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The Determinants of Liquidity in U.S. Corporate, Municipal and Treasury Bond Markets

by

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Abstract

We examine the determinants of the realized bid-ask spread in the U.S. corporate, municipal and Treasury bond markets for the period 1995 to 1997, based on newly available transactions data. We find that the bid-ask spread is negatively related to a bond's trading activity and positively related to its risk. In the corporate and municipal markets, the bid-ask spread increases in the remaining time to maturity and the credit risk. For corporate bonds, the bid-ask spread is concave in the time to maturity and increases in the age of the bond. In addition, the bid-ask spread is negatively related to the buy volume and positively related to the sell volume for corporate and municipal bonds, suggesting that the bond market may view sales as signals of adverse information about the bond. Consistent with this interpretation, the bid-ask spread is negatively related to the sell volume in the Treasury bond market. Further, volume is partly predictable, since only *surprises* in volume affect the bid-ask spread in the corporate and Treasury markets. We find that the bid-ask spread is not significantly different between the three markets, between large or primary market dealers and smaller dealers, and between large and small institutions. 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.

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. 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 Bloomberg; alternatively dealers may broadcast indicative quotes for bonds in their inventory (Schultz (2000)). The Securities and Exchange Commission (SEC) has proposed rules to enhance the transparency of the corporate and municipal bond markets. Electronic trading systems are being planned to reduce the costs of trading corporate and municipal bonds.

Evidence from equity markets suggests that dealers may not provide competitive pricing for customer trades, compared to auction markets (Huang and Stoll (1996), Jones and Lipson (1999), and Porter and Weaver (1998)).[2] Although the U.S. bond market dwarfs the equity market in terms of the dollar volume of trading, similar evidence is lacking for the bond markets due to unavailability, until recently, of transactions data. In the current paper, we use newly available data of insurance company transactions in the secondary bond markets to provide estimates of liquidity and its determinants in the U.S. corporate, municipal and Treasury bond markets for 1995 to 1997. These three bond markets constitute about two-thirds of the average daily trading volume in the U.S. debt markets (Bond Market Association (BMA), 1999) and they

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[1] The total value of bonds outstanding was over $14 trillion in 1999 (Bond Market Association estimates). While the New York Stock Exchange (NYSE) equity trading amounted to $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] Huang and Stoll (1996) find that execution costs are about twice as large on the NASDAQ dealer markets, compared to a matching sample of NYSE stocks. Jones and Lipson (1999) show that quoted prices adjust more slowly to information in the order flow on NASDAQ as compared to the NYSE and AMEX. Finally, Porter and Weaver (1998) document inadequate post-trade transparency on NASDAQ.

differ with respect to credit risk, secondary market trading activity and transparency.[3] To provide a relative measure of the efficiency of dealer pricing in these markets, we compare trading costs across the three markets, after controlling for interest rate risk, credit risk, trading activity and issuer-specific characteristics. We compare trading costs of large and small institutions, and of large dealers (primary market dealers in the Treasury market) and small dealers. Finally, we examine why institutions sometimes trade without dealers.

Our measure of trading costs is the realized bid-ask spread, defined as the difference between the mean daily buy price and the mean daily sell price for a bond. We find that the mean bid-ask spread per $100 par value is the highest in the municipal bond market at 23 cents, followed by the corporate bond market at about 21 cents and the Treasury bond market at 11 cents. The spread is generally higher for bonds with lower Moody's credit ratings, and lower in 1997 than in the earlier years.

Next, we study the determinants of the realized bid-ask spread in the corporate, municipal and Treasury bond markets. In the corporate and municipal markets, we find that the bond's bid-ask spread increases in the remaining time to maturity and the credit risk. For corporate bonds, the bid-ask spread is concave in the time to maturity and increases in the age of the bond, an indication that younger bonds may trade more actively. In addition, the bid-ask spread is negatively related to the buy volume and positively related to the sell volume for corporate and municipal bonds. This is in contrast to equity institutional trades, where buys have larger price

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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 the proliferation of innovative bond issues with uncertain legal bondholder rights. In terms of trading activity, the secondary market in U.S. Treasuries is highly liquid, with large trading volumes and narrow bid-ask spreads (Fleming and Sarkar, 1999). Corporate bonds tend to be relatively active for the first two years after issuance. The municipal market is characterized by a very large number of individual bonds, many of which may be rarely traded. In a recent study, the SEC concluded that the Treasury market is the most transparent and the corporate market the least, while transparency is improving in the municipal market.

impact than sales (Chan and Lakonishok (1995), Keim and Madhavan (1996)). We conjecture that, while higher volume reduces the bid-ask spread, bond sales by insurance companies (who are buy-and-hold investors) signal adverse information about the bond and thus cause the bid-ask spread to increase. Consistent with this interpretation, the bid-ask spread is negatively related to the sell volume for Treasury bonds. Further, only *surprises* in volume affect the bid-ask spread in the corporate and Treasury markets. Consistent with Fleming and Remolona (1999), the Treasury bond bid-ask spread is higher on days with macroeconomic announcements.

