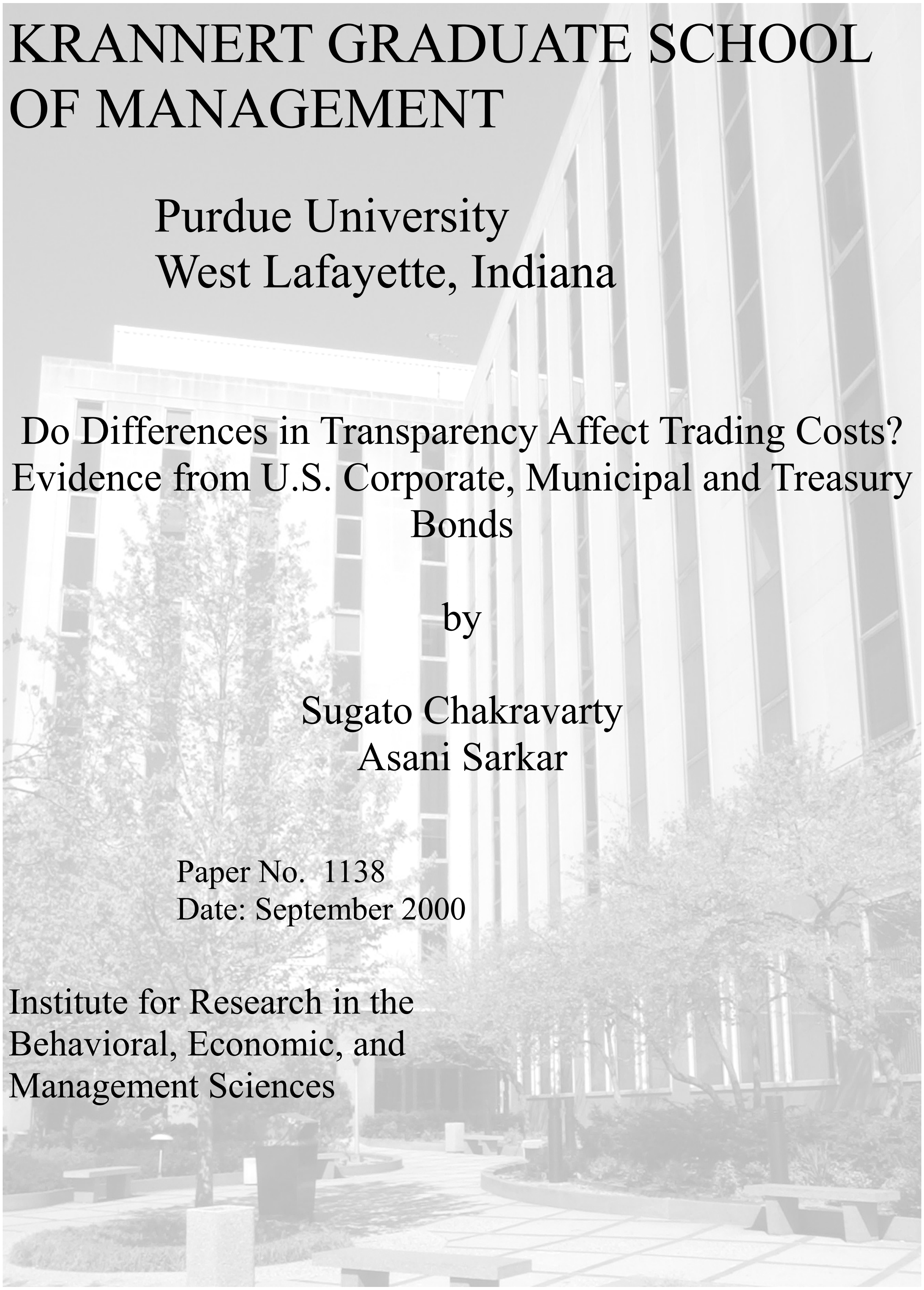

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Do Differences in Transparency Affect Trading Costs? Evidence from U.S. Corporate, Municipal and Treasury Bonds

by

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Abstract

We compare trading costs in the transparent U.S. Treasury bond market with the less transparent U.S. corporate and municipal bond markets, based on newly available transaction data. We estimate that the mean bid-ask spread per $100 par value is 23 cents for municipal bonds, 21 cents for corporate bonds and 11 cents for Treasury bonds. But after controlling for interest rate risk, credit risk and trading activity, we find that the bid-ask spread is not significantly different between the three markets. Our findings suggest that markets with different levels of transparency may nevertheless have similar trading costs. Finally, we examine why institutions sometimes trade without dealers, and find that the relative volume of directly negotiated trades in a bond decreases in its bid-ask spread, interest rate risk and adverse selection risk and increases in its activity level.

JEL Classification codes: G10, G14, G22
Keywords: U.S. bond markets, trading costs

While U.S. bond markets are the largest in the world,[1] mechanisms for trading bonds remain relatively unsophisticated. Most bond transactions occur in over-the-counter dealer markets. Other than U.S. Treasury bonds, these markets lack price transparency since there is no centralized location reporting quotes or trade prices. An institution must call dealers or broadcast requests for quotes through an electronic dealer system; alternatively dealers may broadcast indicative quotes for bonds in their inventory. The Securities and Exchange Commission (SEC) has pushed for greater transparency of the corporate and municipal bond markets, but the effect of transparency on investor welfare is still being debated. Naik, Neuberger and Viswanathan (1999) show that, with interdealer trading, greater transparency may increase or decrease investor welfare since it improves risk sharing between dealers but worsens price revision risk. Evidence from experimental settings is also ambiguous.[2]

In this paper, we use newly available data of secondary bond market transactions to compare trading costs in the corporate, municipal and Treasury bond markets, after controlling for interest rate risk, credit risk, trading activity and issuer-specific characteristics.[3] These three markets, which constitute about two-thirds of the average daily trading volume in the U.S. debt markets (BMA, 1999), differ with respect to the degree of transparency. A recent SEC study concludes that the Treasury market is the most transparent, the corporate market the least, with poor but improving transparency in the municipal market.

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[1] The total value of bonds outstanding was over $14 trillion in 1999 (Bond Market Association (BMA) estimates). While the New York Stock Exchange equity trading was $26 billion per day in 1998, trading volume in bond markets amounted to roughly $350 billion per day during the same period (SEC press release 98-81).

[2] Bloomfield and O'Hara (1999) study post-trade transparency and find that opening spreads are higher but prices are more efficient. Flood, Huisman, Koedijk and Mahieu (1999) examine pre-trade transparency and come to the opposite conclusion.

We estimate that the mean realized bid-ask spread per $100 par value is 23 cents for municipal bonds, 21 cents for corporate bonds and 11 cents for Treasury bonds. Without controlling for credit risk and interest rate risk, we find that the bid-ask spread in the corporate and municipal bond markets is statistically higher than in the Treasury market. After controlling for these risks, however, there is no significant difference in the bid-ask spread of the three markets. Our findings imply that differences in trading costs between these markets mainly reflect differences in risk, rather than differences in the level of transparency.[4]

We also examine why institutions sometimes trade without dealers. Electronic bond trading systems, which are a growing part of U.S. bond markets (Meyer and Sarkar, 2000), promise increased transparency and potentially allow buyers and sellers of bonds to trade directly with each other. We find that bonds with lower bid-ask spreads, lower interest rate and adverse selection risk, and higher activity levels are more likely to be traded directly by institutions, without dealer intervention. Thus, these types of bonds are more likely to migrate to more transparent electronic trading systems in the future.

In related work, Hong and Warga (2000) and Schultz (2000) use the same data set that we do. These papers do not study municipal bonds, nor do they compare trading costs across markets or examine why institutions trade without dealers. Also, these papers do not examine the determinants of volume. We find that daily volume has a strong autoregressive structure, that volume is predictable, and that the bid-ask spread is strongly related to unpredicted volume.

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[3] While U.S. Treasury securities are virtually free of credit risk, corporate bonds may suffer from significant credit risk. Municipal bonds have intermediate credit risk due to the financial fragility of some municipals, and innovative issues with uncertain legal bondholder rights. The secondary market in U.S. Treasuries is highly active, with large trading volumes and narrow bid-ask spreads (Fleming and Sarkar, 1999). Corporate bonds tend to be active for the first two years after issuance, but relatively inactive thereafter.

[4] Hong and Warga (2000) find that the bid-ask spread in the bond dealer market is similar in magnitude to the bid-ask spread for bonds trading in the more transparent exchange markets. Hotchkiss and Ronen (1999) show that market quality is similar for high yield corporate bonds and the underlying (presumably more transparent) stocks.

Hong and Warga (2000) use a methodology similar to ours to estimate the bid-ask spread and its determinants, and compare dealer and exchange market transactions. They find that dealer and exchange market bid-ask spreads are similar in magnitude. The dealer bid-ask spread increases in age, maturity and squared returns, but is not related to total volume. We find a non-linear relation between the corporate bond bid-ask spread, age and maturity and show that the bond bid-ask spread is negatively related to the buy volume and positively related to the sell volume for corporate and municipal bonds.[5] We conjecture that the bond market may view sales by insurance companies (who are buy-and-hold investors) as signals of adverse information about the bond. Consistent with this interpretation, the bid-ask spread is negatively related to the sell volume for Treasury bonds.

Schultz (2000) estimates effective bid-ask spreads for corporate bonds by inferring daily bid quotes from a different data set with month-end quotes. Relative to our bid-ask spread measure, his procedure results in noisier estimates of trading costs but allows for a larger sample of less active bonds. Also, he does not estimate the bid-ask spread of below investment grade bonds that make up about 16 percent of our corporate bond sample (Table 2). Perhaps as a consequence, he finds that bond ratings are not a significant determinant of the bid-ask spread whereas we find that bond ratings explain variations in the bid-ask spread both within and across markets. Schultz (2000) further finds that the bid-ask spread is lower for larger dealers and institutions. We find a similar result for larger dealers and institutions in our full sample of corporate bonds. In our sample, however, large and small dealers or institutions trade less than 10 percent of bonds in common, and for commonly traded bonds, we find no statistically significant difference in trading costs.

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[5] This result is different from the equity markets where buys have larger price impact than sales for equity

Instead of the bid-ask spread, Alexander, Edwards and Ferri (2000) examine the determinants of trading volume of high-yield corporate bonds that are part of the Fixed Income Pricing System (FIPS) of Nasdaq.[6] They find that trading volume is positively related to issue size, default risk, interest rate risk and return volatility and negatively related to bond age. Since insurance company transactions are a subset of the total bond markets, we do not have a measure of the total trading volume. However, unlike the FIPS data, transactions in our sample are exclusively between dealers and customers. We show that insurance company trading volume is strongly related to past volume and past shocks in volume.

