TRACE dataset matches the 27 basis point estimate reported by Schultz. We also calculate spreads directly using our DRT measure, which does not utilize any data external to the TRACE data, or any econometric models for estimating bond prices for bonds that are infrequently traded. Our approach also allows us to disentangle any non-linear effects, such as those due to overall trading frequency, which we find to be an important determinant of the impact of transparency.

From a theoretical perspective, the impact of transparency on market liquidity is ambiguous, as noted in Madhavan (1995), Pagano and Roell (1996), and Naik, Neuberger and Viswanathan (1999).[7] Greater transparency may reduce adverse selection and encourage uninformed investors to enter the trading arena. At the same time it may make it harder for market makers to supply liquidity. In a world with post-trade reporting, a market maker can be in a difficult bargaining position to unwind her inventory following a large trade, leading her to charge a premium for this risk. Bloomfield and O'Hara (1999) provide experimental evidence showing that opening spreads are larger but subsequent spreads are tighter when ex-post

[6] The disseminated bonds considered by Edwards et al. (2005) and Bessembinder et al. (2005) include investment grade bonds with issue size over $1 billion, which were disseminated upon the July 2002 start of TRACE, as well as the 50 high yield bonds disseminated under TRACE to provide continuity for bonds previously reported under the FIPS system. The set of 50 high yield bonds disseminated under TRACE were not selected randomly; bonds disseminated as of July 2002 under TRACE were already disseminated under FIPS (thus we would observe the impact of the incremental transparency). Further, subsequent revisions to the list of 50 disseminated high yield bonds specifically selected bonds which were among the most actively traded in the market, presenting sample selection concerns.

[7] Bias, Glosten and Spatt (2004) provide an overview of these arguments.

transparency is enhanced. Resolving this debate empirically has been difficult because there are very few settings that in practice allow us to observe the impact of a change in transparency.[8] The introduction of the TRACE system, and specifically the experiment we have structured using the BBB market, provides such an opportunity to observe these effects.

This paper is organized as follows. Section 2 describes the TRACE system and the data used in the study. The next two sections present our empirical results on transparency and liquidity. Section 3 considers the effect of transparency on trading frequency and volume. Section 4 analyzes the effect of increased transparency on bond spreads results using our two different estimation methods. Section 5 summarizes and concludes the paper.

2 Data Description and Design of the Experiment

We analyze all secondary market trades in 5,503 BBB-rated corporate bonds for the time period July 8, 2002 through February 27, 2004. Our dataset includes all bond trades during this time, with the exception of a comparatively small amount of trading activity on the NYSE's Automated Bond System (ABS), which is not reported through TRACE. NASD (2004) estimates that 99.9% of trading is transacted over-the-counter and is therefore included in our data.

2.1 Selection of bonds for dissemination and for non-disseminated control groups

The selection of BBB bonds for dissemination under TRACE was based on transactions that occurred in the period from July 8, 2002 through January 31, 2003 ("the selection period"). Our selection process excluded convertible bonds, bonds from banks, and bonds with unusual

[8] A notable exception examining changes in post-trade transparency is Gemmill (1996), who finds that dealer spreads were not affected by changes in the trade disclosure regime of the London Stock Exchange.

features. We also eliminated BBB bonds with an issue size over $1 billion, as their prices were already disseminated as of July 1, 2002, and bonds with an issue size less than $10 million. Because Hotchkiss, Jostova and Warga (2005) indicate that there is an abnormal amount of trading in the first few months following issuance, we did not include newly issued bonds. We also excluded bonds with less than one year remaining to maturity to avoid reaching the maturity date during our measurement period.

Because of concerns about the statistical power of our tests, we chose two groups of bonds for dissemination based on their frequency of trading in the selection period. First, we identified 90 pairs of bonds, matching on industry, trading activity (average trades per day) during the selection period, bond age, and time to maturity; we required that these bonds traded at least once per week on average during the selection period. As pairs of bonds were created, one bond was randomly chosen to be disseminated and the other was assigned to a non-disseminated control group (the "matching" control bonds). We then identified an additional sample of 30 thinly-traded bonds for dissemination, requiring only that the bonds traded on average at least once every two weeks but less than once every two days on average during the selection period. The 30 thinly-traded bonds trade so infrequently that it is not possible to construct a bond-by-bond matched control sample for empirical analysis. In total, 120 BBB bonds (90 actively traded and 30 thinly-traded) were made subject to dissemination under TRACE on April 14, 2003.

As Davies and Kim (2004) note, creating a control set from matching pairs is at times optimal, while at other times a larger control portfolio may be optimal. Using the matching approach, results may be sensitive to the particular choice of bonds for the control portfolio. Using a broader control portfolio, however, will include more bonds that are quite dissimilar to those that are disseminated. Further, we are unable to construct a matched control sample for the 30 thinly-traded bonds. Therefore, we use both approaches in our tests. For the 90 actively traded disseminated bonds, in addition to the matched control sample, we also construct a "non-disseminated control *portfolio*" consisting of bonds whose average number of trades per day is between the minimum and maximum observed for the 90 disseminated bonds in the period July 8, 2002 to January 31, 2003. This control portfolio consists of 3,213 bonds, whose average daily trade count in the selection period ranges from 0.2105 to 24.8.

We use a similar procedure to construct a control portfolio for the 30 thinly traded bonds. This produces a non-disseminated control portfolio consisting of 1,919 bonds, whose average daily trade count in the selection period ranges from 0.1 to 0.4. By comparing the 30 thinly traded bonds to their corresponding non-disseminated control portfolio, we obtain meaningful results for the effects of transparency on these bonds

2.2 Characteristics and Trading Activity of Disseminated and Control Bonds

Industry categories and other bond characteristics for each group of bonds, as well as for the full set of BBB bonds, are described in Table 1. The data for the full set of all BBB bonds indicates the dominance of financial firms in this market: over 44% of all of the bonds are issued by financial firms, although many other industries are also represented. Subsequent results using control portfolios are insensitive to the removal of financial firms from those portfolios. Table 1 also shows that (by construction) the matching non-disseminated bonds have the same distribution across industries as the 90 disseminated bonds.

Table 2 describes other bond traits that have been shown in previous studies to affect inferences concerning bond liquidity, as well as trading activity for the entire period from July 8, 2002 to February 27, 2004. By construction, the issue size, years to maturity, and age match closely for the 90 disseminated bonds and their 90 non-disseminated matchers. Since we do not match on these characteristics for the two large portfolios of non-disseminated bonds, bonds in these control portfolios tend to have a smaller original issue size and somewhat fewer years remaining to maturity.

It is evident from Table 2 that the bonds in general are thinly traded. Based on the 5,503 BBB bonds that have any trades during the selection period, the average BBB bond trades only 1.1 times per day, and on average no trades occur at all on over three quarters of the sample period days for these bonds. The table also shows that trading tends to occur in temporal clusters, as the mean of the average time between trades is about 15 days, while the median is half that (7.3 days). This may be due to dealers' desire to maintain low inventory positions in bonds that are thinly traded, causing them to quickly sell a bond they have recently bought from a customer.

The trading activity statistics for the 90 disseminated bonds and the matching non-disseminated bonds also shows a close match. The median average daily volume is 1,300 for the 90 disseminated bonds and 1,212 for the non-disseminated matching bonds. Even closer, the median average daily trade count is 0.8 for the 90 disseminated bonds and 0.9 for the matching bonds, as is the percent of days traded (38.3% for the disseminated, and 38.9% for the matching), the average days between trades (3.7 for both groups), and the maximum days between trades (21.0 and 21.5, respectively). Both groups are noticeably more active than the bonds in the non-disseminated control portfolio. Turning to the 30 thinly traded bonds, the dollar volume of trade for bonds in their non-disseminated control portfolio is lower than for the 30 disseminated bonds, but the trading activity is otherwise similar.

3 Effect of increased transparency on trade frequency and trading volume

In this section, we measure the impact of transparency by analyzing the change in the level of trading activity before and after the bonds become transparent in April 2003. As discussed above, it is not clear whether the introduction of transparency will be associated with an increase or with a decline in this measure of liquidity. We consider two measures of trading activity: average daily trading volume and average number of trades per day. To allow time to adjust to the new reporting regime, we exclude the two week period surrounding the start of dissemination of data. All results in this and the following sections are similar when we restrict our analysis to the 6 month window surrounding the 4/13/2003 start of dissemination.

Table 3 shows the results for both average daily trading volume (Panel A) and for average number of trades per day (Panel B). Panel A shows that trading volume falls for both the disseminated and the non-disseminated bonds in the transparent period. Though this volume drop of roughly 35% to 40% is both statistically and economically important, it can not be attributed to the effect of transparency as it occurs for both the disseminated and the non-disseminated bonds. We therefore adjust the changes for the 90 and 30 bond disseminated samples by the change in trading activity for their corresponding non-disseminated control groups. The t-statistics show that almost none of these “difference of differences” are significant. Only the drop in the average daily trading volume for the 90 disseminated bonds relative to the non-disseminated control portfolio is statistically significant, indicating that volume decreases relative to this particular control group. Similar outcomes are shown in Panel B for the trade count measure; in this case, none of the results are significant.