Is the bid-ask spread different for the three markets, after controlling for its determinants? We pool observations from all markets, and estimate a common model. The result shows that the bid-ask spread is not statistically different in the three markets. This conclusion is robust to a pair-wise comparison of the markets, and an alternative specification that does not assume a common model for all markets. Since the Treasury market is widely viewed as more transparent than the corporate and municipal markets (see footnote 3), our result may indicate that lower transparency in the latter two markets is not associated with significantly reduced liquidity. This interpretation is consistent with Hong and Warga (2000), who 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. Our evidence also supports Hotchkiss and Ronen (1999), who show that market quality is similar for high yield corporate bonds and the underlying stocks.

For equity markets, Keim and Madhavan (1997) document significant differences in trading costs across institutions even after adjusting for differences in trading styles. We examine whether large bond dealers earn a higher bid-ask spread compared to smaller dealers. Since large and small dealers in the corporate and municipal bond markets have less than 10 percent of bonds in common, we identify large dealers for each bond rather than for the whole market. We find that the bid-ask spread for large and small dealers is similar for bonds that they trade in common. There is also no difference in the bid-ask spread for large and small institutions.

We investigate why institutions sometimes directly negotiate trades without the intervention of dealers. We find that bonds with lower bid-ask spreads, lower risk (both interest rate risk and adverse selection risk) and higher activity levels are more likely to be traded directly by institutions. The result that riskier bonds are more likely to be dealer-traded is similar to Bhasin and Carey (1999), who find that dealers are more likely to make markets in secondary corporate loans for riskier borrowers. However, it is puzzling why bonds with lower bid-ask spreads are more likely to be traded directly.

In related work, Hong and Warga (2000) and Schultz (2000) use the same data set that we do. Schultz (2000) estimates effective bid-ask spreads for corporate bonds by inferring daily bid quotes from a different data set with month-end quote. Relative to our liquidity measure, Schultz's (2000) procedure results in noisier estimates of trading costs but allows for a larger sample of less active bonds (see section *2B* for a discussion of our methodology). In contrast to Schultz (2000), we do not find a difference in the bid-ask spread of large and small dealers and institutions, especially for bonds that they trade in common. Differences in our results could be due to the different sample sizes, as well as the facts that we identify large dealers and institutions for each bond, rather than for the whole market; and, that we exclude trades made without dealer participation. Hong and Warga (2000) find that transaction prices from the dealer market are broadly similar to exchange market prices and bid quotes from a major bond dealer. Neither of these papers studies municipal bonds, nor do they compare trading costs across markets or examine why institutions sometimes trade without dealers.

Instead of the bid-ask spread, Alexander, Edwards and Ferri (1999) examine the determinants of trading volume of high-yield corporate bonds that are part of the Fixed Income Pricing System (FIPS) of Nasdaq.[4] 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, as well as to lagged values of bond age, time till maturity, the yield spread over Treasuries, and the realized bid-ask spread.

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

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[4] Kamara (1994) studies volume of Treasury bill and note securities. Sarig and Warga (1989), Blume, Keim and

transaction, the par amount, and the date of transaction. CAI obtains the data from A.M. Best and further verifies the bond transactions by cross-referencing against other information on their files.[5] 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 contracts 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. We delete additional observations to clean the data of potential errors, as noted below. 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 cases where the transaction day is a Saturday or a Sunday or where the date is an estimate. Finally, we eliminate all observations where the transaction price per $1,000 face value bond is outside the range $500 to $1500. We do this to minimize incidences of data entry error that may adversely affect our analysis.[6] 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.

Patel (1991), Warga (1992), and Crabbe and Turner (1995) use the yield or return spread as a measure of liquidity.

[5] 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.

[6] 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.

B. How Representative is our Data of the Overall Bond Markets?

Table 1 provides the sample distributions of characteristics of investment-grade and below-investment grade bonds in the corporate and municipal markets. 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. 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 in the municipal bond market, followed by the corporate and Government bond markets, respectively. The mean age of the bonds is lowest in the Government bond market and about the same in the other two markets.

Are bonds traded by insurance companies 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 transaction data.[7] 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. Table 2 reports the distribution of the bid-ask spread for the three markets, reported on the basis of a $100 par value. There are 5,671 bond-days (the number of different observations on the realized bid-ask spread) in the three markets. The mean spread is highest for municipal bonds at 23 cents per $100 par value, followed by corporate bonds at 21 cents, and government bonds at 11 cents. In the government market, the mean bid-ask spread for Treasury securities is 11 cents and for Agency securities is 24 cents—a difference indicative of the higher credit risk and lower activity level of the Agency bond market. 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.[8] Utility sector corporate bonds have the highest mean bid-ask spread, followed by the industry/services sector bonds and the banking/financial sector bonds.

B. *Robustness Checks on the Estimated Realized 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. In particular, 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 (sell) on good (bad) news, then the daily bid-ask spread measure may be biased upwards. Since the degree of bias is related to the number of buy and sell trades during the day, 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. The estimates for the noise-adjusted and volume-weighted spreads are reported in Table 3.

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[7] We thank Michael Fleming for the GovPX data, which accounts for two-thirds of the interdealer broker market.
[8] Since we have only 48 observations in the sample for AAA-rated corporate bonds, we do not report the spread

Panel A of Table 3 reports the distribution of the noise-adjusted spreads. Since on most 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 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. The ranking of spreads for the different credit sector bonds is also similar to their ranking in Table 2. For all markets, the mean noise-adjusted spread is lowest in 1997, similar to the unadjusted spread. Panel B of Table 3 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 4.