The rest of the paper is written as follows. In section 1, we discuss our data. In section 2, we estimate the realized bid-ask spread. In section 3, we discuss the theoretical determinants of the bid-ask spread and our methodology. In section 4, we study the empirical determinants of the bid-ask spread, and compare the spread across markets. In section 5, we compare the bid-ask spread for large and small dealers and for large and small institutions. Section 6 examines why institutions sometimes trade without dealers. Finally, section 7 concludes.

1. Data

A. Data Description

The data, purchased from Capital Access International (CAI), includes individual bond transactions by insurance companies. Since 1995 the National Association of Insurance Commissioners (NAIC) began providing transactions data based on Schedule D filings by all its member insurance companies, who are required to provide information on the total cost of transaction, the par amount, and the date of transaction. CAI obtains the data from A.M. Best

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institutional trades (Chan and Lakonishok, 1995), Keim and Madhavan, 1996).

and further verifies the bond transactions by cross-referencing against other information on their files.[7] Our sample is from January 1, 1995 to December 31, 1997. Each record in the data shows the transaction date, a bond identifier, the total dollar value of the transaction, the number of bonds traded, an indication as to whether the transaction is a sale or a purchase, and the identities of the dealers and the customers. We also obtained from CAI the Moody's and S&P credit ratings for each bond, the credit sector of issuer (e.g., whether the bond was issued by an industrial company), the bond issue date and its maturity date.

For our analysis, we exclude bonds of non-U.S. issuers, Rule 144A or private bonds and bonds without rating information. An unusually large number of observations occurring on June 30, 1995, June 30, 1996, and December 31, 1997 are removed. According to CAI, insurance companies may have used these days to record trades that actually occurred on other dates. Also deleted are transaction dates falling on a Saturday or a Sunday or where the date is an estimate. Finally, to minimize the possibility of errors in data, we eliminate all observations where the transaction price per $1,000 face value bond is outside the range $500 to $1500.[8] The final sample has 152,452 trades in corporate bonds, 54,518 trades in government bonds and 83,395 trades in municipal bonds over the period 1995 to 1997.

We exclude days when a bond does not have both a buy and a sell transaction, since our liquidity measure is not defined for these days (see section 2). This leaves us with 6,687 corporate bond trades, 3,176 municipal bond trades and 6,292 government bond trades. The

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[6] Kamara (1994) studies volume of Treasury bill and note securities. Sarig and Warga (1989), Blume, Keim and Patel (1991), Warga (1992), and Crabbe and Turner (1995) use the yield or return spread as a measure of liquidity.

[7] CAI has a security master of over 7 million issues, which they use to validate incoming security information. Mismatched records are looked up in their security master and identified by a data specialist.

[8] The final filter also removes most trades of 500 bonds or less. This may be important because, during our sample period, CAI rounded the total transaction cost to the next highest one thousand dollars. Prices of smaller sized trades will be most affected by the rounding process. Hong and Warga (2000) delete all observations under 500 contracts, but Schultz (2000) does not, arguing that the rounding errors do not affect his trading cost measure.

number of bond days (the number of bonds times the number of days each bond is traded) is 2,515 for the corporate market, 1,933 for the government market, and 1,223 for the municipal market, for a total of 5,671 bond days in the three markets.

Table 1 provides the sample distributions of characteristics of investment-grade and below-investment grade bonds in the corporate and municipal markets. For government bonds, we distinguish between U.S. Treasury securities and a small number of Federal Agency securities issued by government-sponsored enterprises such as Fannie Mae and Freddie Mac. The time-to-maturity, duration and convexity are highest in the municipal bond sector, and about the same in the other two markets. The mean time-to-maturity is intermediate in all three sectors, consistent with the recent emphasis of insurance companies on shorter-duration term life policies, rather than more traditional whole-life policies. The dollar buy and sell volumes are least for municipal bonds and most for Government bonds. The mean bond age is lowest in the Government market and about the same in the other two markets.

B. Is our Data Representative of the Overall Bond Markets?

Hong and Warga (2000) suggest that insurance company transactions comprise about 25 percent of the non-investment grade market and a significantly larger share of the investment grade market. We compare the characteristics of our investment grade bonds with the Merrill Lynch Domestic Master Bond Index, which reports daily values of duration and other variables of interest for U.S. Treasuries and investment grade corporate and municipal bonds. To be included in the Merrill Lynch Index, the bonds must have at least one year to maturity and satisfy a minimum par amount. For the period 1995 to 1997, the mean and standard deviation of bond characteristics from the Merrill Lynch Index are reported in the last column of Table 1. A comparison of the numbers shows that investment-grade corporate and municipal bonds and

Treasury bonds in our sample have characteristics similar to bonds in the overall market.

Insurance companies may trade the same bonds differently from other bond investors. In particular, insurance companies may buy and hold bonds till maturity. Pension funds and hedge funds, in contrast, are reputed to trade more frequently. We indirectly address this issue by comparing the trade size of Treasury bond transactions in our sample with those from GovPX, a Treasury bond transaction database covering most of the major inter-dealer brokers.[9] In our sample, for Treasury bonds with an average time to maturity of 8.7 years, the mean trade size (in million dollars) is between 7.94 for buys and 8.65 for sells (Table 1). We infer from GovPX data the mean trade size for a Treasury bond of similar maturity by interpolating between the trade sizes in 1997 for the 10-year Treasury note (about 6.5 million dollars) and the 5-year Treasury note (about 8.3 million dollars). By this calculation, the mean trade size of GovPX securities was about 7.7 million dollars for a bond with 8.7 years to maturity-- somewhat smaller but still comparable with the trade size of insurance companies.

2. Estimates of the Bid-Ask Spread in Bond Markets

A. *Bid-ask Spread Estimates for the Corporate, Government and Municipal Bond Markets*

For a bond with at least one buy and one sell transaction in a day, the realized bid-ask spread per bond day is the difference between its mean daily selling price and its mean daily buying price. Panel A of Table 2 reports the distribution of the realized bid-ask spread for the three markets per $100 par value. The mean bid-ask spread is 23 cents for municipal bonds, 21

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[9] Two caveats are in order. GovPX data relate to interdealer broker trades, whereas our data are for customer-to-dealer transactions. Further, even for the same trade size, the bid-ask spread for insurance company trades may be different from, say, hedge fund trades if the dealer knows who the customer is. Smaller insurance companies, however, typically go through a money manager, and so are likely to remain anonymous. We thank Michael Fleming for the GovPX data.

cents for corporate bonds, and 11 cents for government bonds. In the government market, the mean bid-ask spread is 11 cents for Treasury securities and 24 cents for the relatively riskier and less active Agency securities. In all markets, the mean bid-ask spread is lowest in 1997 and is generally higher for lower credit ratings. For example, in the corporate market, the mean bid-ask spread is about 7 cents for AA-rated bonds and 23 cents for below-investment-grade bonds. [10]

B. *Robustness Checks on the Estimated Bid-Ask Spreads*

The realized spread is a noisy estimate of transaction costs, since buy and sell trades take place at different times during the day. Further, if the intra-day arrival of buy and sell orders is not random, then our spread measure may be biased. For example, if insurance companies buy on good news and sell on bad news (as our later results suggest), then the daily bid-ask spread measure may be upwardly biased. Since the degree of noise and bias are related to the number of buy and sell trades during the day,[11] we multiply the realized bid-ask spread on day i by $N_i = [(1/N_{bi}) + (1/N_{si})]^{-1/2}$, where N_{bi} (N_{si}) is the number of buy (sell) trades for day i. We call this measure the *noise-adjusted spread* for a bond since, assuming equal variance and no covariance between buy and sell prices, the standard deviation of the unadjusted bid-ask spread is proportional to the inverse of N_i. We also estimate a volume-weighted realized spread, which is the difference between the volume-weighted daily means of sell and buy prices for a bond. This measure adjusts the realized spread for relative imbalances in daily buy and sell volumes.

Panel B of Table 2 reports the distribution of the noise-adjusted spreads. Since on most

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[10] Since we have only 48 observations in the sample for AAA-rated corporate bonds, we do not report the spread distribution for these bonds separately in Table 1.

[11] Suppose insurance companies make a series of purchases following good news released in the middle of the day. Dealers observe the sequence of buys and increase their ask price, with a possibly greater upward adjustment if the buy sequence is longer. Thus, the dealer bid-ask spread based on all trades for day is an upwardly biased estimate of the transaction-level bid-ask spread, with the bias increasing in the number of trades.

days there is one buy or one sell trade, N_i is less than one for most i, and the mean and standard deviation of the noise-adjusted spread are lower compared to those of the unadjusted bid-ask spread. Most important, both within and across markets, the distribution of the noise-adjusted spread is qualitatively similar to that of the unadjusted bid-ask spread in Panel A of Table 2. For example, the mean noise-adjusted spread is highest for the municipal sector and lowest for the government market and, for the corporate market, the mean noise-adjusted spread is lowest for the AA-rated bonds. For all markets, the mean noise-adjusted spread is lowest in 1997, similar to the unadjusted spread. Panel C of Table 2 reports the distribution of volume-weighted spreads. Again, these estimates closely resemble the unweighted spreads.

Inactive bonds are less likely to have one buy and one sell transaction on a day, and so our spread estimates may be mainly applicable to relatively active bonds. Schultz (2000) uses a different methodology for estimating trading costs and obtains a larger sample of corporate bond trades than we do. He finds that the mean and standard deviation of the bid-ask spread is higher than what we report. To check the robustness of requiring one buy and one sell transaction for a bond each day, we calculate the realized spread over two, three, and five-day windows. For example, to obtain the two-day bid-ask spread for a bond, we require that the bond have at least one buy and one sell transaction over two consecutive trading days, and calculate the bid-ask spread as the difference between the 2-day-means of the selling and buying prices. The results are reported in Table 3.

Panel A of Table 3 reports the distribution of realized spreads calculated over a two-day window. The number of bond days in all markets increases from 5,671 for the one-day window to 7,257 for the two-day window, an increase of almost 28 percent. The mean and standard deviation of the bid-ask spread is generally higher, consistent with the inclusion of less active bonds. However, the relative distribution of the spread is robust to the change in the window--for example, the mean corporate bond spread remains lowest for AA-rated bonds and highest for the utility sector. Similar observations apply to the bid-ask spread estimated for three-day windows (panel B of Table 3) and five-day windows (panel C of Table 3). For the three-day window, the number of bond days in all markets is 8,559, a 16 percent increase over the two-day window. For the five-day window, there is a further 19 percent increase in the number of bond days. The mean and standard deviation of the spread generally increases for each increase in the window. But, the spread distribution is qualitatively similar to the one-day window.