Even though aggregate bond volume is generally unaffected by increased transparency in our sample, it is possible that investors, rather than dealers, are in fact drawn to bonds with higher transparency. Table 4 considers this possibility by repeating the analysis but excluding all inter-dealer trades. The table is analogous to Table 3 and most results are similar. Both panels indicate that there is no change in trading activity at conventional levels of significance that is related to the increase in transparency.

The above results indicate no measurable effect of increased transparency on these two trading activity measures of bond liquidity. However, it is possible that changes in liquidity are related to other traits of the bond. Though our sample of 90 matching non-disseminated bonds controls for some of these characteristics, the control portfolios are created based only on trading frequency and so do not. We therefore use a multivariate regression to test whether increased transparency is related to changes in bond trading activity, controlling for cross-sectional differences in bond characteristics. The results of the regression are shown in Table 5. The independent variable in the regression is either average daily trading volume or average number of trades per day.

For the 90 disseminated bonds and their 90 matchers, bonds from larger bond issues have higher trading volume than bonds from smaller issues. Bond age is significantly negatively related to trading volume, as in Hotchkiss, Jostova and Warga (2005). The coefficient on the Post-Dissemination Period Indicator is negative and significant at the 5% level, consistent with our univariate result that volume dropped for the later period.[9] However, the key variable of interest is the interaction variable for Disseminated Bonds in the Post-Dissemination Period. The

[9] We further find (not reported) that average daily trading volume declined for BBB bonds with issue size greater than $1 billion which are transparent throughout this time period, and for high yield bonds that are opaque throughout this time period. The decline in volume therefore appears to be related to other market factors not directly related to transparency.

coefficient on this interacted variable is statistically insignificant. Similarly, no effect is found for the change in average daily trade count.

This result is born out for the other bond groups as well. In fact, across all six regressions in Table 5, the coefficient on the Disseminated Bond in the Post-Dissemination Period is significant only for the average daily volume regression for the 30 thinly traded bonds and their control sample, and then only at the 10% level. Taken together, this table and the two tables that precede it lead us to conclude that there appears to be no significant change in volume in BBB bonds that can be attributed to an increase in last sale transparency.

4 Effect of increased transparency on trading costs

Though transactions costs can have multiple components, perhaps the most important one for our purposes is the effective spread of the bond. This is the difference between what a customer pays when they buy a bond and what they receive if they sell the bond. The price difference is related to the dealer markup or profit on the trades. We prefer the term "spread" as markups can take on certain regulatory implications.

Section 4.1 reports estimates of spreads directly based on dealer round-trip trades. Section 4.2 reports regression-based spread estimates using benchmark prices obtained from a third party data source (Reuters).

4.1 Estimation of spreads from dealer round-trip (DRT) trades

We take as a measure of transaction costs the difference between what a customer pays and receives for a fixed quantity of a bond. We estimate this measure by identifying instances where a certain dealer acquires a bond from a customer and then that *same* dealer subsequently sells the *same* bond to a different customer. By restricting the time between these two trades to be sufficiently short (e.g., one day or five days) that factors such as interest rate and credit changes are unlikely to change, the difference in these two prices is exactly the quantity we seek, the effective spread of the bond.[10]

To calculate this measure, we consider two cases for the duration of the dealer round-trip. In the first, we require that the dealer completes the round-trip in one day, and in the second case we require the round-trip to be completed in five days. Though lengthening the round-trip window to five days permits exogenous factors to affect dealer spreads, it also allows a greater cross-section of trades to enter our sample. Table 6 reports the distribution of these spreads for all principal trades that qualify as part of a dealer round-trip (DRT) for the 5,503 bonds in our sample. The table reports the results grouped into trade size bins, and for each bin gives the mean spread and various percentile points of the spread distribution. Panel A reports results for DRTs that are completed in one day, while Panel B reports the results for DRTs that are completed in five days. Noticeably, spreads are larger for smaller trades. For trades of 10 bonds or less in Panel A, of which there 69,297 one-day round-trips, the mean cost is $2.37 per $100 bond face amount. This number reflects a high cost of trading relative to what has been documented in other markets. Given that trades of 10 or fewer bonds involve retail investors, adverse selection should not be an issue.[11] One important factor explaining these high spreads may be that fixed costs charged to retail customers by their brokers are in turn reflected in spreads, as commissions are not customarily charged on these trades. Still, the standard

[10] We have also estimated results from more complex transactions such as customer-dealer-dealer-customer chains of trades. Although not presented for the sake of brevity, the results throughout the paper are substantively similar. Results are also similar when we include observations of a dealer sale preceding a dealer buy.

[11] Based on discussions with market participants, it is widely held that trades of fewer than 100 bonds are for retail accounts. This is further supported by analysis done by a large clearing firm, showing that trades of 50 or fewer bonds almost entirely involve retail investors. For our purposes, we assume that trades between 50 and 100 bonds are largely retail but may include some institutional trades.

deviation of spreads is very high, and 10% of the round-trip trades in this size group have spreads in excess of $4.00.

The magnitude of the measured spreads, however, may not be as surprising when one simply looks at plots of transaction prices for a given bond. An example of such a plot for a short time interval is given for one of the 90 disseminated bonds in Figure 1. This bond is in the bottom quartile of the 90 bond sample based on average daily trading volume. The observed price differences on trades occurring on the same or close days are strikingly large, even when we consider that the plot does not control for trade size. These plots also raise two important issues related to outliers in the data. First, when trades can sometimes occur at seemingly large spreads, it becomes difficult to infer whether a trade is a data error or a costly trade. Second, though our test statistics should not be driven by outliers, understanding the presence and behavior of the outliers themselves is an important part of understanding overall behavior in this market.

A cursory examination of the means and medians across both panels in Table 6 indicates that there is not much difference between examining one day and five day spreads. As the longer time period allows for significantly more observations (166,613 in total for one day versus 355,625 for five day round-trips), we focus on the five day round-trips throughout the remainder of this paper. However, we have estimated the tables below subject to the requirement that the trades must take place on the same day and find substantively similar results.[12]

[12] We perform two checks to verify that our results are not driven by a sample selection effect due to the requirement that the DRT is completed within 5 days. First, we allow the round-trip time period to range from one day up to 5 days. The results do not qualitatively change as this time window changes. Second, we re-run the results of Table 6 including only the 48 most liquid bonds in the sample, which trade on 99% of the sample days. These bonds trade sufficiently often that the round-trip timing requirement will not cause a selection effect, and again the results are not meaningfully different from Table 6.

Table 6 also shows that spreads fall markedly as trade size increases. Panel B indicates that for institutional trades of over 1000 bonds, or $1 million face value, the median cost is only $.28 per $100 of face value. This is an 87% drop from the median cost for a trade of 10 or fewer bonds of $2.13 per $100. Spreads fall monotonically with increasing trade size. While this is consistent with high fixed costs of trade that are reflected in spreads for small transactions, it could also reflect an uniformed retail investor base that cannot effectively monitor dealer rent seeking, as in Green, et al. (2004). Also consistent with Green, et al. is our finding that although dealers charge lower spreads for larger trades, they are also more apt to lose money on the trades. For example, for trades from 250 to 1000 bonds, a dealer charges on average 57 basis points for the trade, but loses 298 basis points or more one percent of the time. Losses for smaller trades, when they occur, are much smaller.

The magnitude of our estimates can be compared to those of other studies. Edwards, et al. (2004), using a different sample TRACE data, generally report lower trading costs. For example, their estimate of costs on small trades is roughly 40% lower than ours (approximately $1.60 versus our estimate of $2.30) for trades of 10 bonds or less. For larger trades, our median costs estimates do not fall below $0.25, which is substantially higher than the Edwards et al. estimates. This is true even for the one day DRTs, for which there is little risk that an event such as a significant interest rate movements could affect our estimates. Given that the DRTs are observed more often for actively traded bonds, it is surprising that we find significantly higher overall costs. We attribute the difference to the use of our DRT method, versus Edwards et al.'s two stage econometric model. Bessembinder et al.'s (2005) post-TRACE cost estimates are closer to ours, though their analysis can be compared only to our very largest trade size group (> 1000 bonds), which accounts for less than 10% of our DRT observations (Panel B of Table 6).