Panel A of Table 4 reports the distribution of realized spreads calculated over a two-day

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distribution for these bonds separately in Table 1.

window. The number of trades in all markets increases from 5671 for the one-day window to 7257 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 4) and five-day windows (panel C of Table 4). For the three-day window, the number of trades in all markets is 8559, 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 trades. 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, we focus mainly on the unadjusted realized bid-ask spreads in the remainder of our analysis. 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

We describe three empirical models of the bond bid-ask spread and an additional fourth model for corporate bonds only. In the first model, the realized bid-ask spread is regressed on bond characteristics that are exogenous to trading. In the second model, we add trading volume and the third model also includes macroeconomic factors. For corporate bonds, the fourth model incorporates non-linearities in the relationship between the bid-asks spread and its covariates.

A. Description of Model 1

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 price and the risk of the security, and decreases with trading activity (Amihud and Mendelsohn (1980), Garman (1976), Ho and Stoll (1981), Stoll (1978a)). The bond price depends on the risk-free rate, provisions in the bond indenture (such as maturity date, coupon rate, and call provisions) and the probability of default (Leland (1994), Merton (1974)). 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 transactions date till its maturity date. Bonds with greater time to maturity tend to have higher price volatility and larger bid-ask spreads.[9] Time to maturity has a correlation of 0.90 with Macaulay's duration and 0.95 with convexity, and so we do not use duration and convexity in our regressions.[10] As a proxy for trading activity, we use the age of a bond, or the number of years between its issue date and its transactions date. Alexander et al (1999) and Sarig and Warga (1989) find that younger bonds are more liquid and Hong and Warga (2000) show that they have lower bid-ask spreads.

Changes in the market structure, such as an increase in transparency or increased regulatory scrutiny, may affect the bid-ask spread. Naik, Neuberger and Viswanathan (1999) show that greater transparency may increase or decrease investor welfare since it improves risk sharing between dealers but worsens price revision risk. In experimental settings, Bloomfield and O'Hara (1999) find that dealers gain from transparency at the expense of informed traders

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[9] 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.

[10] We calculate Macaulay duration and convexity on the basis of the estimated annual bond yield. We estimate the yield using the semi annual coupon payments and the accrued interest from the previous coupon interest date.

and non-discretionary liquidity traders, but Flood, Huisman, Koedijk and Mahieu (1999) come to the opposite conclusion. Christie, Harris and Schultz (1994) find that dealer spreads declined following publicity regarding their odd quoting behavior. We control for exogenous changes in the bid-ask spread over time through a dummy variable for transactions occurring in 1997.

Our initial regression specification is as follows:

$$Spread_{it} = a_0 + a_1\, Maturity_{it} + a_2\, Age_{it} + a_3\, 1997_t + Control\ Variables + e_{it} \qquad (1)$$

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.

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.

B. Description of Model 2

In our second regression specification, we include volume as an additional 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.

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. We model expected volume as a mixed autoregressive and moving average process ARMA(p,q), where p (q) is the order of the autoregressive (moving-average) process. In addition, lagged values of *Maturity*, *Age*, *Bid-Ask Spread* and the *Yield Spread* predict volume. $Yield\ Spread_{it}$, the difference between the yield for bond i and the 91-day Treasury bill rate on day t, represents the market's perception of credit risk. The prediction model for volume is:

$$Volume_{it} = \mu + \Sigma_i a_i B^i\ Maturity_{it} + \Sigma_i c_i B^i\ Age_{it} + \Sigma_i d_i B^i\ Bid\text{-}Ask\text{-}Spread_{it}$$

$$+ \Sigma_i e_i B^i\ YieldSpread_{it} + [(\theta B)/(\varphi B)]\ e_{it} \qquad (2)$$

where $Volume$ is either buy or sell volume, B is the backshift operator (i.e., $BX_t = X_{t-1}$), $\theta(B)$ is the autoregressive operator, $\varphi(B)$ is the moving-average operator and e_{it} is the error term. We choose optimal lag values using the criteria of Akaike (1974) and Schwarz (1978).

We use maximum likelihood to estimate (2) separately for buy and sell volumes. The results (reported in Table A1 of the Appendix) show that buy and sell volumes are strongly and positively correlated to the first lags in volume and innovations in volume, and negatively correlated to the second lag in volume. In addition, *Volume* is related to lagged values of *Maturity*, *BondAge*, *YieldSpread* and the *Bid-Ask-Spread*. The fitted value from (2) is a proxy for expected volume, while the innovation is the unexpected volume. The *Spread* equation is:

$$Spread_{it} = a_0 + a_1\, Maturity_{it} + a_2\, Age_{it} + a_3\, Expected\ BuyVolume_{it} + a_4\, Unexpected\ BuyVolume_{it} + a_5\, Expected\ SellVolume_{it} + a_6\, Unexpected\ SellVolume_{it} + a_7\, 1997_{it} + Control\ Variables + e_{it} \quad (3)$$

C. Description of Model 3

We add a macroeconomic announcement dummy to (3). The dummy is equal to 1 on days with an announcement about employment, the Consumer Price Index (CPI), the Producer Price Index (PPI), industrial production or housing starts. Bollerslev, Cai and Song (1999) identify these announcements as having major price impacts over our sample period.