Given these results, in the remainder of our analysis we focus mainly on the daily realized bid-ask spreads reported in Panel A of Table 2. Wherever necessary, however, we check the robustness of our results by repeating the analysis for the alternative spread measures.

3. Determinants of the Bond Bid-Ask Spread: Discussion and Methodology

Since the realized bid-ask spread represents dealers' average daily revenues for a bond, it should be related to dealers' costs of adjusting inventory. Inventory models suggest that the bid-ask spread increases with the bond price and the risk of the security, and decreases with trading activity (Amihud and Mendelsohn (1980), Garman (1976), Ho and Stoll (1981), Stoll (1978a)). Leland (1994) and Merton (1974) suggest that the bond price should depend on the risk-free rate, provisions in the bond indenture (such as maturity date, coupon rate, and call provisions) and the probability of default. We control for the default risk by creating dummy variables based on Moody's credit ratings. We do not control for the coupon rate or the risk-free rate in the regressions because these variables are highly correlated with our other explanatory variables. As a proxy for interest rate risk, we use the time to maturity, or the number of years from a bond's transaction date till its maturity date.[12] Time to maturity is highly correlated with duration and convexity and so we do not use duration and convexity in our regressions.[13] As a proxy for trading activity, we use the age of a bond, or the number of years between its issue date and its transaction date. Alexander et al (2000) and Sarig and Warga (1989) find that younger bonds are more liquid.

We control for exogenous changes in the bid-ask spread over time through a dummy variable for transactions occurring in 1997. Hong and Warga (2000) suggest that the corporate bond bid-ask spread has been declining in the 1990s. Changes in the market structure over our sample period, such as an increase in transparency or increased regulatory scrutiny of the bond markets, may affect the bid-ask spread. Christie, Harris and Schultz (1994) find that dealer spreads on Nasdaq declined following publicity regarding their odd quoting behavior.

Finally, we include volume as an explanatory variable. Easley and O'Hara (1992) show that, if no-trade episodes are important (as in bond markets), a market maker's probability of an information event increases in volume. Increased volume may result in a higher bid-ask spread if trading is primarily information driven (Copeland and Galai (1983), Easley and O'Hara (1987), Glosten and Milgrom (1985)) or in a lower bid-ask spread if trading is mainly liquidity motivated (Stoll (1978b)). We distinguish between buy and sell volumes. Since insurance companies typically hold bonds to maturity and then reinvest the principal, bond sales may be more information sensitive than bond buys.

Our basic regression specification is as follows:

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[12] The effective time to maturity is lower for callable bonds. However, Hong and Warga (2000) multiply the time to maturity by a callability dummy and find that the dummy does not have any explanatory power for their bid-ask spread regressions. Hence, we do not adjust the time to maturity for the callability of the bond.

[13] For example, the correlation of corporate bond maturity with duration is 0.90 and with convexity is 0.95. We calculate Macaulay duration and convexity on the basis of the estimated annual bond yield. We estimate the yield

$$Spread_{it} = a_0 + a_1\ Maturity_{it} + a_2\ Age_{it} + a_3\ Log\ Buy\ Volume_{it} + a_4\ Log\ Sell\ Volume_{it}$$

$$+\ a_5\ 1997_t + a_6 Macro\ Announcement\ Dummy_t + Control\ Variables + e_{it} \qquad (1)$$

For bond i on day t, the regression variables are: $Spread_{it}$, the daily realized bid-ask spread per $100 par value; $Maturity_{it}$, the time-to-maturity in years; Age_{it}, the time in years between the bond transaction date and its issuance date; and e_{it}, the error term. 1997_t is a dummy variable equal to one if the bond traded in the year 1997, and 0 otherwise. The macro announcement dummy is equal to 1 on days with an announcement about the Consumer Price Index (CPI), the Producer Price Index (PPI), and industrial production. Bollerslev, Cai and Song (1999) identify these announcements as having major price impacts over our sample period.

Control Variables represent credit risk and issuer characteristics in the corporate and municipal markets. In the government market, we focus on Treasury securities only, and so we do not need to control for credit risk. For both the corporate and municipal markets, we include dummy variables for Moody's ratings categories from *A1* to *A3*. For example, the dummy *A1* is one for bonds rated *A1* by Moody's, and zero otherwise. For the corporate market only, we define dummy variables for ratings *BAA1* to *BAA3* and for bonds rated either *AAA* or *AA*. The omitted rating category in the corporate market is *Junk*, those bonds rated *Ba* or below. For the municipal market alone, we include dummy variables for *AA*-rated bonds and for bonds rated *Below A3* (i.e., *BAA1* and below). The omitted rating category in the municipal market is *AAA*. Finally, we include dummy variables for bonds of different issuer categories since they may have different abilities to meet their contractual obligations. For corporate bonds, we identify bonds issued by utilities, banking/finance companies and industrial companies. For the municipal market, we have dummy variables for utility bonds and health care bonds.

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using the semi annual coupon payments and the accrued interest from the previous coupon interest date.

For corporate bonds, we also allow for a non-linear relation between the bond bid-ask spread, *Maturity* and *Age*. Longstaff and Schwartz (1995) predict that the credit spread for risky debt initially increases with time to maturity and then declines. We include the square of *Maturity* as an additional independent variable in (1). To allow a non-linear relation between the bid-ask spread and *Age*, we follow Alexander et al. (2000) and define a dummy variable that is one if *Age* is more than 2 years and zero otherwise.

Easley and O'Hara (1992) predict that volume at time t affects prices at t+1 and, further, only *abnormal* or unexpected volume moves prices. Bessembinder and Seguin (1993) find that unexpected volume shocks have a larger effect on futures volatility than expected volume shocks. Accordingly, we decompose the buy and sell volume into their expected and unexpected parts for the same sample of bonds used to estimate the bid-ask spread. We pool observations for these bonds and use maximum likelihood to estimate a mixed autoregressive (AR) and moving average (MA) process ARMA(p,q) for the log volume, where p (q) is the order of the AR (MA) process.[14] Optimal lag values are chosen using the criteria of Akaike (1974) and Schwarz (1978).

The results are reported in Panel A of Tables 4, 5 and 6 for corporate, municipal and Treasury bonds, respectively. In all markets, volume is strongly and positively correlated to the first lags in volume and innovations in volume, and negatively correlated to the second lag in volume. The fitted value from the ARMA(p,q) process is a proxy for expected volume, while the innovation is the unexpected volume. Our basic regression is then modified as follows:

$Spread_{it} = a_0 + a_1\ Maturity_{it} + a_2\ Age_{it} + a_3\ Expected\ Buy\ Volume_{it} + a_4\ Unexpected\ Buy\ Volume_{it}$

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[14] In a previous version of the paper, we also included lagged values of *Maturity*, *Age*, *Bid-Ask Spread* and the *Yield Spread* to predict volume, where *Yield Spread* is the difference between the bond yield and the 91-day Treasury bill rate. The estimated coefficients on these variables were generally not significant.

$+ a_5$ *Expected Sell Volume*$_{it}$ $+ a_6$ *Unexpected Sell Volume*$_{it}$ $+ a_7$ *1997*$_t$

$+ a_8$ *Macro Announcement Dummy*$_t$ + *Control Variables* + e_{it} (2)

4. Empirical Determinants of the Bid-ask Spread and its Comparison Across Markets

In section *A*, we examine the factors that determine the bid-ask spread in each market separately. In section *B*, we compare the bid-ask spread across the three markets.

A. Estimation Results for Individual Bond Markets

For all three bond markets, Durbin-Watson test statistics indicate significant serial correlation in the error terms when the bid-ask spread regressions (1) or (2) are estimated with Ordinary Least Squares (OLS). Lagrange multiplier and White's tests (White, 1980) also detect the presence of heteroscedasticity in the OLS error terms. To control for autocorrelation and to avoid assuming a form for the heteroscedasticity, we use the Generalized Method of Moments (GMM) of Hansen (1982) as our estimation technique. The GMM weighting matrix is initialized from a 2-stage-least-squares estimation of the system. The explanatory variables are used as instruments, and the system is exactly identified. GMM estimation results for regression (1) and regression (2) are reported in Panel B of Tables 4, 5 and 6.

Panel B of Table 4 reports results for the corporate market. Considering first the results for regression (1), we find that the bid-ask spread is concave in *Maturity*, increasing at a decreasing rate with the bond's remaining time to maturity. The bid-ask spread increases by 11 cents when the bond ages by another year. The coefficient on the non-linear age dummy (not reported) is positive and significant, indicating the spread is lower for bonds younger than two years. The bid-ask spread is negatively related to the buy volume and positively related to the sell volume. *AAA* and *AA* rated bonds have significantly lower spreads relative to junk bonds.

The coefficients of the other credit ratings variables generally have the right sign, although they are not significant. The announcement day dummy is not significant. The results from regression (2) show that the bid-ask spread is negatively related to the *unexpected* buy volume and positively related to the *unexpected* sell volume, but expected buy and sell volumes do not affect the bid-ask spread.

For the municipal market (Panel B of Table 5), the bid-ask spread is positively related to *Maturity* and negatively related to the *1997* transactions dummy. The coefficient on the *Below-A3* credit rating dummy is positive and significant, indicating that the bid-ask spread on these bonds is higher relative to *AAA*-rated bonds (the omitted category). From regression (1), the bid-ask spread is negatively related to the buy volume and positively related to the sell volume. From regression (2), the bid-ask spread is negatively and significantly related to both the expected and the unexpected buy volume. The coefficients on the expected and unexpected sell volume are positive, but only the former is significant.

For government bonds (Panel B of Table 6), we delete all Federal Agency bonds, so that the remaining bonds are all Treasury securities. There is weak evidence that the bid-ask spread was lower in 1997, relative to the earlier years. The coefficient of the announcement day dummy is positive and significant, consistent with Fleming and Remolona (1999). Regression (1) shows that the bid-ask spread is negatively related to the sell volume, but unrelated to the buy volume. Regression (2) shows that the bid-ask spread is negatively related to the unexpected sell volume, but unrelated to the expected sell volume.

It is possible that the buy and sell volumes do not affect the "true" spread and our statistical results are due to a bias in measuring the "true" spread, as discussed in section 2*B*. To test this possibility, we use the noise-adjusted spread (see section 2*B*) instead of the realized spread as the dependent variable. Our results remain qualitatively unchanged.