We next apply our method of measuring trading costs to the question of whether liquidity changes when transparency increases. In Table 7 we report spreads separately for DRTs that occur in the pre-dissemination and post-dissemination periods. We eliminate trades that occur at negative spreads or at spreads over \$5.00. Such trades are more likely to reflect instances where other factors, such as a firm specific event, cause a significant change in the bond's value. We report results only for the 90 disseminated bonds and their control groups; the additional 30 disseminated bonds contribute relatively few DRT observations because of their lower trading frequency.

For the 90 disseminated bonds, there is a significant decrease in the mean spread across all trade size groups, though the median change for the smallest trade size group is zero. For the 90 non-disseminated matchers, we also observe a decline in the mean and median spread, though the differences are not significant for intermediate sized trades. Finally, for the non-disseminated control portfolio, there is actually an increase in spreads at smaller trade sizes but significant decreases for larger trades. For smaller trades, the mean and median spreads for disseminated bonds are somewhat larger than for non-disseminated bonds, even in the pre-dissemination period.

As in Tables 3 and 4 above, we use a "difference of differences" method to measure the relative change in spreads from the pre- to the post-dissemination period, controlling for changes in the trading environment. For example, for the 51-100 trade size bin, the mean spread for disseminated bonds decreases by \$0.65 (from \$1.37 to \$0.73), while the mean for the matching non-disseminated bonds decreases only \$0.24 (from \$0.78 to \$0.54.) The difference of these differences is (-0.65) – (-0.24) = -0.40, or a relative decrease in spread of 40 basis points (significant at the 5% level). Similarly, the mean spread for non-disseminated control portfolio falls only \$0.08 (from \$1.08 to \$1.00). Relative to the control portfolio, the disseminated bonds have a decrease in spread of 57 basis points, which is significant at the 1% level.

The only case in Table 7 where we observe a significant increase in relative spreads is for the smallest trade size group (10 bonds or less). For these trades, we observe an increase in the mean spread of \$0.36 relative to the 90 matching non-disseminated bonds (and a 0.56 basis point relative increase based on the median, which is not influenced by outliers). This result, however, is not robust to the choice of control group as we observe a significant decline of \$0.26 relative to the non-disseminated control portfolio. In all other size groups, the results based on the non-disseminated control portfolio are supportive of those based on the matching bonds. As noted in Biasis and Green (2005), it is difficult to postulate a theory of why, when transparency increases, retail investors would face larger trading costs in small information-less trades, especially given that larger trades appear to benefit from the transparency. For intermediate size trades, we observe the largest relative decline in spreads.

Another possibility is that the effects of increased transparency depend on other traits of the bond. To control for cross-sectional differences in bond characteristics, we again use a multivariate regression to estimate whether increased transparency is associated with changes in spreads, controlling for bond characteristics. The results of these regressions are shown in Table 8. The dependent variable in the regression is the five day DRT spread estimate. Table 8a reports results for the 90 disseminated bonds and their 90 non-disseminated matchers, while Table 8b reports results for the 90 disseminated bonds and the non-disseminated control portfolio.

The results in these tables are generally consistent with our univariate analysis. The results in both Tables 8a and 8b indicate that not including the effects of dissemination, the disseminated bonds as a group had higher spreads than non-disseminated bonds, and that spreads for all bonds fell from the pre-dissemination period to the post-dissemination period. To understand the impact of transparency on spreads, the key coefficient is that of the interacted variable, "disseminated bond in post-dissemination period". Table 8a indicates a relative decrease in spreads when bonds become disseminated, for all trade size bins except the smallest. Table 8b shows a decline relative to the non-disseminated control portfolio across all trade size groups. The impact of transparency appears greatest for intermediate sized trades (100 bonds), with a decline of -0.454 relative to the non-disseminated matching bonds and -0.549 relative to the non-disseminated control portfolio.

The regression results control for the DRT holding period, defined as the time (in days) between the dealer's purchase from a customer and sale to a customer. As this time increases, it is more likely that the spread estimate is influenced by other market events. The positive significant coefficient for this variable may also reflect compensation to dealers for the risk of holding the bond over a longer time period. Interpretation of the other control variables is most useful for Table 8b using the non-disseminated control portfolio, which does not already match bonds based on characteristics. We find that spreads are higher as the interest rate risk (measured by time to maturity) of the bond increases, as the bond ages, and as the issue size falls. We also control for whether a bond has a disseminated "sibling", which occurs when there is another bond of the same issuer with an issue size greater than $1 billion. Because bonds over $1 billion are also disseminated under TRACE during this time period, such a bond might benefit from the transparency of its larger disseminated sibling. Alternatively, this variable may proxy for larger firms with complex capital structures and thus more public information available and lower trading costs. This effect is most pronounced for smaller trades, where bonds with disseminated siblings have lower estimated spreads.[13] Finally, bonds that have been actively traded in the prior 30 days are also associated with higher trading costs (Table 8b), though we find this result does not hold for the regressions comparing the 90 disseminated bonds to their 90 matching bonds (Table 8a).

4.2 Regression-based estimates of spreads

A chief advantage to the estimation method used in the previous section is that provides a very direct and easily interpretable measure of spreads, using no data external to TRACE and not dependent on assumptions embedded in the modeling of spreads. Its chief drawback is that it only uses a portion of the data available, in that transactions must be part of a dealer round-trip as we have defined it. To address this concern, we examine regression-based spread estimates that utilize all of the trading data.[14] Effective spreads are estimated by regressing the difference between the transaction price for a customer and an estimated bid price on a dummy variable that equals one for customer buys and zero for customer sells:

$$[\text{customer trade price} - \text{bid price}]_i = \alpha_0 + \alpha_1 D_i^{Buy} + \varepsilon_i$$

The difficulty in implementing this approach is that we must use estimated rather than actually observed dealer bid prices. For this study, we use dealer bid prices reported by Reuters for the end of day prior to the transaction. Reuters bases these estimates on daily quotes obtained from individual dealers and largely does not use matrix prices.[15] Since the bid prices are updated daily

[13] We also control for whether the bond is displayed on the NYSE's ABS, but do not report those results here, as trading on the ABS is relatively more important to the high yield market. Our coefficient estimates and our conclusions as to the impact of transparency under TRACE are not affected by this additional control variable.

[14] Bessimbinder, Maxwell, and Venkataraman (2005) note that their methodology, the methodology in Schultz (2001), and that in Edwards, Harris, and Piwowar (2004) use broadly similar indicator variable regression approaches. The regression-based methodology in this paper also falls into this category. A significant difference of the Besseimbinder et al. methodology from ours is that they utilize econometric methods to account for the fact that the NAIC data is not time stamped, which is not necessary for the TRACE data.

[15] Although there are a large number of outstanding investment grade corporate bond issues, there are only approximately 500 distinct issuers. Based on our conversations, Reuters estimates that their analysts obtain direct quotes from dealers for about 85% of these issuers. Warga and Welch (1993) stress the importance of using dealer

by Reuters' analysts to reflect changes in treasury prices, equity prices, and other firm specific information, we do not need additional controls for changes in interest rates and related factors in our regressions.[16]

To eliminate obvious data errors, we exclude observations from our regressions if the difference between the trade price and the Reuters bid price (our dependent variable) is greater than 20. We also winsorize regressions at 5% to reduce the influence of outliers (results are invariant to other percentage cutoffs). Further, transactions are excluded if the end of day Reuters bid price for the transaction date has changed more than $0.50 from the previous day's closing bid as reported by Reuters, since in these cases the prior day's ending bid price is less likely to be a useful estimate of the bid quote at the time of the transaction. Results (not reported) are also virtually identical when we include only observations where there is no change in the Reuters bid price between the day prior to and the day of the transaction.

Table 9 reports the regression-based spread estimates for all principal trades in the 90 bonds and their non-disseminated control portfolio. Inferences concerning the impact of transparency are the same when we examine estimates (not reported for brevity) based on the 90 disseminated bonds versus the 90 matching control bonds. We report results based on comparison with the control portfolio because it is useful to examine the coefficients of the additional control variables when the control bonds are not already matched on those characteristics.

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bid prices rather than data incorporating matrix prices. For this reason, much prior academic research uses the Lehman Brothers Fixed Income Database which contains monthly quotes by Lehman Brothers for corporate bonds included in Lehman Indices. Reuters obtains quotes from Lehman as well as other dealers on a daily basis.

[16] For example, Schultz (2001) constructs estimated bid prices by interpolating between monthly dealer quotes, accounting for changes in treasury prices within the month. Bessembinder et al. (2005) include the return on a maturity-matched treasury bond and the return on the firm's equity to control for these movements. These approaches are equivalent to using a matrix price for the benchmark bid price.

The intercept in these regressions, α_0 , is the mean difference between the customer sale price and the estimated bid quote. For the full sample under the heading "All", the intercept is negative and significant, but the regressions for trade size groups show that this is largely due to the smaller trades. This indicates that for smaller trades, the Reuters bid price is greater than actual customer sale prices. The Reuters prices are largely supplied to the institutional market. Since our estimates also reflect bid prices for smaller retail trades, it is likely that prices obtained by customers on these small customer sales are lower.