D. Description of Model 4 for Corporate Bonds

We allow non-linearities between the corporate 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 (3). To allow a non-linear relation between the bid-ask spread and *Age*, we follow Alexander et al. (1999) and define a dummy variable that is one if *Age* is more than 2 years and zero otherwise. In the next section, we report the results of estimating Models 1 to 4.

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

In section *A*, we study 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. GMM Estimation Results for Individual Bond Markets

For all three markets, Durbin-Watson test statistics indicate significant serial correlation in the error terms when (1) or (3) is 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 estimates of all four models are reported in Tables 5-7.

Table 5 reports results for the corporate market. When volume is excluded as an explanatory variable (Model 1), the coefficients on *Maturity* and *Age* are positive and significant. The results indicate that the spread increases by 2 cents for every one-year increase in the bond's remaining time to maturity, and by 1 cent when the bond ages by another year. *AAA* and *AA* rated bonds have significantly lower spreads relative to junk bonds. The coefficients of the other credit ratings variables also have the right sign, although they are not significant. The addition of volume as an explanatory variable (Model 2) almost doubles the adjusted R-square. The bid-ask spread is negatively related to the unexpected buy volume and positively related to the unexpected sell volume. However, expected buy and sell volumes do not affect the spread. The sign and significance of the other variables remain the same. The announcement day dummy

(Model 3) does not add explanatory power, and its coefficient is not significant. Results from Model 4 of show that the bid-ask spread is concave in *Maturity* and non-linear in *Age*. Specifically, the coefficient of the square term in *Maturity* is negative and significant, and the coefficient on the non-linear age dummy is positive and significant.

For government bonds, we delete all bonds with no ratings information. This includes all Federal Agency bonds as well as bonds that we could not identify as either Treasury or Agency securities with certainty. The remaining bonds are all Treasury securities. Without volume (Model 1 of Table 6), no coefficient estimate is significant. With volume (Model 2), the adjusted R-square increases substantially, and the bid-ask spread is negatively related to the unexpected sell volume. When the announcement day dummy is added (Model 3), its coefficient is positive and significant, and the adjusted R-square is higher.

For the municipal market (Table 7), the bid-ask spread is positively and significantly related to *Maturity* and negatively and significantly related to the *1997* transactions dummy (Model 1). When volume is added (Model 2), the adjusted R-square once again increases substantially and the intercept is no longer significant. 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, although only the former is significant. 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). The announcement day dummy is not significant (Model 3).

As discussed in section 2*B*, if insurance companies sell (buy) on bad (good) news then our realized bid-ask spread measure may be biased upwards, with the degree of bias increasing in the number of daily buys and sells. It is possible that the buy and sell volume does not affect the "true" spread and that our statistical results are due to the bias is measuring the "true" spread. 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 are unchanged. The coefficient on the buy volume is not affected and the coefficient on the sell volume is marginally lower, but both coefficients still carry the same sign and significance as before. The remaining coefficient estimates also retain their earlier signs and significance levels.

In summary, the bond bid-ask spread increases in the interest rate risk and the 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, since 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

In this section, we pool observations across the three market sectors to test whether the bid-ask spread is different in the three sectors. Since our earlier results show that a common set of variables may not explain variations in the bid-ask spread of all markets, we check the sensitivity of the results by pooling observations across all *market pairs*. We estimate a modified version of Model 3 with the pooled data. We use dummies for the corporate and municipal markets as additional independent variables. The coefficients of these dummy variables indicate whether corporate and municipal bonds have higher bid-ask spreads than Treasury bonds, 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*. The remaining explanatory variables are the same as before.

Table 8 reports the results of the GMM estimation with pooled data.

When observations are pooled across all three markets (column 2 of Table 8) 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 municipal market pair (column 3), the adjusted R-square is double that of the 3-market case and the sign and significance of the coefficients are consistent with the individual market regressions. However, the municipal sector dummy is not significant. Similar remarks apply to the corporate and Treasury markets pair (column 4) and the Treasury and municipal market pair (column 5).

As a robustness check, we estimate the bid-ask spread in the three markets as a seemingly unrelated regression model (SURM). These results are reported in Table A2 of the Appendix. With the SURM, we need not assume the same model for all markets, and yet the common information in each market is incorporated through the correlation between the error terms.[11] Consistent with results from Table 8, 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.

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

We compare trading costs for large and small bond dealers and institutions. *For each bond*, dealers and institutions are ranked according to their shares of the value traded in the bond. The alternative procedure of ranking by the entire market share does not allow for the possibility

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[11] 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.

that dealers and institutions may specialize in certain bonds. For example, a dealer may have a large market share in one bond, a small market share in another bond and not trade a third bond. Large institutions are those with a cumulative market share of at least 50 percent in the bond. The same is true for large dealers in the corporate and municipal markets. In the Treasury market, *primary* dealers in the Treasury auctions market are categorized as "large.[12] Small dealers and institutions are those *not* identified as "large". We compare trading costs of large and small dealers in section 5*A*, and of large and small institutions in section 5*B*.