In summary, the bond bid-ask spread increases in interest rate and credit risk, and decreases in measures of trading activity (age and buy volume). The bid-ask spread for corporate and municipal bonds increases in the sell volume, perhaps indicating that sales by insurance companies signal adverse information about the bond. Volume appears to be predictable, and only the unexpected volume affects the bid-ask spread in the corporate and Treasury markets.

B. Comparison of the Bid-Ask Spread in the Corporate, Treasury and Municipal Bond Markets

Initially, we pool observations across markets to test whether the bid-ask spread is different in the three bond markets. Since our earlier results indicate that a common set of variables may not explain variations in the bid-ask spread of all markets, we estimate two regressions. In the first, we *only* control for factors that are significant (according to the regression (2) results) in *all* of the markets being compared. For example, when comparing all three markets, we only control for the sell volume. In the second regression, we control for factors significant in *any* of the markets being compared. We define a dummy variable that is one for corporate bonds and zero otherwise, and another dummy variable that is one for municipal bonds and zero otherwise. A positive dummy coefficient implies that the bid-ask spread is higher compared to the Treasury market, after controlling for other factors. To avoid collinearity between the dummy variables and the intercept, we omit the intercept term. To control for credit risk, we define dummy variables for every rating category except *AAA*. To check the sensitivity of the results, we repeat our analysis for all *market pairs*.

Table 7 reports the results of the GMM estimation with pooled data. Panel A of Table 7 reports results when observations are pooled across all three markets. When we control only for common significant factors (regression 1), the market dummies are positive and significant, indicating that the bid-ask spread in the municipal and corporate markets are higher by 12 cents and 11 cents, respectively, compared to the Treasury market. However, when we control for credit risk and time to maturity (regression 2), neither the corporate nor the municipal dummies are significant, indicating that the bid-ask spread in the three markets is not statistically different. These results are confirmed when observations are pooled for pairs of markets. For the corporate and Treasury market pair (Panel B), the bid-ask spread is higher in the corporate market when adjusted only for sell volume, but not when adjustment is also made for credit risk and maturity. Similar remarks apply to the municipal and Treasury markets pair (Panel C). The bid-ask spreads for corporate and municipal bonds (Panel D) are statistically indistinguishable even when adjusted for common significant factors.

As expected, when we control for additional factors (such as the buy volume and bond age), the bid-ask spread remains statistically similar across markets. To gauge the robustness of pooling observations across markets, we also estimate the bid-ask spread in the three markets as a seemingly unrelated regression model (SURM). These results are reported in Table A1 of the Appendix. The SURM does not assume a common model for all markets, but takes into account the common information in each market through the correlation between the error terms.[15] Consistent with results from Table 7, the null hypothesis that the mean bid-ask spread (the intercept parameter) is equal across markets cannot be rejected by a chi-square test. These results do not change when the SURM is applied to market pairs. We conclude that, after properly adjusting for risk (in particular, credit risk and maturity risk), the bid-ask spread is not

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[15] To implement the SURM, we consider only days when there is trading in all three markets. We also need to average observations over different bonds trading during a day. To do this, the credit ratings are assigned numerical values to obtain an average credit rating for different bonds trading on the same day.

statistically different across the corporate, municipal and Treasury markets.

5. The Bid-ask Spread of Trades by Large and Small Dealers and Institutions

For equity markets, Keim and Madhavan (1997) document significant differences in trading costs across institutions even after adjusting for differences in trading styles. More than in equity, differences in the bond bid-ask spread for large and small dealers and institutions may reflect differences in the type of bonds traded by them. To allow for dealer specialization in particular bonds, we rank dealers and institutions *for each corporate and municipal bond* according to their shares of the value traded in the bond. The dealers with the highest market shares in a bond, such that their cumulative shares just add up to 50 percent, are identified as "large." The remaining dealers are "small." In the Treasury market, large dealers are *primary* dealers in the Treasury auctions market.[16]

In Table 8, we show characteristics of bonds traded by large and small dealers, and bonds that are directly traded. We exclude direct trades for the analysis in this section, but they are analyzed in section 6. In the municipal and Treasury markets, large dealers execute bonds with higher volatility (i.e., time to maturity, duration and convexity), but the opposite is true for the corporate market. In the Treasury market, large dealers are involved in proportionately more sell trades compared to small dealers.

We calculate a dealer's bid-ask spread for a bond as the dealer's mean daily sell price minus the mean daily buy price for the bond. Panel A of Table 9 shows that the bid-ask spreads of large and small dealers in the Treasury and municipal markets are not significantly different.

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[16] All primary dealers are also "large" in the sense of their market shares in the secondary market. In our sample period, the Federal Reserve designated between 37 and 38 government dealers as primary dealers. All are active in the secondary market, with the exception of two Japanese companies and one European company.

For corporate bonds, large dealers earn a lower bid-ask spread than smaller dealers do, and the difference is significant according to the Kruskal-Wallis nonparametric test. This result is consistent with Schultz (2000), who uses a different methodology for identifying large dealers.[17] However, Panel B of Table 9 shows that large dealers trade only 9 percent of bonds in common with small dealers in the corporate market. Panel C of Table 9 shows that, for corporate bonds traded in common by large and small dealers, the bid-ask spread for large dealers is still smaller than small dealers, but the difference is not statistically significant.

Since inactive bonds have fewer dealers than active bonds, they may have proportionately more dealers with high market share. Hence, the large dealer dummy may be correlated with the activity level of bonds. We use regression analysis to control for the activity level of bonds. Specifically, the realized bid-ask spread is regressed on buy and sell volume, a dummy variable for large dealers, a dummy variable for directly negotiated trades and the usual control variables. The results (reported in Table A2 of the Appendix) show that, for all markets, the large dealer dummy coefficient is not significant after controlling for the activity level. We conclude that, after controlling for differences in the bonds traded, the bid-ask spread of large and small dealers is not significantly different in any market.

We perform a parallel analysis of the bid-ask spread for large and small institutions, and obtain similar results (reported in the appendix.) Trading costs of large and small institutions are not different in any market, after controlling for differences in the bonds traded. For *all* corporate bonds, trading costs are lower for large institutions according to the Kruskal-Wallis test (panel A of Table A3). But large and small institutions in the corporate market trade only 5 percent of bonds in common (panel B of table A3) and, for bonds traded in common by large and

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[17] Schultz (2000) ranks dealers and institutions by the market share in all bonds, rather than the share in each bond.

small institutions, trading costs are not significantly different (panel C of table A3). In the municipal sector, the mean bid-ask spread is higher for large institutions (panel A of Table A3) but, after using a regression to control for differences in bond characteristics, trading costs of large and small institutions are no longer different (table A4 of the Appendix).

6. Why do Institutions Sometimes Trade without Dealers?

Institutions sometimes negotiate trades directly among themselves and agree on execution at a common price. While the bid-ask spread for direct trades is zero by definition, and the dealer spread is positive, this does not necessarily indicate that effective trading costs are higher with dealers. The dealer spread may reflect the value of providing liquidity to the market. For example, dealers may specialize in bonds that are more volatile or have higher credit risk. Table 8 shows that, relative to direct trades, volatility (i.e., time to maturity, duration and convexity) and volume is greater and age is lower for bonds traded by large and small dealers in all markets. In the corporate market, the share of investment grade bonds is lower for dealer-traded bonds relative to directly traded bonds, but the reverse is true for the municipal market.

It follows that an institution's desire to trade bonds directly should be related to bond characteristics, as well as the cost of trading the bond with dealers. Thus, we regress an institution's daily share of volume traded without dealers in a bond on the realized bid-ask spread, a dummy variable that is one if the institution is large (and zero otherwise), buy and sell volume and the usual control variables. The results are in Table 10.

Table 10 shows that, in the corporate and municipal markets, institutions' share of volume traded without dealers is increasing in the age of the bond, decreasing in the bid-ask spread and in the sell volume. One interpretation of the result is that, to remain competitive, dealers narrow the bid-ask spread for bonds that institutions find easier to trade directly. Further, if institutions sell on bad news, then the result also implies that dealers execute more information-sensitive bonds. In the corporate market, institutions are also more likely to trade directly if the bond has lower interest rate risk (i.e., time to maturity) and higher buy volume. Overall, dealers appear more likely to be involved in trading relatively riskier and more active bonds. This is similar to Bhasin and Carey (1999), who find that dealers are more likely to make markets in secondary corporate loans for riskier borrowers. Large institutions are less likely to be involved in direct trades in the corporate and Treasury markets, and more likely to trade directly in the municipal market.

Since in many cases the daily share of direct trading in total volume is zero or one, a censored regression may be a more appropriate estimation method. We estimate an accelerated failure time model, and assume that the data is censored on the left at zero and on the right at one and that the failure time follows a logistic distribution.[18] The results, reported in table A5 of the Appendix, are qualitatively similar to the earlier results for corporate and municipal bonds.

7. Conclusion

This paper compares the realized bid-ask spread in the U.S. corporate, municipal and Treasury bond markets for 1995 to 1997, based on newly available transaction data. We estimate that the mean bid-ask spread per $100 par value is 23 cents for municipal bonds, 21 cents for corporate bonds and 11 cents for Treasury bonds. After controlling for credit risk, interest rate risk and trading activity, there is no significant difference in the bid-ask spread of the three markets. Since the Treasury market is widely viewed as more transparent than the

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[18] By comparison, in the classic Tobit model, the failure time is normally distributed and the data is usually censored at the left. The estimates from the logistic distribution are robust since they have bounded influence functions. An influence function measures the difference in standard deviation units between estimates with and without an individual observation.

corporate and municipal bond markets, the result indicates that differences in the level of transparency need not be associated with significant differences in trading costs.

We find that the realized bid-ask falls on buys and increases on sells for corporate and municipal bonds. This suggests that, while increased volume enhances liquidity and reduces the spread, a sell event may signal adverse information about bonds and increase the spread. Consistent with this notion, the bid-ask spread falls with sell volume for Treasury bonds (where there is no issuer-specific information). Further, only unexpected volume affects the bid-ask spread in the corporate and Treasury markets.

We examine why institutions sometimes trade without dealers and show that the volume of directly negotiated trades in a bond decreases in its bid-ask spread, indicating that dealers may lower the bid-ask spread for bonds that institutions are likely to trade directly. While dealers provide liquidity for riskier bonds, they also appear reluctant to support older bonds, or bonds close to maturity. Electronic bond trading systems potentially allows buyers and sellers to interact directly. Our results suggest that, at least initially, only relatively low risk and active bonds may migrate to these systems.