The first regression for each trade size group shows the estimated round-trip trading costs (α_1 , the coefficient on the "buy dummy" variable). We estimate these costs to be \$1.71 overall, but find the same inverse relationship with trade size as documented in the previous section. The magnitude of the coefficients is also supportive of our DRT estimates. Trades of 10 bonds or less have a spread of \$2.45, while spreads for trades of up to 1000 bonds have a spread of \$0.48. Interestingly, the regression adjusted R^2s decline for larger trades, but do not appear to be related to the number of observations which remains quite large.

The second regression for each group allows us to control for additional bond characteristics related to spreads, and to observe the coefficient for our transparency variable ("disseminated bond in post-dissemination period"). As in Schultz (2001), each additional variable is multiplied by +1 for buy and -1 for sale transactions. Results are similar when we do not assume that the spread is symmetric, i.e. including separate buy and sell dummy variables. The coefficient on "disseminated bond in post-dissemination period" is negative and significant at the 1% level for all trade size groups except for over 1000 bonds, and indicates that spreads are lower when a bond's price is publicly disseminated. The magnitude of this coefficient is similar for all trade size groups under 100 bonds, and then begins to decline. For example, trades of 10 bonds or fewer show a decline of $0.26 for bonds that become transparent. This falls to a $0.14 decline for spreads for trade sizes from 251 to 1000 bonds, and becomes an insignificant $0.04 for the largest trades. Overall, these results in magnitude and significance support those found in Table 8b, indicating that the DRT results are not related to transaction sample selection issues as the data is reduced to include transactions that are part of a round-trip.

Table 10 reports a similar set of regressions for the additional 30 disseminated thinly traded bonds and their non-disseminated control portfolio. Of concern for these bonds is that increased transparency could harm dealers' willingness to commit capital to trade a bond, for fear of having prices fall when the dealer attempts to reposition his inventory. In this scenario, dealers would demand a larger initial price concession from investors, especially at larger sizes, resulting in a higher spread. The results in the table show that this is not the case. The coefficient on "disseminated bond in post-dissemination period" is insignificant for almost all trade sizes. The only exception is for trades between 11 and 20 bonds, where bond spreads fall by $1.08, but this is only significant at the 10% level. The important result in Table 10 is the lack of support for the hypothesis that investors paid higher costs for thinly traded bonds because of the increased transparency regime. Availability of last trade price information may have little impact on our regression-based spread estimates when the last sale occurred days or weeks before. Interestingly, the spread estimates themselves are somewhat lower for the thinly traded bonds than was estimated for the 90 disseminated bonds and control portfolio in Table 9.

Overall, we find that the magnitude of the effect of transparency on spreads varies considerably with trade size, and also depends on the pre-dissemination level of trading activity for the bond. We find that decreases in spreads range from zero to 55 basis points. These results can be contrasted with the findings of Edwards et al. (2004) who find that transparency is associated with a drop in trading costs of about 10 basis points (round-trip) across the range of trade sizes, and Bessembinder et al (2005) who find a drop of 12 to 14 basis points for trades comparable to those in our largest trade size group.

5 Summary and Conclusions

This paper presents the results of a unique controlled experiment designed to assess the impact of increased transparency on corporate bond liquidity. Examining transactions data for BBB rated corporate bonds, we investigate how trading volume and round-trip trading costs change when post-trade transparency is introduced into the market by regulatory fiat.

In general, both spreads and measures of trading activity, such as daily trading volume and number of transactions per day, either decline or show no increase. Using two alternative methods, we find evidence that spreads decrease for bonds whose prices become transparent, and that this effect is strongest for intermediate (20 to 250 bond) trade sizes. The decrease in transactions costs for such trades is consistent with investors being able to negotiate better terms of trade with dealers once the investors have access to broader bond pricing data. We do not find any effect (positive or negative) of transparency for very thinly-traded bonds. Overall, our findings indicate that the increased post-trade transparency had a neutral or positive effect on market liquidity.

Policy makers should take comfort in the results of the paper. There are few instances in the tables above that show any harm to investors from increasing transparency, and a number of examples that show how investors benefit from the change. The earliest adopters of systems providing access to TRACE data were investment professionals rather than retail investors, so that over time there may be more benefit to the retail market. There are well-founded economic models that argue that transparency should lower transactions cost, especially for smaller trades. The results of this study should help to guide the debate over increasing transparency for securities markets.

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Appendix: Data cleaning and sample construction

Prior to the inception of TRACE, there was no mandatory reporting of corporate bond transactions. On January 23, 2001, the SEC approved rules requiring NASD members to report over-the-counter secondary market transactions in eligible fixed income securities. These comprehensive reporting requirements apply to investment grade, high yield and unrated debt of U.S. companies, and cover eligible securities including Rule 144A issues, convertible debt, floating rate notes, and various other types of corporate debt. Transactions reports for all eligible securities are reported to the NASD via TRACE system that was implemented on July 1, 2002.[17]

The initial raw TRACE dataset consists of observations for all 5,503 TRACE eligible securities with a BBB rating and that traded at least once in the period from July 8, 2002 through January 31, 2003. The data includes fields for CUSIP, execution date, time, price, yield, quantity, transacting parties ids, principal/agent flag, commissions (if applicable) and buy/sell code. For principal trades, the price must include any markups or markdowns. For agency trades, the price does not include the commission charged, since commission is reported in a separate field. The characteristic data includes CUSIP, embedded option flags, default status, bond rating, and other characteristic fields. The analysis includes trades in bonds identified by TRACE as BBB-rated based on the bond's rating at the time of the trade.

The raw data includes observations that contain entry errors, represent duplicate entries, or indicate cancelled or corrected trade reports. For example, the trade entry system itself includes checks to screen out data entry errors for price and yield, and returns an error message when these entries deviate significantly from other recent transactions in the same security. The

[17] As of July 2002, member firms were required to submit reports within one hour and fifteen minutes of trade execution during normal system hours. The reporting window was shortened to 45 minutes on October 1, 2003. See http://www.nasd.com/mkt_sys/TRACE_info.asp for detailed description of the reporting requirements under TRACE.

reporting party can still however resubmit the transaction with an "override flag."[18] TRACE guidelines also require users to enter the number of bonds traded; some observations, however, are consistent with users entering the par value of the bonds. Trade quantities that exceed the total number of issued bonds in a particular CUSIP are adjusted by the par value of the issue. All other quantities are assumed to have been entered correctly

TRACE reporting guidelines result in duplicate entries in our dataset for several types of transactions. Because all NASD member firms are required to submit the details for their own side of the transaction, the raw data include two observations for most interdealer trades. To avoid double counting trades, we follow the NASD's convention of retaining the sell side entries of interdealer trades with duplicate entries. Customer transactions only have duplicate entries when the member firm acts in an agent capacity and trades on behalf of one of its customers; again we exclude the buy side observation to remove duplicate entries. Lastly, TRACE has specific guidelines as to the entry of certain other interdealer and agency trades; we exclude trades that have entries inconsistent with these guidelines.[19]

In addition, a small percentage of trade reports are incorrectly entered into TRACE. All canceled trades are flagged as such and excluded from the analysis. When a user modifies the details of a trade, TRACE creates a new observation that contains all of the current terms of the trade. The original observation is flagged as modified. For those trades that have been revised, we retain the observation with the most recent revision.

[18] To check for remaining price errors, the median monthly price is used as a baseline. Prices that exceed the baseline by more than 50% are divided by an adjustment factor that assumes the price is either off by a factor of 10 or 100. The adjustment factor is assumed to be the multiple that provides an adjusted price closest to the baseline.
[19] These include incorrect entry of "Give-up" trades, and duplicate entries from undisclosed "Automatic Give-Up" trades.

Table 1
Characteristics of the BBB sample

Bond characteristics and industry sector for the sample of 5,503 non-convertible BBB bonds that have an original issue size between $10 million and $1 billion and at least one trade between 7/8/2002 and 1/31/2003 (the "selection period"). This table reports information on all BBB bonds in the sample, the 90 bonds disseminated as of 4/14/2003, the 90 matching non-disseminated bonds, the control portfolio of 3,213 non-disseminated bonds whose trading frequency (average daily trade count) falls within the minimum and maximum of the 90 disseminated bonds during the selection period, the 30 thinly traded bonds also disseminated as of 4/14/2003, and the control portfolio of 1,865 thinly traded non-disseminated bonds whose trading frequency falls in the range for the 30 thinly traded disseminated bonds.