A. The Bid-Ask Spread for Large and Small Dealers

We calculate the realized bid-ask spread for a dealer with at least one buy and one sell in a bond each day, by subtracting the dealer's mean daily buy price from its mean daily sell price for the bond. Panel A of Table 9 shows the bid-ask spread for large and small dealers in each market (direct trades are analyzed in section 6). A ★★ sign indicates that the mean bid-ask spread is significantly different between large and small dealers. The mean bid-ask spread is not significantly different for large and small dealers in any market. However, in the corporate market, a Kruskal-Wallis non-parametric test shows the bid-ask spread of large and small dealers is different at the one percent level. Thus, there is some evidence that large dealers earn a higher bid-ask spread than smaller dealers in the corporate market, but not in other markets.

Differences in the bid-ask spread may represent differences in the type of bonds traded by large and small dealers. In Table 10, we show characteristics of bonds traded by large and small dealers. In all markets, large dealers are involved in proportionately more sell trades compared to small dealers. In the corporate and Treasury markets, large dealers execute bonds with lower

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[12] 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

bond age and higher credit risk (yield spread and share of investment grade bonds) and volatility (time to maturity, duration and convexity), but the opposite is true for the municipal market.

To examine whether differences in bond characteristics explain differences in the bid-ask spread of small and large dealers, we estimate the bid-ask spread for bonds traded in common by the two groups. Panel A of Table 11 shows that the share of bonds traded in common by large and small dealers in the corporate and municipal markets is below 10 percent. For example, in the corporate market, large dealers have only 9 percent of bonds in common with small dealers. Panel B of Table 11 shows that, in the corporate market, the difference in bid-ask spreads for bonds traded in common by large and small dealers is no longer significant. Using regression analysis, we generalize this result to all three markets (results reported in Table A3 of the Appendix). Specifically, when the realized bid-ask spread for *all* bonds is regressed on a dummy variable for large dealers, a dummy variable for directly negotiated trades, volume and the usual control variables, the large dealer dummy coefficient is not significant. We conclude that, after controlling for differences in the bonds traded, the bid-ask spread of large and small dealers does not appear to be significantly different.

B. The Bid-Ask Spread for Large and Small Institutions

Similar to our analysis of large and small dealers, we compare the bid-ask spread for large and small institutions (results reported in Table A4 of the Appendix). We find that the bid-ask spread is not significantly different for large and small institutions. For all corporate bonds, trading costs are lower for large institutions according to the Kruskal-Wallis test (panel A of Table A4) but this is not true for corporate bonds traded in common by large and small institutions (panel C of table A4). In the municipal sector, the mean bid-ask spread is higher for

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the secondary market, with the exception of two Japanese companies and one European company.

large institutions (panel A of Table A4) but, after controlling for differences in bond characteristics, this is no longer true (table A5 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. The bid-ask spread for direct trades is zero by definition. Table 9 shows that, in all markets, the bid-ask spread for dealer trades and direct trades are different according to the Kruskal-Wallis test. The mean difference between direct trades and dealer trades is also significant (when indicated by a single ★) in the corporate and municipal markets, but not in the Treasury market. One possible explanation is that the mean bid-ask spread for dealers is relatively low in the Treasury market but not in the other two markets.

Dealers may provide liquidity to the market and the dealer spread may reflect the value of providing this liquidity. For example, dealers may specialize in bonds that are more volatile or have higher credit risk. Table 10 shows that, in all markets, volatility (as represented by time to maturity, duration and convexity) and volume is greater and bond age is lower for bonds traded by dealers, both large and small, relative to direct trades. In the corporate market, credit risk (as represented by the yield spread and the share of investment grade bonds) is higher for dealer-traded bonds relative to directly traded bonds---but the reverse is true for the municipal market. Panel A of Table 11 shows that large and small dealers in all markets have less than 15 percent of bonds in common with direct trades. However, even for the commonly traded bonds, panel B of Table 11 shows that the bid-ask spread is significantly different between large dealers and direct trades in the corporate and Treasury markets. For the municipal market, there are not enough observations to perform statistical inference.

The above results do not necessarily imply that direct trades have lower effective costs than dealer trades, since our regressions explain only a small proportion of the variation in dealers' bid-ask spreads. So, instead, we examine determinants of the relative *volume* of direct trading by institutions as a function of the bid-ask spread and other bond characteristics. We regress an institution's daily share of volume traded without dealers in a bond on the 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 12.

Table 12 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. In the corporate market, institutions are also more likely to trade without dealers if the bond has lower time to maturity and higher buy volume. 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. The results indicate that those bonds with lower bid-ask spreads, lower risk and higher activity are more likely to be traded directly.

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. We assume that the failure time follows a logistic distribution since it provides robust estimates.[13] In the classic Tobit model, by comparison, the failure time is normally distributed and the data is usually censored at the left. The results, reported in table A6 of the Appendix, show that the earlier results for corporate and municipal bonds are robust to this alternative specification. For Treasury bonds, the estimated coefficients are not significant.

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[13] The estimates from the logistic distribution have bounded influence functions. An influence function measures the difference in standard deviation units between estimates with and without an individual observation. However, qualitatively similar estimates are obtained when the failure time distribution is normal or lognormal.