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Table 1
Distribution of Bond Characteristics in the Corporate, Government and Municipal Sectors

Annual yield (in percent) is the annualized yield-to-maturity calculated on the basis of the market convention for accrued interest. Bond age is the time (in years) between a bond's issue date and the transactions date. Volume is in million dollars. The sample consists of public bonds traded by insurance companies during the period January 1995 to December 1997.

	Investment grade bonds			Below-investment grade bonds			Merrill Lynch Master Bond Index	
	No. of observations	Mean	Standard deviation	No. of observations	Mean	Standard deviation	Mean	Standard deviation
Panel A: Corporate bond market								
Annual yield	2120	7.08	1.04	362	8.84	1.94	6.78	0.28
Macaulay's Duration	2120	6.13	2.69	362	6.17	1.93	6.82	0.10
Convexity	2120	57.92	60.24	362	53.23	44.69	---	---
Time to maturity	2134	9.17	7.64	368	9.34	5.97	---	---
Bond age	2140	3.68	4.79	375	2.37	2.68	---	---
Coupon rate	2125	7.56	1.32	368	8.96	1.82	7.68	0.15
Buy volume	2140	4.23	7.44	375	5.57	8.61	---	---
Sell volume	2140	4.57	5.55	375	3.73	4.84	---	---
Panel B: Municipal bond market								
Annual yield	1200	5.41	0.84	20	6.42	1.07	5.48	0.30
Macaulay's Duration	1200	8.14	2.84	20	6.61	2.72	12.05	0.47
Convexity	1200	92.18	62.8	20	63.91	55.27	---	---
Time to maturity	1202	11.32	5.78	21	9.94	6.73	---	---
Bond age	1202	3.49	3.51	21	5.40	8.41	---	---
Coupon rate	1200	5.78	0.93	20	6.56	1.13	5.82	0.23
Buy Volume	1202	2.97	3.43	21	3.57	3.22	---	---
Sell volume	1202	3.40	3.90	21	3.24	3.06	---	---
Panel C: Government bond market								
	Treasury securities			**Agency securities**				
Annual yield	1813	6.32	5.75	73	6.91	7.47	5.88	0.35
Macaulay's Duration	1813	6.09	2.96	73	5.79	2.30	5.21	0.18
Convexity	1813	59.23	69.46	73	47.36	39.94	---	---
Time to maturity	1848	8.66	7.29	76	7.68	4.55	---	---
Bond age	1856	2.47	2.62	77	0.03	0.23	---	---
Coupon rate	1820	6.66	9.57	74	6.96	9.59	7.12	0.11
Buy Volume	1856	7.94	2.28	77	2.80	6.14	---	---
Sell volume	1856	8.65	2.40	77	3.70	5.05	---	---

Table 2
The Realized Bid-Ask Spread of Corporate, Government and Municipal Bonds

In Panel A, the daily realized bid-ask spread (per $100 par value) of a bond is the difference between its mean sell price and its mean buy price. In Panel B, the noise-adjusted bid-ask spread (per $100 par value) of a bond is the realized daily bid-ask spread multiplied by $N_i=[(1/N_{ib})+(1/N_{is})]^{-1/2}$, where, for day i, N_{ib} (N_{is}) is number of buy (sell) trades. In Panel C, the daily volume-weighted spread of a bond is the difference between its daily volume-weighted sell price and its daily volume-weighted buy price. Bond ratings are from Moody's. Bond ratings are from Moody's. The sample is public bonds traded by insurance companies from January 1995 to December 1997.

	Corporate Market				Government Market				Municipal Market			
	Number of bonds	Number of bond days	Mean bid-ask spread	Standard deviation of spread	Number of bonds	Number of bond days	Mean bid-ask spread	Standard deviation of spread	Number of bonds	Number of bond days	Mean bid-ask spread	Standard deviation of spread
Panel A: Realized bid-ask spread												
1995-1997	1789	2515	0.21	1.01	226	1933	0.11	1.73	1168	1223	0.23	0.42
1995	544	630	0.29	1.52	90	527	0.13	2.31	317	318	0.34	0.54
1996	845	1041	0.19	0.81	136	738	0.15	1.93	407	410	0.22	0.43
1997	732	844	0.17	0.70	161	668	0.05	0.82	486	495	0.16	0.31
Treasury bonds	---	---	---	---	154	1856	0.11	1.75	---	---	---	---
Agency bonds	---	---	---	---	72	77	0.24	0.94	---	---	---	---
AAA bonds	---	---	---	---	---	---	---	---	609	628	0.23	0.42
AA bonds	193	259	0.07	0.94	---	---	---	---	402	432	0.22	0.40
A bonds	754	1078	0.21	0.64	---	---	---	---	136	142	0.20	0.46
BAA bonds	527	755	0.23	1.13	---	---	---	---	---	---	---	---
Below investment-grade bonds	281	375	0.23	1.54	---	---	---	---	---	---	---	---
Below A3 bonds	---	---	---	---	---	---	---	---	21	21	0.43	0.72
Panel B: Noise-adjusted bid-ask spread												
1995-1997	1789	2515	0.16	0.76	226	1933	0.10	1.52	1168	1223	0.17	0.33
1995	544	630	0.22	1.18	90	527	0.14	2.07	317	318	0.26	0.42
1996	845	1041	0.14	0.57	136	738	0.13	1.61	407	410	0.16	0.32
1997	732	844	0.13	0.54	161	668	0.05	0.67	486	495	0.12	0.24
AA bonds	193	259	0.05	0.86	---	---	---	---	402	432	0.17	0.31
A bonds	754	1078	0.16	0.48	---	---	---	---	136	142	0.15	0.33
Below-investment grade bonds	281	375	0.19	1.16	---	---	---	---	---	---	---	---
Below A3 bonds	---	---	---	---	---	---	---	---	21	21	0.32	0.51
Panel C: Volume-weighted realized bid-ask spread												
1995-1997	1789	2515	0.21	1.00	226	1933	0.11	1.73	1168	1223	0.23	0.42
1995	544	630	0.30	1.51	90	527	0.13	2.21	317	318	0.33	0.53
1996	845	1041	0.19	0.81	136	738	0.15	1.93	407	410	0.22	0.43
1997	732	844	0.17	0.69	161	668	0.05	0.82	486	495	0.16	0.30
AA bonds	193	259	0.11	0.87	---	---	---	---	402	432	0.22	0.39
A bonds	754	1078	0.21	0.64	---	---	---	---	136	142	0.19	0.46
Below-investment grade bonds	281	375	0.23	1.54	---	---	---	---	---	---	---	---
Below A3 bonds	---	---	---	---	---	---	---	---	21	21	0.43	0.72

Table 3
Distribution of the Realized Bid-Ask Spread for Different Windows

The realized bid-ask spread (per $100 par value) of a bond is the difference between its daily mean sell price and its daily mean buy price. Bond ratings are from Moody's. The sample consists of public bonds traded by insurance companies during January 1995 to December 1997.

	Corporate market				Government market				Municipal market			
	Number of bonds	Number of bond days	Mean bid-ask spread	Standard deviation of spread	Number of bonds	Number of bond days	Mean bid-ask spread	Standard deviation of spread	Number of bonds	Number of bond days	Mean bid-ask spread	Standard deviation of spread
Panel A: Realized bid-ask spread for 2-day window												
1995-1997	2156	3297	0.21	1.08	254	2618	0.12	1.86	1271	1342	0.25	0.45
1995	699	853	0.31	0.38	106	718	0.09	2.35	373	375	0.34	0.56
1996	806	1283	0.18	0.98	76	945	0.15	2.20	433	452	0.25	0.44
1997	651	1161	0.18	0.93	72	955	0.10	0.76	465	515	0.20	0.36
AA bonds	242	358	0.13	1.11	---	---	---	---	440	481	0.26	0.46
A bonds	921	1427	0.23	0.72	---	---	---	---	145	152	0.23	0.44
Below-investment grade bonds	340	490	0.17	1.74	---	---	---	---	---	---	---	---
Industrial/service bonds	955	1544	0.19	1.21	---	---	---	---	---	---	---	---
Banking/finance bonds	704	1059	0.18	0.69	---	---	---	---	---	---	---	---
Utility bonds	303	413	0.32	0.97	---	---	---	---	260	279	0.25	0.38
Health care bonds	---	---	---	---	---	---	---	---	31	35	0.56	0.84
Panel B: Realized bid-ask spread for 3-day window												
1995-1997	2449	3954	0.22	1.24	279	3087	0.11	1.66	1429	1518	0.28	0.52
1995	840	1056	0.28	1.56	117	861	0.12	2.18	421	426	0.37	0.62
1996	894	1509	0.22	1.03	88	1089	0.10	1.84	504	531	0.28	0.53
1997	715	1389	0.18	1.18	74	1137	0.12	0.80	504	561	0.21	0.40
AA bonds	266	435	0.22	1.01	---	---	---	---	501	550	0.28	0.52
A bonds	1037	1707	0.22	0.97	---	---	---	---	161	170	0.27	0.54
Below-investment grade bonds	388	584	0.17	1.63	---	---	---	---	---	---	---	---
Industrial/service bonds	1085	1849	0.20	1.42	---	---	---	---	---	---	---	---
Banking/finance bonds	781	1262	0.19	0.76	---	---	---	---	---	---	---	---
Utility bonds	349	490	0.35	0.96	---	---	---	---	298	327	0.26	0.49
Health care bonds	---	---	---	---	---	---	---	---	34	38	0.47	0.66
Panel C: Realized bid-ask spread for 5-day window												
1995-1997	2882	5112	0.27	1.45	313	3472	0.12	1.69	1804	1930	0.32	0.56
1995	1025	1368	0.37	2.13	135	963	0.14	2.09	568	576	0.40	0.69
1996	1026	1929	0.24	1.12	90	1151	0.10	2.02	612	655	0.32	0.53
1997	831	1815	0.23	1.10	88	1358	0.11	0.86	624	699	0.25	0.43
AA bonds	320	566	0.28	2.24	---	---	---	---	629	693	0.30	0.55
A bonds	1205	2192	0.26	0.95	---	---	---	---	210	222	0.32	0.65
Below-investment grade bonds	470	756	0.23	1.75	---	---	---	---	---	---	---	---
Industrial/service bonds	1264	2384	0.25	1.76	---	---	---	---	---	---	---	---
Banking/finance bonds	907	1617	0.23	0.89	---	---	---	---	---	---	---	---
Utility bonds	436	659	0.39	1.02	---	---	---	---	360	397	0.30	0.55
Health care bonds	---	---	---	---	---	---	---	---	49	53	0.64	0.87

Table 4
Determinants of Volume and the Bid-Ask Spread for Corporate Bonds

In Panel A, buy and sell volumes are explained by an ARMA(2,1) model. AR1 and AR2 are the first and second lags of the autoregressive factors. MA1 is the first lag of the moving average process. Optimal lags are determined by the Akaike-Schwarz criteria. Volume is in million dollars. The estimation method is maximum likelihood (MLE). *T* values are in parenthesis. In Panel B, the daily realized bid-ask spread (per $100 par value) for a bond is regressed on the log of buy and sell volume in model (1) and the expected and unexpected volumes in model (2). Expected volume is the fitted value from the ARMA(p,q) model. Other explanatory variables are time to maturity and its square, bond age, and dummy variables for Moody's credit ratings, the issuer industry, 1997 and macroeconomic announcement days. *Bank/fin* is the banking and finance sector dummy; *Ind/Ser* is the industrial/service sector dummy. The estimation method is the Generalized Method of Moments (GMM). The *p*-values are in parentheses. Estimates significant at the 0.10 level or higher are in bold. The sample consists of publicly traded bonds by insurance companies during the period January 1995 to December 1997.