			90 bond sample						30 bond sample			
Bond Characteristics	All BBB (n=5,503)		Disseminated bonds (n=90)		Matching non-disseminated bonds (n=90)		Non-disseminated control portfolio (n=3,213)		Disseminated bonds (n=30)		Non-disseminated control portfolio (n=1,865)	
	# of bonds	*%*	*# of bonds*	*%*	*# of bonds*	*%*	*# of bonds*	*%*	*# of bonds*	*%*	*# of bonds*	*%*
Callable	945	17.2%	0	0.0%	6	6.7%	651	20.3%	0	0.0%	312	16.7%
Convertible	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Issued after 7/8/02	473	8.6%	2	2.2%	2	2.2%	327	10.2%	4	13.3%	124	6.6%
Changed rating[1]	746	13.6%	2	2.2%	3	3.3%	523	16.3%	0	0.0%	206	11.0%
Industry sector:												
Consumer goods	123	2.2%	0	0.0%	0	0.0%	74	2.3%	1	3.3%	40	2.1%
Electric	664	12.1%	12	13.3%	12	13.3%	382	11.9%	1	3.3%	203	10.9%
Energy	368	6.7%	13	14.4%	13	14.4%	233	7.3%	4	13.3%	104	5.6%
Manufacturing	871	15.8%	23	25.6%	23	25.6%	512	15.9%	10	33.3%	303	16.2%
Other financial	2,431	44.2%	14	15.6%	14	15.6%	1,363	42.4%	11	36.7%	927	49.7%
Services	647	11.8%	24	26.7%	24	26.7%	427	13.3%	2	6.7%	166	8.9%
Telecom	127	2.3%	2	2.2%	2	2.2%	84	2.6%	0	0.0%	21	1.1%
Transportation	171	3.1%	2	2.2%	2	2.2%	97	3.0%	1	3.3%	74	4.0%
Banks	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Gas Distribution	69	1.3%	0	0.0%	0	0.0%	33	1.0%	0	0.0%	19	1.0%
Other	32	0.6%	0	0.0%	0	0.0%	8	0.2%	0	0.0%	8	0.4%

[1] Indicates bonds whose credit rating moves outside the BBB+/BBB/BBB- range before 2/27/2004

Table 2
BBB Bond Characteristics and Trading Activity

Mean (median) characteristics are reported for the time period from July 8, 2002 through Februrary 27, 2004. Bond groups are as defined in Table 1. Years to maturity and bond age are calculated as of the 4/14/2003 dissemination date.

		90 bond sample			*30 bond sample*	
	All BBB bonds < $1 billion (n=5,503)	*Disseminated bonds (n=90)*	*Matching non-disseminated bonds (n=90)*	*Non-disseminated control portfolio (n=3,213)*	*Disseminated bonds (n=30)*	*Non-disseminated control portfolio (n=1,865)*
Issue size (# bonds)	161,996 (100,000)	363,658 (300,000)	380,269 (300,000)	201,343 (150,000)	204,333 (200,000)	103,048 (50,000)
Years to maturity	7.8 (4.5)	9.5 (7.6)	10.4 (6.9)	8.4 (5.1)	12.4 (7.1)	7.6 (4.2)
Age (years)	4.9 (4.4)	3.9 (2.7)	4.2 (3.6)	4.5 (3.9)	3.8 (4.1)	5.0 (4.7)
Avg daily volume	677 (68)	2,309 (1,300)	1,917 (1,212)	948 (188)	408 (343)	177 (25)
Avg daily trade count	1.1 (0.3)	2.3 (0.8)	1.6 (0.9)	1.4 (0.6)	0.2 (0.2)	0.2 (0.2)
% days traded	24.2% (14.1%)	44.5% (38.3%)	44.4% (38.9%)	35.7% (29.0%)	13.2% (12.0%)	12.0% (10.4%)
Avg days between trades	14.9 (7.3)	4.9 (3.7)	5.1 (3.7)	6.5 (4.5)	12.5 (11.7)	14.5 (11.3)
Total volume (# bonds)	184,341 (21,715)	934,541 (532,585)	731,652 (465,971)	250,397 (54,310)	159,747 (140,813)	60,971 (7,989)
Total trade count	349.8 (92.0)	901.4 (351.5)	627.3 (347.5)	473.8 (210.0)	92.9 (81.5)	85.4 (69.0)
Max days between trades	70.0 (45.0)	28.4 (21.0)	32.3 (21.5)	41.2 (29.0)	69.8 (69.0)	80.9 (67.0)

Table 3
Impact of transparency on trading volume and trade frequency

The table reports two measures of liquidity, trade volume and trade frequency, during periods of different transparency regimes. The opaque period runs from July 8, 2002 through April 4, 2003. The transparency period runs from April 21, 2003 through February 27, 2004. The first column reports the trading activity in the Opaque Period when no BBB bonds under $1 billion have disseminated prices; the second column reports the results for the Transparent Period, after April 14, 2003, when the disseminated bonds became transparent. The "difference of the differences" is the difference of the transparency effects on the variable of interest verses the disseminated group. The t-statistic for the difference of differences normalizes volume by the opaque period level.

Panel A: Average daily trading volume (bonds per day)

	Opaque period	Transparent period	difference	t-statistic	difference of differences	t-statistic
90 bond sample						
Disseminated bonds	2,842	1,867	-976	8.99		
Matching non-disseminated bonds	2,250	1,449	-801	9.87	-175	-0.24
Non-disseminated control portfolio	920	521	-399	46.12	-577	-2.29
30 bond sample						
Disseminated bonds	510	317	-193	4.12		
Non-disseminated control portfolio	219	123	-96	18.62	-97	-0.64

Panel B: Average number of trades per day

	Opaque period	Transparent period	difference	difference of differences	t-statistic
90 bond sample					
Disseminated bonds	2.60	1.89	-0.71		
Matching non-disseminated bonds	1.84	1.31	-0.53	-0.18	-0.42
Non-disseminated control portfolio	1.54	1.15	-0.40	-0.31	-0.54
30 bond sample					
Disseminated bonds	0.25	0.23	-0.02		
Non-disseminated control portfolio	0.24	0.22	-0.02	0.00	0.10

Table 4
Impact of transparency on *customer* trading volume and trade frequency

The table reports two measures of liquidity, trade volume and trade frequency, for all customer trades during periods of different transparency regimes. The opaque period runs from July 8, 2002 through April 4, 2003. The transparency period runs from April 21, 2003 through February 27, 2004. The first column reports the trading activity in the Opaque Period when no BBB bonds under $1 billion have disseminated prices; the second column reports the results for the Transparent Period, after April 14, 2003, when the disseminated bonds became transparent. The "difference of the differences" is the difference of the transparency effects on the variable of interest verses the disseminated group. The t-statistic for the difference of differences normalizes volume by the opaque period level.

Panel A: Average daily customer trading volume (bonds per day)

	Opaque period	Transparent period	difference	t-statistic	difference of differences	t-statistic
90 bond sample						
Disseminated bonds	2,291	1,194	-1097	12.03		
Matching non-disseminated bonds	1,836	1,123	-713	9.88	-384	-1.62
Non-disseminated control portfolio	769	403	-366	49.13	-731	-0.06
30 bond sample						
Disseminated bonds	468	264	-203	4.79		
Non-disseminated control portfolio	201	106	-95	19.71	-109	-0.38

Panel B: Average number of customer trades per day

	Opaque period	Transparent period	difference	difference of differences	t-statistic
90 bond sample					
Disseminated bonds	2.00	1.28	-0.73		
Matching non-disseminated bonds	1.39	0.89	-0.50	-0.23	-0.10
Non-disseminated control portfolio	1.24	0.85	-0.38	-0.34	-1.65
30 bond sample					
Disseminated bonds	0.21	0.17	-0.04		
Non-disseminated control portfolio	0.20	0.17	-0.03	-0.01	-0.54

Table 5
Regressions of trading volume and trading frequency

The table reports regressions of trade volume and trade frequency for the period July 8, 2002 through February 27, 2004. Bond Age and Years to Maturity are measured as of April 14, 2003. "Disseminated Bond" equals 1 if the bond was disseminated as of April 14, 2003, and zero otherwise. "Post-Dissemination Period" equals 1 for observations after April 14, 2003, and 0 otherwise. T-statistics are in parentheses.