7. Conclusion

This paper estimates the determinants of 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 find that the realized bid-ask is increasing in a bond's risk and decreasing in its trading activity. Specifically, in the corporate and municipal markets, the bid-ask spread is positively related to a bond's time to maturity and credit risk. In the corporate market, the bid-ask spread is concave in the time to maturity and increases in the age of the bond. The bid-ask spread falls on buys and increases on sells for corporate and municipal bonds. This may indicate 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 *surprises* in volume affect the bid-ask spread in the corporate and Treasury markets. Finally, the bid-ask spread is higher on announcement days for Treasury bonds and is lower in 1997 relative to earlier years for municipal bonds.

We also find that the bid-ask spread is not significantly different between the three markets, between large or primary market dealers and smaller dealers, and between large and small institutions. 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 and its risk, and increases in its activity. The results suggest that dealers facilitate the execution of relatively more "difficult" trades, such as when institutions sell on the basis of information or if the bonds have relatively high interest rate risk. However, the result that institutions are more likely to directly trade bonds with lower bid-ask spreads is puzzling, since the opposite is implied if institutions behave competitively. This is an avenue for future research.

References

H. Akaike, 1974, A new look at the Statistical Model identification, *IEEE Transaction on Automatic Control*, AC-19, 716-723.

Alexander, G. J., Edwards, A. K. and M. G. Ferri, 1999, The determinants of trading volume of high-yield corporate bonds, *forthcoming*, *Journal of Financial Markets*.

Amihud, Y. and H. Mendelsohn, 1980, Dealership market: Market making with inventory, *Journal of Financial Economics*, 8, 31-53.

Bessembinder, H. and P. J. Seguin, 1993, Price volatility, trading volume, and market depth: Evidence from futures markets, *Journal of Financial and Quantitative Analysis*, 28, 1, 21-39.

Bhasin, V. and M. Carey, 1999, The determinants of corporate loan liquidity, Working paper, Federal Reserve Board, Washington D.C.

Bloomfield, M. and M. O'Hara, 1999, Market transparency: Who wins and who loses? *Review of Financial Studies*, 12, 5-36.

Blume, M., Keim, D. and S. Patel, 1991, Returns and volatility of low-grade bonds, 1977-81, *Journal of Finance*, 46, 49-74.

Bollerslev, T., Cai, J. and F. M. Song, 1999, Intraday periodicity, long memory volatility, and macro announcements in the U.S. Treasury bond market, Working paper, Duke University.

Chan, L. and J. Lakonishok, 1995, The behavior of stock prices around institutional trades, *The Journal of Finance*, 50, 1147-1174.

Christie, W. G. , Harris, J.G. and P.H. Schultz, 1994, Why did NASDAQ market makers stop avoiding odd-eighth quotes? *Journal of Finance*, 49, 5, 1841-60.

Copeland, T. and G. Galai, 1983, Information effects and the bid-ask spread, *Journal of Finance*, 54, 721-745.

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

Easley, D., and M. O'Hara, 1992, Time and the process of security price adjustment, *Journal of Finance*, 47, 2, 576-605.

Easley, D., and M. O'Hara, 1987, Price, trade size and information in securities markets, *Journal of*

Financial Economics, 19, 69-90.

Fleming, M. J. and E. M. Remolona, 1999, Price formation and liquidity in the U.S. Treasury market: The response to public information, *Journal of Finance*; 54, 5, 1901-15.

Fleming, M. J. and A. Sarkar, 1999, Liquidity in the U.S. Treasury Spot and Futures markets, *Market Liquidity: Research Findings and Selected Policy Implications*, Bank of International Settlements.

Flood, M., Huisman, R., Koedijk, K. and R. Mahieu, 1999, Quote disclosure and price discovery in multiple dealer financial markets, *Review of Financial Studies*, 12, 37-60.

M. Garman, 1976, Market microstructure, *Journal of Financial Economics*, 3, 257-275.

Glosten, L. and P. Milgrom, 1985, Bid, ask, and transaction prices in a specialist market with heterogeneously informed traders, *Journal of Financial Economics*, 13, 71-100.

Hansen, L., 1982, Large sample properties of generalized method of moments estimators, *Econometrica*, 50, 1029-1084.

Ho, T. and H. R. Stoll, 1981, Optimal dealer pricing under transactions and return uncertainty, *Journal of Financial Economics*, 9, 47-73.

Hong, G., and A. Warga, 2000, An empirical study of bond market transactions, *Financial Analysts Journal*, 56, 2, 32-46.

Hotchkiss, E. S. and T. Ronen, 1999, The informational efficiency of the corporate bond market: An intraday analysis, Working paper, Boston College.

Huang, R. D. and H. R. Stoll, 1996, Dealer versus auction markets: A paired comparison of execution costs on NASDAQ and the NYSE, *Journal of Financial Economics*, 41, 3, 313-57.

Jones, C. M. and M. L. Lipson, 1999, Price impacts and quote adjustment on the NASDAQ and NYSE/Amex, Working paper, Columbia University.

Keim, D.B., and A. Madhavan, 1997, Transactions costs and investment style: an inter-exchange analysis of institutional equity trades, *Journal of Financial Economics*, 46, 3, 265-92.

Keim, D.B., and A. Madhavan, 1996, The upstairs market for large-block trades: Analysis and measurement of price effects, *Review of Financial Studies*, 9, 1-36.