Panel A: Determinants of Volume in the Corporate bond market

Dependent variable	Constant	MA1	AR1	AR2
Log buy volume	**14.49**	**0.84**	**0.98**	**-0.05**
	(261.48)	**(20.47)**	**(21.07)**	**(-2.12)**
Log sell volume	**14.61**	**0.77**	**0.89**	---
	(264.31)	**(22.54)**	**(36.53)**	

Panel B: Determinants of the Bid-Ask Spread in the Corporate bond market

Dependent variable	Constant	Time to maturity (years)	Square of time to maturity	Bond age (years)	Log buy volume	Log sell volume	Expected log buy volume	Unexpected log buy volume	Expected log sell volume	Unexpected log sell volume	Macro announcement dummy
(1) Bid-ask spread	**0.65**	**0.03**	**-0.0003**	**0.11**	**-0.09**	**0.05**	----	----	----	----	0.02
	(0.0159)	**(0.0001)**	**(0.0013)**	**(0.0113)**	**(0.0001)**	**(0.0279)**					(0.7270)
(2) Bid-ask spread	0.25	**0.03**	**-0.0003**	**0.11**	----	----	-0.11	**-0.09**	0.10	**0.05**	0.00
	(0.7960)	**(0.0001)**	**(0.0011)**	**(0.0089)**			(0.2048)	**(0.0001)**	(0.2551)	**(0.0432)**	(0.7385)
	1997 dummy	Bank/fin dummy	Ind/Ser dummy	Utility dummy	AAA/AA dummy	A1 dummy	A2 dummy	A3 dummy	BAA1 dummy	BAA2 dummy	BAA3 dummy
(1)	-0.04	-0.07	-0.10	-0.06	**-0.24**	-0.11	-0.08	-0.10	-0.05	-0.12	0.02
	(0.2443)	(0.6113)	(0.5277)	(0.7041)	**(0.0247)**	(0.2728)	(0.3548)	(0.2944)	(0.5984)	(0.2398)	(0.8787)
(2)	-0.04	-0.07	-0.10	-0.06	**-0.24**	-0.11	-0.08	-0.10	-0.05	-0.12	0.02
	(0.2602)	(0.6158)	(0.5279)	(0.7006)	**(0.0238)**	(0.2670)	(0.3455)	(0.2964)	(0.5912)	(0.2348)	(0.8915)
(1) Number of observations	2397	Adjusted R-square	2.57								
(2) Number of observations	2397	Adjusted R-square	2.50								

Table 5

Determinants of Volume and the Bid-Ask Spread for Municipal Bonds

In Panel A, buy and sell volumes are explained by an ARMA(2,1) model. AR1 and AR2 are the first and second lags of the autoregressive factors. MA1 is the first lag of the moving average process. Optimal lags are determined by the Akaike-Schwarz criteria. Volume is in million dollars. The estimation method is maximum likelihood (MLE). *T* values are in parenthesis. In Panel B, the daily realized bid-ask spread (per $100 par value) for a bond is regressed on the log of buy and sell volume in model (1) and the expected and unexpected volumes in model (2). Expected volume is the fitted value from the ARMA(p,q) model. Other explanatory variables are the time to maturity, bond age, and dummy variables for Moody's credit ratings, the issuer industry, 1997 and macroeconomic announcement days. The estimation method is the Generalized Method of Moments (GMM). The *p*-values are in parentheses. Estimates significant at the 0.10 level or higher are in bold. The sample consists of publicly traded bonds by insurance companies during the period January 1995 to December 1997.

Panel A: Determinants of Volume in the Municipal bond market

Dependent variable	Constant	MA1	AR1	AR2
Log buy volume	**14.33**	**0.92**	**1.11**	**-0.13**
	(131.26)	**(37.76)**	**(28.72)**	**(-3.95)**
Log sell volume	**14.46**	**0.93**	**1.15**	**-0.17**
	(113.12)	**(41.77)**	**(30.95)**	**(-5.20)**

Panel B: Determinants of the Bid-Ask Spread in the Municipal bond market

Dependent variable	Constant	Time to maturity (years)	Bond age (years)	Log buy volume	Log sell volume	Expected log buy volume	Unexpected log buy volume	Expected log sell volume	Unexpected log sell volume	1997 transaction dummy	Macro announcement dummy
(1) Bid-ask spread	**0.41**	**0.02**	-0.00	**-0.08**	**0.06**	---	---	---	---	**-0.11**	0.00
	(0.0074)	**(0.0003)**	(0.2845)	**(0.0257)**	**(0.0755)**					**(0.0001)**	(0.9490)
(2) Bid-ask spread	0.21	**0.02**	-0.00	---	---	**-0.19**	**-0.08**	**0.18**	0.06	**-0.11**	0.00
	(0.6476)	**(0.0004)**	(0.2965)			**(0.0485)**	**(0.0322)**	**(0.0234)**	(0.1161)	**(0.0001)**	(0.9598)

	Utility dummy	Health dummy	AA dummy	A1 dummy	A2 dummy	A3 dummy	Below A3 dummy
(1)	-0.03	0.14	-0.01	-0.07	-0.02	0.12	**0.28**
	(0.2011)	(0.2992)	(0.6964)	(0.1310)	(0.7351)	(0.4102)	**(0.0566)**
(2)	-0.03	0.14	-0.01	-0.07	-0.03	0.12	**0.28**
	(0.2202)	(0.2869)	(0.7135)	(0.1236)	(0.6989)	(0.4206)	**(0.0652)**

(1) Number of observations 1219 Adjusted R-square 4.16
(2) Number of observations 1219 Adjusted R-square 4.25

Table 6
Determinants of Volume and the Bid-Ask Spread for Treasury Bonds

In Panel A, buy and sell volumes are explained by an ARMA(1,1) model. AR1 and AR2 are the first and second lags of the autoregressive factors. MA1 is the first lag of the moving average process. Optimal lags are determined by the Akaike-Schwarz criteria. Volume is in million dollars. The estimation method is maximum likelihood (MLE). *T* values are in parenthesis. In Panel B, the daily realized bid-ask spread (per $100 par value) for a bond is regressed on the log of buy and sell volume in model (1) and the expected and unexpected volumes in model (2). Expected volume is the fitted value from the ARMA(p,q) model. Other explanatory variables are the time to maturity, bond age, and dummy variables for 1997 and macroeconomic announcement days. The estimation method is the Generalized Method of Moments (GMM). The *p*-values are in parentheses. Estimates significant at the 0.10 level or higher are in bold. The sample consists of publicly traded bonds by insurance companies during the period January 1995 to December 1997.

Panel A: Determinants of Volume in the Treasury bond market

Dependent variable	Constant	MA1	AR1	AR2
Log buy volume	**14.28**	**0.94**	**0.97**	---
	(151.82)	**(41.98)**	**(63.54)**	
Log sell volume	**14.56**	**0.97**	**1.04**	**-0.05**
	(181.02)	**(54.55)**	**(35.20)**	**(-1.99)**

Panel B: Determinants of the Bid-Ask Spread in the Treasury bond market

Dependent variable	Constant	Time to maturity (years)	Bond age (years)	Log buy volume	Log sell volume	Expected log buy volume	Unexpected log buy volume	Expected log sell volume	Unexpected log sell volume	1997 transaction dummy	Macro announcement dummy
(1) Bid-ask spread	**1.57**	0.01	0.00	-0.01	**-0.10**	---	---	---	---	-0.10	**0.17**
	(0.0020)	(0.3594)	(0.9558)	(0.8520)	**(0.0168)**					(0.1038)	**(0.0784)**
(2) Bid-ask spread	2.94	0.01	0.00	---	---	-0.08	-0.00	-0.12	**-0.10**	**-0.11**	**0.17**
	(0.3539)	(0.3617)	(0.9605)			(0.5211)	(0.9026)	(0.5195)	**(0.0187)**	**(0.0935)**	**(0.0763)**

(1) Number of observations 1848 Adjusted R-square 0.96
(2) Number of observations 1848 Adjusted R-square 0.87

Table 7

Comparison of the Bid-Ask Spread for Corporate, Treasury and Municipal Bonds

There are two regressions. For regression (1), the daily realized bid-ask spread (per $100 par value) for a bond is regressed *only* on bond characteristics that are significant in *all* markets being compared. For regression (2), in panels A, B and C, the bid-ask spread is also regressed on credit rating dummies and the time to maturity. In Panel D, the bid-ask spread is regressed on volume, credit rating and time to maturity. *N* is the number of observations. R^2 is the adjusted R-square. The estimation method is the Generalized Method of Moments (GMM). *P*-values are in parentheses. Coefficient estimates significant at the 0.10 level or higher are in bold. The sample is public bonds traded by insurance companies from January 1995 to December 1997.