	90 disseminated bonds and matchers		90 disseminated bonds and non-disseminated control portfolio		30 thinly traded disseminated bonds and non-disseminated control portfolio	
Variable	Average daily volume	Average daily trade count	Average daily volume	Average daily trade count	Average daily volume	Average daily trade count
Intercept	-22275.053 a	-29.001 a	-5086.317 a	-4.176 a	-796.179 a	0.181 a
	-(5.32)	-(6.30)	-(23.76)	-(14.88)	-(25.50)	(7.00)
Log (Issue Amount)	1997.337 a	2.421 a	574.084 a	0.495 a	100.789 a	0.008 a
	(6.25)	(6.89)	(30.59)	(20.11)	(33.37)	(3.36)
Bond Age	-0.582 a	0.000	-0.249 a	0.000	-0.034 a	0.000 a
	-(3.65)	(0.94)	-(13.40)	(0.05)	-(9.85)	-(8.16)
Time to Maturity	0.051	0.000	0.012	0.000 b	0.008 a	0.000 a
	(0.98)	-(0.21)	(1.43)	(2.18)	(5.65)	(4.49)
Disseminated Bond	461.273	0.656	966.698 a	0.358	119.430 b	-0.018
	(1.02)	(1.32)	(4.21)	(1.19)	(2.23)	-(0.41)
Post-Dissemination Period	-909.382 b	-0.615	-545.346 a	-0.298 a	-91.210 a	-0.014 c
	-(2.01)	-(1.23)	-(9.95)	-(4.14)	-(9.46)	-(1.81)
Disseminated Bond *	-49.075	0.194	-413.111	-0.122	-127.523 c	-0.014
Post Dissemination Period	-(0.08)	(0.28)	-(1.28)	-(0.29)	-(1.69)	-(0.23)
Adjusted R-squared	20.0%	12.8%	17.2%	7.2%	29.5%	2.4%
N	359	359	6,297	6,297	3,686	3,686

a, b, c, indicate significance at the 1%, 5%, and 10% level, respectively

Table 6
Dealer round-trip (DRT) spread estimates

The table reports estimates of the effective bid-ask spread based on all principal trades from July 8, 2002 through February 27, 2004 for the full set of 5,503 BBB-rated corporate bonds, excluding convertibles and bonds issued by banks. Estimates are formed by identifying dealer round-trips for a given bond as chain of a customer sale to a dealer followed by a sale by the same dealer to a customer. For Panel A, the entire chain is completed in one day; for Panel B, the entire change is completed in no more than 5 days. Spreads are calculated as the difference between the customer buy price at the end of the chain and the customer sell price at the beginning of the chain. The number of observations is the number of customer/dealer/customer chains in each trade size bin.

Panel A: One day spreads

Trade Size (number of bonds)	Mean	Median	Stdev	% obs > 1 stdev	1st percentile	10th percentile	25th percentile	75th percentile	90th percentile	99th percentile	Number of observations
< = 10	2.37	2.25	4.33	0.7%	0.00	0.50	1.25	3.25	4.00	6.25	69,297
>10, <=20	2.16	2.00	1.79	12.6%	-0.09	0.31	1.00	3.00	4.00	6.00	22,720
>20, <=50	1.62	1.38	1.71	12.8%	-0.50	0.00	0.45	2.50	3.52	5.75	22,808
>50, <=100	0.83	0.38	1.60	10.1%	-0.75	0.00	0.06	1.25	2.44	5.00	7,244
>100, <=250	0.53	0.20	0.98	10.6%	-0.73	0.00	0.05	0.75	1.60	3.95	6,336
>250, <1,000	0.49	0.25	1.35	6.6%	-1.00	0.00	0.05	0.75	1.50	3.75	13,063
> 1,000	0.47	0.25	1.04	6.0%	-0.75	0.00	0.03	0.68	1.25	3.25	25,145

Panel B: Five day spreads

Trade Size (number of bonds)	Mean	Median	Stdev	% obs > 1 stdev	1st percentile	10th percentile	25th percentile	75th percentile	90th percentile	99th percentile	Number of observations
< = 10	2.32	2.13	3.62	2.4%	-0.55	0.45	1.13	3.25	4.25	6.88	166,432
>10, <=20	2.26	2.06	1.78	10.5%	-0.41	0.46	1.15	3.13	4.13	6.55	55,611
>20, <=50	1.87	1.63	1.81	11.9%	-0.83	0.14	0.75	2.75	3.88	6.47	52,471
>50, <=100	1.11	0.70	1.71	11.5%	-1.28	0.00	0.13	1.75	3.00	6.00	13,491
>100, <=250	0.70	0.35	1.29	11.3%	-1.58	0.00	0.06	1.00	2.00	5.00	10,920
>250, <1,000	0.57	0.33	1.63	6.6%	-2.98	-0.01	0.05	0.99	1.80	5.00	21,621
> 1,000	0.48	0.28	1.37	6.4%	-2.25	0.00	0.02	0.75	1.50	4.00	35,079

Table 7
Pre and post-dissemination dealer round-trip (DRT) spread estimates for 90 bond sample

The table reports estimates of the effective bid-ask spread for the 90 disseminated bonds, matching non-disseminated bonds, and the non-disseminated control portfolio. Estimates are formed by identifying dealer round-trip trades in each trade size bin, as in Table 6. For each trade size bin, the table calculates the difference of means and of medians of the effective spreads between the two time periods. The "difference of the differences" compares the spread changes of the disseminated verses the control group. All calculations exclude agency trades and spreads of less than $0 or greater than $5. a, b, c, indicate significance at the 1%, 5%, and 10% level, respectively.

		Pre-dissemination period (7/8/02 - 4/4/03)			Post-dissemination period (4/21/03 - 2/27/04)					Difference of differences	
Trade Size	Bond Classification	Mean	Median	N	Mean	Median	N	diff. of means	diff. of medians	means	medians
10	disseminated	2.80	2.75	1,768	2.58	2.75	783	-0.22 a	0.00		
10	non-disseminated matching	2.37	2.20	913	1.80	1.64	435	-0.58 a	-0.56 a	0.36 a	0.56
10	non-disseminated control portfolio	2.17	2.00	57,911	2.21	2.12	51,657	0.03 a	0.12 a	-0.26 a	-0.12
20	disseminated	2.73	2.75	607	2.31	2.37	344	-0.43 a	-0.38 a		
20	non-disseminated matching	2.12	2.00	295	1.72	1.40	146	-0.39 a	-0.60 a	-0.03	0.22
20	non-disseminated control portfolio	2.11	2.00	18,285	2.18	2.10	17,143	0.07 a	0.10 a	-0.50 a	-0.48
50	disseminated	2.33	2.51	639	1.90	1.61	328	-0.43 a	-0.90 a		
50	non-disseminated matching	1.43	1.13	355	1.17	0.81	171	-0.26 b	-0.32 b	-0.17	-0.58
50	non-disseminated control portfolio	1.74	1.56	17,295	1.79	1.63	15,320	0.05 a	0.06 b	-0.48 a	-0.96
100	disseminated	1.37	1.13	209	0.73	0.37	107	-0.65 a	-0.76 a		
100	non-disseminated matching	0.78	0.26	147	0.54	0.14	90	-0.24 c	-0.13	-0.40 b	-0.63
100	non-disseminated control portfolio	1.08	0.74	4,537	1.00	0.60	3,786	-0.08 a	-0.15 a	-0.57 a	-0.61
250	disseminated	0.99	0.42	189	0.49	0.25	139	-0.50 a	-0.17 a		
250	non-disseminated matching	0.49	0.25	133	0.40	0.13	115	-0.09	-0.13	-0.42 a	-0.04
250	non-disseminated control portfolio	0.81	0.48	3,555	0.65	0.26	2,988	-0.17 a	-0.21 a	-0.34 b	0.05
1000	disseminated	0.77	0.48	348	0.44	0.22	182	-0.32 a	-0.27 a		
1000	non-disseminated matching	0.69	0.46	290	0.39	0.17	195	-0.30 a	-0.28 a	-0.03	0.01
1000	non-disseminated control portfolio	0.78	0.50	7,527	0.60	0.33	5,552	-0.18 a	-0.17 a	-0.14	-0.09
>1000	disseminated	0.57	0.36	639	0.37	0.25	337	-0.20 a	-0.11 a		
>1000	non-disseminated matching	0.60	0.44	601	0.52	0.28	308	-0.08 c	-0.16 a	-0.12 b	0.05
>1000	non-disseminated control portfolio	0.68	0.48	12,688	0.51	0.35	8,552	-0.17 a	-0.13 a	-0.04	0.02

Table 8a

Dealer round-trip (DRT) spread estimate regressions for 90 disseminated bonds and non-disseminated matchers

The table reports regressions for dealer round-trip (DRT) spread estimates, for the 90 disseminated and 90 matching non-disseminated BBB bonds, from July 8, 2002 through February 27, 2004. The estimate of transactions cost in the dependent variable is formed by identifying dealer round-trip trades over five days as in Table 6. Buy Dummy is equal to 1 if the order is a customer buy and 0 otherwise. Disseminated Bond equals 1 if the bond was disseminated after April 14, 2003, and zero otherwise. Post-Dissemination Period equals 1 for observations after April 14, 2003, and 0 otherwise. Holding period is the time between the dealer's buy from a customer and subsequent sale to a customer. Bond Age and Time to Maturity are measured as of the transaction date. Average daily trading volume is computed for each bond for the 30 days prior to the transaction. Regressions are run for trades in bins of 0-10, 11-20, 21-50, 51-100, 101-250, 251-1000 bonds, and more than 1000 bonds, and bins are labeled by their upper limit size. All calculations exclude spreads of less than $0 or greater than $5. Standard errors are in parentheses.