Leland, H., 1994, Corporate debt value, bond covenants, and optimal capital structure, *Journal of Finance*, 69, 1213-1252.

Longstaff, F. A. and E. S. Schwarz, 1995, A simple approach to valuing risky fixed and floating rate debt, *Journal of Finance*, 50, 3, 789-819.

Madhavan, A., and S. Smidt, 1993, An analysis of daily changes in specialist inventories and quotations, *Journal of Finance*, 48, 1595-1628.

Merton, R.C., 1974, On the pricing of corporate debt: the risk structure of interest rates, *Journal of Finance*, 29, 2, 449-470.

Naik, N., A. Neuberger and S. Viswanathan, 1999, Trade disclosure regulations in markets with negotiated trades, *Review of Financial Studies*; 12, 4, 873-900.

Porter, D. C. and D. G. Weaver, 1998, Post-trade transparency on Nasdaq's National Market System, *Journal of Financial Economics*, 50, 2, 231-52.

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

Schultz, P., 2000, Corporate bond trading costs: A peek behind the curtain, working paper, University of Notre Dame.

G. Schwarz, 1978, Estimating the dimension of the model, *Annals of Statistics*, 6, 461-64.

H. R. Stoll, 1978a, The supply of dealer services in securities markets, *Journal of Finance*, 33, 1133-1151.

H. R. Stoll, 1978b, The pricing of security dealer services: An empirical study of Nasdaq stocks, *Journal of Finance*, 33, 1153-1172.

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

White, H., 1980, A heteroscedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity, *Econometrica*, 48, 4, 817-838.

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.

Variable	No. of observations	Mean	Standard deviation	No. of observations	Mean	Standard deviation	Mean	Standard deviation
	Investment grade bonds			**Below-investment grade bonds**			**Merrill Lynch Master Bond Index**	
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	---	---
Sell volume	1252	6.36	17.04	----	---	---	---	---
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

The daily 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 the period 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
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
Industrial/Service sector bonds	798	1169	0.21	1.01	---	---	---	---	---	---	---	---
Banking/Finance sector bonds	567	781	0.17	0.61	---	---	---	---	---	---	---	---
Utility sector bonds	253	331	0.26	1.01	---	---	---	---	226	240	0.21	0.29
Health care sector bonds	---	---	---	---	---	---	---	---	21	24	0.39	0.66

Table 3
Alternative Bid-Ask Spread Measures of Corporate, Government and Municipal Bonds

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. 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. The sample consists of public bonds traded by insurance companies during the period 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: 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
Industrial/service bonds	798	1169	0.16	0.76	---	---	---	---	---	---	---	---
Banking/finance bonds	567	781	0.13	0.47	---	---	---	---	---	---	---	---
Utility bonds	253	331	0.19	0.84	---	---	---	---	226	240	0.16	0.22
Health care bonds	---	---	---	---	---	---	---	---	21	24	0.33	0.58
Panel B: Volume-weighted bid-ask spread												
1995-1997	1789	2515	0.21	1.00	226	1933	0.11	1.73	1168	1223	0.22	0.41
1995	544	630	0.30	1.51	90	527	0.13	2.21	317	318	0.32	0.51
1996	845	1041	0.19	0.81	136	738	0.15	1.93	407	410	0.21	0.42
1997	732	844	0.17	0.69	161	668	0.05	0.82	486	495	0.16	0.29
AA bonds	193	259	0.11	0.87	---	---	---	---	402	432	0.23	0.40
A bonds	754	1078	0.21	0.64	---	---	---	---	136	142	0.18	0.40
Below-investment grade bonds	281	375	0.23	1.54	---	---	---	---	---	---	---	---
Industrial/service bonds	798	1169	0.21	1.01	---	---	---	---	---	---	---	---
Banking/finance bonds	567	781	0.17	0.61	---	---	---	---	---	---	---	---
Utility bonds	253	331	0.26	1.01	---	---	---	---	226	240	0.21	0.29
Health care bonds	---	---	---	---	---	---	---	---	21	24	0.39	0.66

Table 4
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 5
Determinants of the Bid-Ask Spread for Corporate Bonds

In Model 1, the daily realized bid-ask spread (per $100 par value) for a bond is regressed on bond characteristics, Moody's credit ratings, the issuer industry and a dummy for the year 1997. Model 2 adds volume and Model 3 adds a dummy for macroeconomic announcement days as independent variables. Model 4 adds the square of maturity and a dummy equal to 1 when age exceeds 2. 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 is insurance company-traded public bonds from January 1995 to December 1997.