Dependent Variable	Municipal market dummy	Corporate market dummy	Unexpected log sell volume	Expected log sell volume	Time to maturity (years)	AA dummy	A1 dummy	A2 dummy	A3 dummy	BAA1 dummy	BAA2 dummy	BAA3 dummy	Below BAA3 dummy
Panel A: All markets													
(1) Bid-ask spread	**0.12**	**0.11**	**-0.04**	**0.01**	---	---	---	---	---	---	---	---	---
N=5523 R^2=0.37	**(0.0073)**	**(0.0139)**	**(0.0499)**	**(0.0095)**									
(2) Bid-ask spread	0.09	0.05	**-0.05**	-0.00	**0.01**	-0.04	0.05	0.05	0.06	**0.09**	0.04	0.15	0.09
N=5509 R^2=0.80	(0.1133)	(0.4690)	**(0.0276)**	(0.8763)	**(0.0058)**	(0.1912)	(0.3251)	(0.3227)	(0.3139)	**(0.0957)**	(0.5681)	(0.2107)	(0.3544)
Panel B: Corporate and Treasury markets													
(1) Bid-ask spread	---	**0.12**	**-0.05**	**0.01**	---	---	---	---	---	---	---	---	---
N=4301 R^2=0.42		**(0.0103)**	**(0.0506)**	**(0.0118)**									
(2) Bid-ask spread	---	0.17	**-0.06**	-0.00	**0.01**	-0.21	-0.04	-0.06	-0.06	-0.02	-0.09	0.06	-0.03
N=4287 R^2=0.83		(0.2380)	**(0.0330)**	(0.7876)	**(0.0144)**	(0.1275)	(0.7610)	(0.6272)	(0.6343)	(0.8583)	(0.5044)	(0.7193)	(0.8550)
Panel C: Municipal and Treasury markets													
(1) Bid-ask spread	**0.12**	---	**-0.07**	**0.01**	---	---	---	---	---	---	---	---	---
N=3075 R^2=0.82	**(0.0076)**		**(0.0198)**	**(0.0107)**									
(2) Bid-ask spread	0.09	---	**-0.08**	0.00	0.01	0.01	-0.06	-0.02	0.11	---	---	---	0.22
N=3070 R^2=0.88	(0.1988)		**(0.0196)**	(0.5215)	(0.2754)	(0.6885)	(0.2265)	(0.7641)	(0.4194)				(0.1189)
Panel D: Corporate and Municipal markets													
Bid-ask spread	0.06	---	**0.05**	0.02	**0.01**	-0.04	0.03	0.06	0.06	**0.09**	0.06	0.10	0.12
N=3661 R^2=2.02	(0.1647)		**(0.0168)**	(0.8202)	**(0.0001)**	(0.1095)	(0.4946)	(0.1890)	(0.2636)	**(0.0797)**	(0.3946)	(0.3376)	(0.2015)
			Unexpected log buy volume	Expected log buy volume									
			-0.09	-0.02									
			(0.0001)	(0.8395)									

Table 8
Characteristics of Bonds Traded without Dealers, by Large Dealers and by Small Dealers

Annual yield (in percent) is the annualized yield-to-maturity calculated on the basis of the market convention for accrued interest. Bond age is the time (in years) between a bond's issue date and the transactions date. Volume is in million dollars. For each bond, dealers are ranked according to their share in the value traded over the sample. Dealers with cumulative market share of at least (less than) 50 percent are designated large (small) dealers. For the Treasury market, large (small) dealers are those dealers designated (not designated) as primary dealers for Treasury bonds. Direct trades are transactions without involving dealers. The sample consists of public bonds traded by insurance companies during the period January 1995 to December 1997.

	Large dealers		Small dealers		Direct trades	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Panel A: Corporate market						
Time to maturity	9.69	7.60	10.02	8.14	7.44	5.77
Bond age	3.58	4.74	3.30	3.61	5.05	5.96
Macaulay's Duration	6.28	2.75	6.44	2.64	5.41	2.26
Convexity	61.49	61.88	63.31	60.76	43.05	47.04
Buy volume	6.15	6.25	2.58	3.62	2.69	2.11
Sell volume	7.21	6.88	3.06	3.33	2.68	2.08
Coupon rate	7.77	1.45	7.83	1.42	8.10	1.32
Annual yield	7.36	1.14	7.42	1.40	7.20	1.32
Yield spread	2.06	1.10	2.11	1.38	2.06	1.34
% investment-grade bonds	84.76	---	84.28	---	92.21	---
Panel B: Treasury market						
Time to maturity	8.52	6.93	7.79	6.13	6.97	6.45
Bond age	2.34	2.59	2.48	2.79	3.06	4.45
Macaulay's Duration	6.09	2.84	5.72	2.62	4.94	3.28
Convexity	57.90	66.17	49.64	56.34	44.84	52.43
Buy volume	4.18	10.85	4.50	13.37	1.97	1.99
Sell volume	6.89	19.45	4.04	9.43	1.97	1.99
Coupon rate	6.70	0.97	6.72	0.96	7.35	1.32
Annual yield	6.31	0.56	6.39	0.65	7.06	1.15
Panel C: Municipal market						
Time to maturity	11.49	5.72	11.24	5.84	9.39	6.63
Bond age	3.40	3.36	3.28	3.26	7.06	7.28
Macaulay's Duration	8.22	2.83	8.08	2.80	6.84	3.62
Convexity	93.89	61.68	90.61	63.61	74.27	69.88
Buy volume	3.01	3.73	3.01	3.23	1.26	1.30
Sell volume	3.43	4.10	3.54	3.93	1.26	1.30
Yield spread	0.17	0.84	0.14	0.90	0.13	0.75
Coupon rate	5.81	0.98	5.78	0.91	5.56	0.93
Annual yield	5.46	0.83	5.40	0.90	5.22	0.72
% investment-grade bonds	98.84	---	98.14	---	93.75	---

Table 9

The Bid-ask Spread for Large and Small Dealers in Corporate, Municipal and Treasury Bonds

For each bond, dealers are ranked according to their share in the value traded over the sample. Dealers with cumulative market share of at least (less than) 50 percent are large (small) dealers. For the Treasury market, large dealers are primary dealers for Treasury bond auctions. A dealer's daily realized bid-ask spread (per $100 par value) for a bond is the difference between the dealer's daily mean sell price and daily mean buy price in that bond. All directly negotiated trades are excluded from the sample. The Kruskal-Wallis test indicates whether the distribution of the bid-ask spread is different between large and small institutions. Differences significant at the 10 percent level or lower are in bold. The sample is public bonds traded by insurance companies during January 1995 to December 1997.

Panel A: Bid-ask spread for large and small dealers: All bonds

	Large dealer trades			Small dealer trades		
	Number of bond days	Mean bid-ask spread	Standard deviation of spread	Number of bond days	Mean bid-ask spread	Standard deviation of spread
Corporate market	813	**0.22**	1.19	628	**0.23**	0.85
Kruskal-Wallis test	**χ^2=2.13**	**p=0.0336**				
Treasury market	560	0.08	1.23	452	0.05	1.22
Kruskal-Wallis test	χ^2=1.33	p=0.2493				
Municipal market	506	0.21	0.44	491	0.21	0.40
Kruskal-Wallis test	χ^2=0.34	p=0.7333				

Panel B: Common and distinct bonds traded by large and small dealers

	Number of common bonds	Number of distinct bonds	Percent of common bonds in total
Corporate market	111	1078	9.34
Treasury market	90	98	47.07
Municipal market	254	193	58.80

Panel C: Bid-ask spread for large and small dealers: Common bonds

	Large dealer trades			Small dealer trades		
	Number of bond days	Mean bid-ask spread	Standard deviation of spread	Number of bond days	Mean bid-ask spread	Standard deviation of spread
Corporate market	123	0.07	0.85	137	0.20	0.86
Kruskal-Wallis test	χ^2=0.26	p=0.7975				
Treasury market	503	0.08	1.26	375	0.08	1.01
Kruskal-Wallis test	χ^2=1.20	p=0.2732				
Municipal market	326	0.21	0.43	474	0.22	0.40
Kruskal-Wallis test	χ^2=0.15	p=0.8776				

Table 10
Why do Institutions Trade Without Dealers?

The dependent variable is an institution's daily share of volume traded without a dealer in a bond. The explanatory variables are the bid-ask spread, volume, bond characteristics, and dummy variables for large institutions and Moody's credit ratings. Institutions with cumulative market share of at least (less than) 50 percent in a bond are large (small) institutions. The estimation method is the Generalized Method of Moments (GMM). *P*-values are in parentheses. Coefficient estimates significant at the 0.10 level or higher are in bold. The sample consists of public bonds traded by insurance companies from January 1995 to December 1997.

Independent variables	Corporate market	Treasury market	Municipal market
Intercept	**-1.58**	**-1.55**	**1.20**
	(0.0001)	**(0.0613)**	**(0.0005)**
Time to maturity (years)	**-0.003**	0.00	0.00
	(0.0004)	(0.9839)	(0.2551)
Bond age (years)	**0.01**	0.00	**0.01**
	(0.0001)	(0.9788)	**(0.0012)**
Expected log buy volume	**0.23**	**0.06**	0.02
	(0.0001)	**(0.077)**	(0.5201)
Unexpected log buy volume	**0.02**	-0.01	0.01
	(0.0001)	(0.1186)	(0.5076)
Expected log sell volume	**-0.11**	0.05	**-0.10**
	(0.0001)	(0.1363)	**(0.0028)**
Unexpected log sell volume	**-0.01**	0.00	-0.01
	(0.0375)	(0.2681)	(0.2396)
Large institutions dummy	**-0.19**	**-0.16**	**0.22**
	(0.0001)	**(0.0396)**	**(0.0001)**
Bid-As Spread	**-0.01**	0.00	**-0.07**
	(0.0734)	(0.371)	**(0.0001)**
AA and AAA dummy	-0.01	----	---
	(0.7167)		
AA dummy	----	---	0.01
			(0.5879)
A1 dummy	0.01	----	-0.04
	(0.6304)		(0.1726)
A2 dummy	0.04	----	-0.01
	(0.1134)		(0.8866)
A3 dummy	0.02	----	0.06
	(0.3820)		(0.4456)
BAA1 dummy	0.02	----	---
	(0.5637)		
BAA2 dummy	0.03	----	---
	(0.3452)		
Baa3 dummy	0.02	----	---
	(0.5520)		
Below A3 dummy	----	----	0.11
			(0.3039)
Number of observations	1637	1025	870
Adjusted R-square	14.45	2.21	22.18

Table A1 of Appendix

Seemingly Unrelated Regressions for Corporate, Treasury and Municipal Bond Transactions

We report results from estimating a Seemingly Unrelated Regression model (SURM) of corporate, Treasury and municipal bond bid-ask spreads regressed on bond characteristics, volume, credit score, and dummy variables for macroeconomic announcement days and the year 1997. The credit score is constructed by assigning numbers to Moody's credit ratings, with higher scores for higher ratings. The *p*-values are in parentheses. Coefficient estimates significant at the 10 percent level or lower are in bold. The chi-square statistic is a test for the equality of the intercept term across all three markets. The sample consists of public bonds traded by insurance companies during the period January 1995 to December 1997.