Trade Size Bin (# bonds)	*10*	*20*	*50*	*100*	*250*	*1000*	*>1000*
Intercept	1.185 a	2.745 a	2.959 a	2.045 b	0.523	0.357	1.385 a
	(0.117)	(0.527)	(0.423)	(0.942)	(0.669)	(0.341)	(0.174)
disseminated bond	0.786 a	0.886 a	1.015 a	0.516 a	0.484 a	0.161 b	0.147 a
	(0.056)	(0.103)	(0.099)	(0.141)	(0.110)	(0.071)	(0.046)
post-dissemination period	-0.563 a	-0.367 a	-0.235 b	-0.205	-0.126	-0.293 a	-0.119 a
	(0.069)	(0.127)	(0.116)	(0.142)	(0.106)	(0.067)	(0.043)
disseminated bond in	0.323 a	-0.070	-0.287 b	-0.454 b	-0.424 a	-0.085	-0.140 b
post-dissemination period	(0.087)	(0.152)	(0.144)	(0.189)	(0.140)	(0.093)	(0.060)
holding period	0.622 a	1.362 a	2.079 a	1.709 a	2.070 a	2.097 a	1.404 a
	(0.150)	(0.273)	(0.257)	(0.379)	(0.279)	(0.183)	(0.146)
ln(trade size)	0.139 a	-0.500 a	-0.645 a	-0.359 c	-0.008	-0.005	-0.117 a
	(0.032)	(0.174)	(0.111)	(0.211)	(0.125)	(0.051)	(0.020)
time to maturity (*1000)	0.115 a	0.083 a	0.090 a	0.052 a	0.003	0.039 a	0.044 a
	(0.007)	(0.012)	(0.013)	(0.019)	(0.016)	(0.009)	(0.005)
bond age (*1000)	0.144 a	0.118 a	0.038	0.030	0.054	0.081 a	0.047 b
	(0.022)	(0.040)	(0.040)	(0.055)	(0.044)	(0.030)	(0.018)
issue amount (*1000000)	0.999 a	0.881 a	0.277	-0.149	-0.361	-0.076	-0.046
	(0.144)	(0.245)	(0.239)	(0.291)	(0.233)	(0.140)	(0.075)
disseminated sibling*1000	-0.487 a	-0.323 a	0.032	0.311 b	-0.063	-0.047	-0.218 a
	(0.066)	(0.117)	(0.111)	(0.152)	(0.110)	(0.070)	(0.045)
average daily volume	-0.007	-0.038 b	-0.004	-0.024 c	0.014	0.011	0.003
(prior 30 days (*1000))	(0.009)	(0.015)	(0.013)	(0.014)	(0.012)	(0.007)	(0.002)
Adjusted R-squared	16.8%	14.0%	18.7%	14.2%	15.6%	16.9%	12.9%
N	3,852	1,382	1,486	551	575	1,015	1,883

a, b, c, indicate significance at the 1%, 5%, and 10% level, respectively

Table 8b

Dealer round-trip (DRT) spread estimate regressions for 90 disseminated bonds and non-disseminated control portfolio

The table reports regressions for Customer/Dealer/Customer (CDC) spread estimates, for the 90 disseminated BBB bonds and non-disseminated control portfolio, from July 8, 2002 through February 27, 2004. The estimate of transactions cost in the dependent variable is formed by identifying customer/dealer/customer chains over five days as in Table 6. Buy Dummy is equal to 1 if the order is a customer buy and 0 otherwise. Disseminated Bond equals 1 if the bond was disseminated after April 14, 2003, and zero otherwise. Post-Dissemination Period equals 1 for observations after April 14, 2003, and 0 otherwise. Holding period is the time between the dealer's buy from a customer and subsequent sale to a customer. Bond Age and Time to Maturity are measured as of the transaction date. Average daily trading volume is computed for each bond for the 30 days prior to the transaction. Regressions are run for trades in bins of 0-10, 11-20, 21-50, 51-100, 101-250, 251-1000 bonds, and more than 1000 bonds, and bins are labeled by their upper limit size. All calculations exclude spreads of less than $0 or greater than $5. Standard errors are in parentheses.

Trade Size Bin (# bonds)	*10*	*20*	*50*	*100*	*250*	*1000*	*>1000*
Intercept	1.398 a	2.630 a	3.212 a	2.193 a	0.068	-0.222 b	1.426 a
	(0.015)	(0.091)	(0.078)	(0.239)	(0.203)	(0.106)	(0.058)
disseminated bond	0.608 a	0.602 a	0.690 a	0.402 a	0.196 a	0.075 c	-0.041
	(0.027)	(0.046)	(0.046)	(0.075)	(0.065)	(0.045)	(0.029)
post-dissemination period	-0.060 a	-0.046 a	-0.064 a	-0.097 a	-0.197 a	-0.201 a	-0.202 a
	(0.007)	(0.012)	(0.013)	(0.023)	(0.022)	(0.014)	(0.010)
disseminated bond in	-0.201 a	-0.324 a	-0.464 a	-0.549 a	-0.342 a	-0.168 b	-0.044
post-dissemination period	(0.049)	(0.076)	(0.077)	(0.126)	(0.099)	(0.075)	(0.048)
holding period	0.616 a	1.055 a	1.667 a	2.477 a	2.160 a	1.958 a	1.579 a
	(0.027)	(0.048)	(0.051)	(0.095)	(0.088)	(0.060)	(0.049)
ln(trade size)	0.123 a	-0.393 a	-0.580 a	-0.325 a	0.110 a	0.127 a	-0.104 a
	(0.005)	(0.032)	(0.022)	(0.053)	(0.039)	(0.016)	(0.007)
time to maturity (*1000)	0.204 a	0.194 a	0.176 a	0.059 a	0.048 a	0.040 a	0.039 a
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.001)
bond age (*1000)	0.022 a	0.032 a	0.033 a	0.061 a	0.031 a	0.036 a	0.018 a
	(0.003)	(0.005)	(0.005)	(0.009)	(0.009)	(0.007)	(0.005)
issue amount (*1000000)	0.023	-0.238 a	-0.316 a	-0.444 a	-0.489 a	-0.260 a	-0.241 a
	(0.021)	(0.035)	(0.034)	(0.052)	(0.049)	(0.035)	(0.023)
disseminated sibling*1000	-0.266 a	-0.187 a	-0.113 a	0.033	0.052 b	-0.093 a	-0.072 a
	(0.009)	(0.015)	(0.015)	(0.024)	(0.022)	(0.016)	(0.011)
average daily volume	0.025 a	0.034 a	0.016 a	0.003	0.006 a	0.011 a	0.006 a
(prior 30 days (*1000))	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)	(0.001)
Adjusted R-squared	25.2%	23.1%	21.1%	11.9%	12.2%	11.5%	10.9%
N	111,585	36,244	33,491	8,622	6,861	13,594	22,202

a, b, c, indicate significance at the 1%, 5%, and 10% level, respectively

Table 9

Regression-based spread estimates for 90 disseminated bonds and non-disseminated control portfolio

The table reports regressions of transactions costs using the 90 disseminated bonds and the non-disseminated portfolio for the 90 bonds from July 8, 2002 through February 27, 2004. The estimate of transactions cost in the dependent variable is formed by taking the difference in price between the a customer transaction price and the prevailing market quote at the end of the day as reported by Reuters. For the independent variables, Buy Dummy is equal to 1 if the order is a customer buy and 0 otherwise. Disseminated Bond equals 1 if the bond was disseminated after April 14, 2003, and zero otherwise. Post-Dissemination Period equals 1 for observations after April 14, 2003, and 0 otherwise. Disseminated Bond in Post-Dissemination Period equals 1 for disseminated bonds after April 14, 2003, and 0 otherwise. Bond Age and Time to Maturity are measured as of the transaction date. Average daily trading volume is computed for each bond over the 30 days before each transaction. Regressions are run for trades overall and in bins of 0-10, 11-20, 21-50, 51-100, 101-250, 251-1000 bonds, and more than 1000 bonds. Bids are labeled by their upper limit size. All calculations exclude agency trades and spreads of less than $0 or greater than $5. Standard errors are in parentheses.