Independent Variables	Corporate bonds	Treasury bonds	Municipal bonds
Intercept	-1.94	1.07	**0.73**
	(0.2665)	(0.1520)	**(0.0927)**
Time to maturity (years)	**0.05**	0.02	**0.02**
	(0.0025)	(0.2135)	**(0.0210)**
Bond age (years)	**0.08**	-0.03	0.01
	(0.0336)	(0.3520)	(0.3672)
Log buy volume	0.04	-0.04	**-0.15**
	(0.6559)	(0.2494)	**(0.0003)**
Log sell volume	0.11	-0.02	**0.08**
	(0.2892)	(0.6310)	**(0.0553)**
Macroeconomic announcement day	----	0.05	----
		(0.6945)	
Credit score	-0.05	----	0.02
	(0.1729)		(0.1828)
1997 transaction dummy	-0.18	-0.05	-0.08
	(0.3652)	(0.6821)	(0.1167)
Number of observations	313	313	313
Adjusted R-square	4.15	-0.66	6.11
Test for equality of intercepts	Chi-square = 2.54	p = 0.28	

Table A2 of Appendix
Is the Bid-Ask Spread Different for the Large and Small Dealers?

The dependent variable is a dealer's daily realized bid-ask spread (per $100 par value) for a bond. The explanatory variables are volume, bond characteristics, and dummy variables for large dealers, directly negotiated trades, Moody's credit ratings, the year 1997, and macroeconomic announcement days. The estimation method is the Generalized Method of Moments (GMM). *P*-values are in parentheses. Coefficient estimates significant at the 10 percent level or lower are in bold. The sample consists of public bonds traded by insurance companies from January 1995 to December 1997.

Independent variables	Corporate markets	Treasury market	Municipal market
Intercept	0.08	0.27	0.16
	(0.9265)	(0.9506)	(0.6946)
Time to maturity (years)	**0.01**	-0.01	**0.01**
	(0.0003)	(0.4357)	**(0.0122)**
Bond age (years)	**0.01**	-0.01	0.00
	(0.0259)	(0.7579)	(0.8804)
Expected log buy volume	0.17	0.14	**-0.18**
	(0.2980)	(0.4092)	**(0.0026)**
Unexpected log buy volume	**-0.05**	-0.03	-0.05
	(0.0308)	(0.1626)	(0.1889)
Expected log sell volume	-0.16	-0.15	**0.18**
	(0.2974)	(0.6251)	**(0.0015)**
Unexpected log sell volume	**0.05**	**-0.07**	0.03
	(0.0124)	**(0.0618)**	(0.4510)
Macroeconomic announcement	-0.03	-0.03	0.02
day dummy	(0.6850)	(0.6948)	(0.6715)
Large dealer dummy	0.00	0.10	-0.01
	(0.9912)	(0.4953)	(0.7476)
Direct trade dummy	**-0.24**	-0.05	**-0.20**
	(0.0001)	(0.8366)	**(0.0001)**
AA and AAA dummy	-0.11	----	---
	(0.3213)		
AA dummy	---	---	-0.01
			(0.7035)
A1 dummy	0.02	----	**-0.08**
	(0.8282)		**(0.0914)**
A2 dummy	0.05	----	0.02
	(0.6098)		(0.8048)
A3 dummy	0.09	----	0.18
	(0.3214)		(0.2930)
BAA1 dummy	0.09	----	---
	(0.3057)		
BAA2 dummy	0.02	----	---
	(0.8551)		
Baa3 dummy	0.19	----	---
	(0.2480)		
Below A3 dummy	----	----	0.29
			(0.1179)
1997 Transaction Dummy	-0.06	-0.02	**-0.09**
	(0.1164)	(0.7850)	**(0.0010)**
Number of observations	1776	993	1050
Adjusted R-square	2.51	0.67	5.29

Table A3 of Appendix
The Bid-Ask Spread for Large and Small Institutions in Corporate, Municipal and Treasury Bonds

We calculate the bid-ask spread per institution per bond day by subtracting its mean daily sell price from its mean daily buy price for each institution. Institutions are ranked according to their share in the value traded over the sample. Institutions with cumulative market share of at least (less than) 50 percent are designated large (small) institutions. In panel C, the bid-ask spread is calculated for bonds traded in common by large and small institutions. All directly negotiated trades are excluded from the sample. The Kruskal-Wallis test indicates whether the distribution of the bid-ask spread is different between large and small institutions. Differences significant at the 10 percent level or lower are in bold. The sample consists of publicly traded bonds by insurance companies during the period January 1995 to December 1997.

Panel A: Bid-ask spread for large and small institutions: All bonds

	Large institution trades			**Small institution trades**		
	Number of bond days	Mean bid-ask spread	Standard deviation of spread	Number of bond days	Mean bid-ask spread	Standard deviation of spread
Corporate market	399	**0.13**	0.85	984	**0.20**	1.23
Kruskal-Wallis test	χ^2**=2.98**	**p=0.0843**				
Treasury market	205	0.04	1.35	863	0.09	1.37
Kruskal-Wallis test	χ^2=1.35	p=0.1787				
Municipal market	120	**0.30**	0.68	699	**0.17**	0.39
Kruskal-Wallis test	χ^2**=38.57**	**p=0.0001**				

Panel B: Common and distinct bond traded by large and small institutions

	Number of common bonds	Number of distinct bonds	Percent of common bonds in total
Corporate market	56	1049	5.07
Treasury market	72	119	37.70
Municipal market	3	774	0.39

Panel C: Bid-ask spread for large and small institutions: Common bonds

	Large institution trades			**Small institution trades**		
	Number of bond days	Mean bid-ask spread	Standard deviation of spread	Number of bond days	Mean bid-ask spread	Standard deviation of spread
Corporate market	61	0.10	0.77	84	0.22	1.29
Kruskal-Wallis test	χ^2=2.47	p=0.1160				
Treasury market	191	0.02	1.37	630	0.09	1.45
Kruskal-Wallis test	χ^2=1.11	p=0.2918				
Municipal market	3	0.19	0.87	3	0.14	0.16
Kruskal-Wallis test	----	-----				

Table A4 of Appendix
Is the Bid-Ask Spread Different for the Large and Small Institutions?

The dependent variable is an institution's daily realized bid-ask spread (per $100 par value) for a bond. The explanatory variables are volume, bond characteristics, and dummy variables for large dealers, directly negotiated trades, Moody's credit ratings, the year 1997, and macroeconomic announcement days. The estimation method is the Generalized Method of Moments (GMM). *P*-values are in parentheses. Coefficient estimates significant at the 10 percent level or lower are in bold. The sample consists of public bonds traded by insurance companies from January 1995 to December 1997.

Independent variables	Corporate markets	Treasury market	Municipal market
Intercept	0.53	0.41	0.12
	(0.7217)	(0.9399)	(0.7855)
Time to maturity (years)	**0.01**	-0.01	0.01
	(0.0033)	(0.5294)	(0.1108)
Bond age (years)	**0.02**	-0.01	-0.00
	(0.0296)	(0.5320)	(0.7065)
Expected log buy volume	0.01	0.07	-0.13
	(0.8920)	(0.6724)	(0.1409)
Unexpected log buy volume	-0.04	-0.04	-0.02
	(0.3134)	(0.2055)	(0.6375)
Expected log sell volume	-0.03	-0.09	**0.13**
	(0.8467)	(0.8216)	**(0.0992)**
Unexpected log sell volume	0.05	**-0.05**	-0.01
	(0.1108)	**(0.0817)**	(0.8833)
Macroeconomic announcement day dummy	-0.10	0.07	0.03
	(0.1571)	(0.5133)	(0.4601)
Large dealer dummy	-0.07	0.07	0.05
	(0.4551)	(0.9257)	(0.4232)
Direct trade dummy	**-0.18**	-0.07	**-0.21**
	(0.0023)	(0.4527)	**(0.0001)**
AA and AAA dummy	-0.23	----	---
	(0.1238)		
AA dummy	---	---	-0.01
			(0.8498)
A1 dummy	-0.08	----	**0.11**
	(0.5807)		**(0.0743)**
A2 dummy	-0.06	----	0.06
	(0.6453)		(0.5541)
[illegible]nmy	-0.07	----	0.44
	(0.6105)		(0.1548)
[illegible] dummy	-0.05	----	---
	(0.7305)		
B[illegible]2 dummy	-0.11	----	---
	(0.4422)		
Baa3 dummy	-0.12	----	---
	(0.5626)		
Below A3 dummy	----	----	**0.35**
			(0.0806)
1997 Transaction Dummy	-0.05	-0.01	**-0.09**
	(0.3519)	(0.9303)	**(0.0067)**
Number of observations	1637	1025	870
Adjusted R-square	1.80	0.34	5.29

Table A5 of Appendix
Censored Regression Results for Direct Trades

We estimate an accelerated failure time model where the dependent variable is an institution's daily share of volume traded without a dealer in a bond. The shares are censored at zero and one. The failure time is assumed to be a logistic distribution. The explanatory variables are the bid-ask spread, volume, bond characteristics, and dummy variables for large institutions and Moody's credit ratings. Institutions with cumulative market share of at least (less than) 50 percent in a bond are designated large (small) institutions. *P*-values are in parentheses. Coefficient estimates significant at the 0.10 level or higher are in bold. The sample consists of public bonds traded by insurance companies from January 1995 to December 1997.

Independent variables	Corporate market	Treasury market	Municipal market
Intercept	**-4.90**	-1.29	5.90
	(0.0001)	(0.3771)	(0.1430)
Time to maturity (years)	**-0.04**	-0.01	**-0.35**
	(0.0009)	(0.5921)	**(0.0123)**
Bond age (years)	**0.06**	-0.01	**0.22**
	(0.0001)	(0.8273)	**(0.0013)**
Log buy volume	**0.41**	-0.06	0.09
	(0.0001)	(0.4388)	(0.8425)
Log sell volume	**-0.17**	-0.02	**-0.91**
	(0.0187)	(0.7721)	**(0.0532)**
Large institutions dummy	**-2.95**	-0.75	**4.74**
	(0.0001)	(0.1507)	**(0.0002)**
Bid-As Spread	**-0.25**	-0.02	**-3.39**
	(0.0035)	(0.8309)	**(0.0013)**
AA and AAA dummy	0.04	---	---
	(0.8921)		
AA dummy	----	---	0.00
			(0.9956)
A1 dummy	0.28	----	-1.51
	(0.3413)		(0.2797)
A2 dummy	**0.58**	----	-0.81
	(0.0308)		(0.7086)
A3 dummy	0.40	----	3.14
	(0.1387)		(0.2179)
BAA1 dummy	0.43	----	---
	(0.1512)		
BAA2 dummy	**0.58**	----	---
	(0.0494)		
Baa3 dummy	0.30	----	---
	(0.3574)		
Below A3 dummy	----	----	1.96
			(0.1276)
Number of observations	1637	1025	873

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