Trade Size Bin (# bonds)	*All*	*All*	*10*	*10*	*20*	*20*	*50*	*50*	*100*	*100*	*250*	*250*	*1000*	*1000*	*>1000*	*>1000*
Intercept	-0.233 a	-0.697 a	-0.758 a	0.194 a	-0.627 a	-0.179	-0.480 a	-0.913 a	-0.119 a	-1.113 a	0.072 a	-0.678 a	0.293 a	-0.456 a	0.505 a	0.397 a
	(0.004)	(0.011)	(0.009)	(0.025)	(0.012)	(0.112)	(0.010)	(0.076)	(0.014)	(0.204)	(0.013)	(0.174)	(0.009)	(0.099)	(0.008)	(0.065)
buy dummy	1.707 a	2.607 a	2.446 a	0.662 a	2.464 a	1.698 a	2.226 a	3.188 a	1.428 a	3.494 a	0.804 a	2.367 a	0.477 a	1.990 a	0.263 a	0.455 a
	(0.005)	(0.020)	(0.011)	(0.046)	(0.015)	(0.223)	(0.013)	(0.150)	(0.020)	(0.408)	(0.018)	(0.348)	(0.013)	(0.198)	(0.011)	(0.130)
disseminated bond		0.410 a		0.535 a		0.528 a		0.498 a		0.259 a		0.198 a		0.163 a		0.011
		(0.013)		(0.026)		(0.036)		(0.032)		(0.052)		(0.047)		(0.034)		(0.026)
post-dissemination period		0.015 a		0.006		0.086 a		0.041 a		-0.023		-0.075 a		-0.060 a		-0.031 a
		(0.005)		(0.011)		(0.015)		(0.013)		(0.020)		(0.019)		(0.014)		(0.012)
disseminated bond in post-dissemination period		-0.256 a		-0.294 a		-0.249 a		-0.275 a		-0.261 a		-0.212 a		-0.136 a		-0.039
		(0.019)		(0.039)		(0.053)		(0.045)		(0.072)		(0.065)		(0.049)		(0.038)
ln(trade size)		-0.189 a		0.215 a		-0.018		-0.243 a		-0.275 a		-0.157 a		-0.113 a		-0.014 c
		(0.001)		(0.009)		(0.039)		(0.021)		(0.045)		(0.033)		(0.015)		(0.008)
time to maturity (*1000)		0.058 a		0.077 a		0.069 a		0.071 a		0.040 a		0.031 a		0.011 a		0.018 a
		(0.001)		(0.002)		(0.002)		(0.002)		(0.003)		(0.003)		(0.002)		(0.002)
bond age (*1000)		-0.021 a		-0.055 a		-0.053 a		-0.026 a		0.019 b		0.010		0.010		0.006
		(0.002)		(0.004)		(0.006)		(0.006)		(0.009)		(0.009)		(0.007)		(0.006)
issue amount (*1000000)		0.251 a		0.603 a		0.456 a		0.161 a		-0.067		-0.112 b		-0.134 a		-0.022
		(0.014)		(0.029)		(0.040)		(0.034)		(0.054)		(0.048)		(0.036)		(0.028)
average daily volume		0.010 a		0.028 a		0.014 a		0.020 a		0.012 a		0.000		-0.001		-0.003 a
(prior 30 days (*1000))		(0.001)		(0.001)		(0.001)		(0.001)		(0.002)		(0.002)		(0.001)		(0.001)
days since last trade		-0.038 a		-0.082 a		-0.084 a		-0.070 a		-0.042 a		-0.024 a		-0.005 b		0.008 a
		(0.001)		(0.002)		(0.004)		(0.003)		(0.004)		(0.003)		(0.002)		(0.002)
Adjusted R-squared	18.2%	24.0%	26.8%	30.6%	28.5%	31.1%	26.6%	29.1%	15.3%	16.5%	7.3%	8.1%	3.0%	3.4%	0.9%	1.1%
N	446,023	446,023	131,705	131,705	66,006	66,006	85,987	85,987	29,596	29,596	25,947	25,947	42,085	42,085	64,697	64,697

Table 10
Regression-based spread estimates for 30 disseminated bonds and non-disseminated control portfolio

The table reports regressions of transactions costs using the 30 disseminated bonds and the portfolio of 1947 thinly traded non-disseminated bonds whose traits match those of the 30 thinly traded disseminated bonds, from July 8, 2002 through March 1, 2004. The estimate of transactions cost in the dependent variable is formed by taking the difference in price between the a customer transaction price and the prevailing market quote at the end of the day as reported by Reuters. For the independent variables, Buy Dummy is equal to 1 if the order is a customer buy and 0 otherwise. Disseminated Bond equals 1 if the bond was disseminated after April 14, 2003, and zero otherwise. Post-Dissemination Period equals 1 for observations after April 14, 2003, and 0 otherwise. Disseminated Bond in Post-Dissemination Period equals 1 for disseminated bonds after April 14, 2003, and 0 otherwise. Bond Age and Time to Maturity are measured as of the transaction date. Average daily trading Volume is computed for each bond over the 30 days before each transaction. Regressions are run for trades oveall and in bins of 0-10, 11-20, 21-50, 51-100, 101-250, 251-1000 bonds, and more than 1000 bonds. Bids are labeled by their upper limit size. All calculations exclude agency trades and spreads of less than $0 or greater than $5. Standard errors are in parentheses

Trade Size Bin (# bonds)	*All*	*All*	*10*	*10*	*20*	*20*	*50*	*50*	*100*	*100*	*250*	*250*	*1000*	*1000*	*>1000*	*>1000*
Intercept	-0.628 a	-0.847 a	-1.833 a	-1.123 a	-1.732 a	-0.989	-1.442 a	-1.987 a	-0.599 a	0.994	-0.176 a	0.045	0.066	0.540	0.607 a	0.434
	(0.020)	(0.044)	(0.046)	(0.107)	(0.067)	(0.637)	(0.052)	(0.396)	(0.070)	(1.022)	(0.061)	(0.829)	(0.041)	(0.435)	(0.035)	(0.281)
buy dummy	1.169 a	1.621 a	2.015 a	0.783 a	2.182 a	0.868	1.939 a	3.136 a	1.195 a	-1.930	0.728 a	0.402	0.682 a	-0.285	0.419 a	0.760
	(0.026)	(0.076)	(0.055)	(0.192)	(0.082)	(1.268)	(0.066)	(0.782)	(0.096)	(2.044)	(0.084)	(1.657)	(0.057)	(0.868)	(0.048)	(0.556)
disseminated bond		0.119		-0.746 a		0.434		0.243		-0.031		0.333		0.200		0.093
		(0.097)		(0.250)		(0.402)		(0.322)		(0.398)		(0.354)		(0.176)		(0.146)
post-dissemination period		0.178 a		0.181 a		0.430 a		0.185 a		-0.044		0.053		0.063		-0.028
		(0.026)		(0.052)		(0.080)		(0.067)		(0.100)		(0.087)		(0.060)		(0.050)
disseminated bond in post-dissemination period		-0.128		0.508		-1.089 c		0.153		0.312		-0.245		-0.152		-0.061
		(0.137)		(0.335)		(0.556)		(0.402)		(0.531)		(0.460)		(0.273)		(0.225)
ln(trade size)		-0.084 a		0.245 a		0.087		-0.242 b		0.246		-0.012		0.071		-0.016
		(0.006)		(0.042)		(0.223)		(0.110)		(0.229)		(0.157)		(0.066)		(0.033)
time to maturity (*1000)		0.027 a		0.046 a		0.034 a		0.049 a		0.045 a		0.018 c		0.008		0.008
		(0.003)		(0.007)		(0.010)		(0.008)		(0.011)		(0.010)		(0.007)		(0.005)
bond age (*1000)		-0.003		-0.019		0.026		0.013		0.128 a		0.024		-0.019		-0.024
		(0.008)		(0.013)		(0.023)		(0.023)		(0.044)		(0.037)		(0.029)		(0.024)
issue amount (*1000000)		-0.187 c		-0.344		-0.571		-0.503 c		0.188		0.262		0.059		-0.096
		(0.110)		(0.233)		(0.363)		(0.295)		(0.403)		(0.382)		(0.254)		(0.213)
average daily volume		0.003		-0.006		0.030 c		-0.002		0.010		0.004		-0.003		0.001
(prior 30 days (*1000))		(0.003)		(0.011)		(0.017)		(0.011)		(0.014)		(0.010)		(0.006)		(0.004)
days since last trade		-0.007 a		-0.019 a		-0.020 a		-0.012 b		-0.010		-0.013 c		0.002		0.000
		(0.002)		(0.004)		(0.007)		(0.006)		(0.008)		(0.007)		(0.004)		(0.004)
Adjusted R-squared	5.7%	6.8%	13.2%	14.4%	15.2%	16.2%	14.3%	15.1%	6.8%	7.9%	3.1%	3.2%	3.0%	3.0%	1.0%	0.9%
N	34,375	34,375	8,747	8,747	3,928	3,928	5,115	5,115	2,097	2,097	2,330	2,330	4,517	4,517	7,641	7,641

a, b, c, indicate significance at the 1%, 5%, and 10% level, respectively

Figure 1
Transaction history for a sample bond