Independent Variables	Model 1 estimates	Model 2 estimates	Model 3 estimates	Model 4 estimates
Intercept	0.18 (0.2255)	-0.23 (0.7379)	-0.22 (0.7476)	-0.35 (0.6121)
Time to maturity (years)	**0.02** **(0.0001)**	**0.01** **(0.0001)**	**0.01** **(0.0001)**	**0.02** **(0.0001)**
Square of time to maturity	---	---	---	**-0.0002** **(0.0014)**
Bond age (years)	**0.01** **(0.0137)**	**0.01** **(0.0333)**	**0.01** **(0.0335)**	---
Non-linear bond age dummy variable	---	---	---	**0.09** **(0.0229)**
Expected log buy volume	---	-0.07 (0.3376)	-0.07 (0.3401)	-0.08 (0.2765)
Unexpected log buy volume	---	**-0.10** **(0.0001)**	**-0.10** **(0.0001)**	**-0.10** **(0.0001)**
Expected log sell volume	---	0.09 (0.1844)	0.09 (0.1798)	0.11 (0.1102)
Unexpected log sell volume	---	**0.04** **(0.0891)**	**0.04** **(0.0893)**	**0.04** **(0.0969)**
Macro announcement day dummy variable	----	----	0.01 (0.9243)	0.00 (0.9563)
Moody's AAA & AA dummy	**-0.21** **(0.0477)**	**-0.26** **(0.0123)**	**-0.26** **(0.0124)**	**-0.24** **(0.0193)**
Moody's A1 dummy	-0.05 (0.5968)	-0.13 (0.1759)	-0.13 (0.1774)	-0.13 (0.1668)
Moody's A2 dummy	-0.06 (0.4836)	-0.10 (0.2589)	-0.10 (0.2600)	-0.10 (0.2636)
Moody's A3 dummy	-0.08 (0.3718)	-0.12 (0.1973)	-0.12 (0.1990)	-0.11 (0.2238)
Moody's BAA1 dummy	-0.04 (0.6676)	-0.07 (0.4476)	-0.07 (0.4479)	-0.07 (0.4618)
Moody's BAA2 dummy	-0.12 (0.2303)	-0.13 (0.1787)	-0.13 (0.1796)	-0.13 (0.1931)
Moody's Baa3 dummy	0.04 (0.7748)	-0.10 (0.2955)	-0.10 (0.3003)	-0.11 (0.2568)
Banking/Finance sector dummy	-0.06 (0.6653)	0.06 (0.3839)	0.06 (0.3919)	0.05 (0.4273)
Industrial/Service sector dummy	-0.08 (0.6106)	0.06 (0.3591)	0.06 (0.3636)	0.04 (0.5356)
Utility sector dummy	-0.05 (0.7695)	0.10 (0.2517)	0.10 (0.2551)	0.07 (0.3773)
1997 transaction dummy	-0.05 (0.2209)	-0.05 (0.1527)	-0.05 (0.1588)	-0.04 (0.2471)
Number of observations	2397	2327	2327	2327
Adjusted R-square	1.48	2.92	2.88	2.88

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

In Model 1, the daily realized bid-ask spread (per $100 par value) for a bond is regressed on bond characteristics and a dummy for the year 1997. Model 2 also includes volume and Model 3 further includes a macroeconomic announcement day dummy. The estimation method is the Generalized Method of Moments (GMM). The 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 during the period January 1995 to December 1997.

Independent Variables	Model 1 estimates	Model 2 estimates	Model 3 estimates
Intercept	-0.01	16.40	19.04
	(0.9701)	(0.1766)	(0.1385)
Time to maturity (years)	0.02	0.02	0.02
	(0.3092)	(0.2585)	(0.2568)
Bond age (years)	-0.00	-0.02	-0.02
	(0.9682)	(0.6733)	(0.6868)
Expected log buy volume	---	-0.09	0.00
		(0.7569)	(0.9884)
Unexpected log buy volume	---	0.01	0.01
		(0.7753)	(0.7711)
Expected log sell volume	---	-1.05	-1.33
		(0.1828)	(0.1234)
Unexpected log sell volume	---	**-0.16**	**-0.17**
		(0.0052)	**(0.0052)**
Macroeconomic announcement day dummy variable	---	---	**0.23**
			(0.0901)
1997 Transaction Dummy	-0.05	-0.16	-0.18
	(0.6212)	(0.2106)	(0.1604)
Number of observations	1252	1251	1251
Adjusted R-square (per cent)	0.21	2.19	2.28

Table 7
Determinants of the Bid-Ask Spread for Municipal Bonds

In Model 1, the daily realized bid-ask spread (per $100 par value) for a bond is regressed on bond characteristics, Moody's credit ratings, the issuer industry and a dummy for the year 1997. Model 2 also includes volume and Model 3 further includes a macroeconomic announcement day dummy. The estimation method is the Generalized Method of Moments (GMM). The 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 during the period January 1995 to December 1997.

Independent Variables	Model 1 estimates	Model 2 estimates	Model 3 estimates
Intercept	**0.21**	0.04	0.05
	(0.0001)	(0.9332)	(0.9164)
Time to maturity (years)	**0.01**	**0.01**	**0.01**
	(0.0043)	**(0.0040)**	**(0.0038)**
Bond age (years)	-0.00	-0.00	-0.00
	(0.3123)	(0.2606)	(0.2216)
Expected log buy volume	---	**-0.19**	**-0.19**
		(0.0337)	**(0.0335)**
Unexpected log buy volume	---	**-0.08**	**-0.08**
		(0.0383)	**(0.0386)**
Expected log sell volume	---	**0.20**	**0.19**
		(0.0104)	**(0.0109)**
Unexpected log sell volume	---	0.06	0.06
		(0.1338)	(0.1359)
Macroeconomic announcement day dummy variable	---	---	0.03
			(0.3284)
Moody's AA dummy	-0.01	-0.01	-0.01
	(0.7263)	(0.7439)	(0.7619)
Moody's A1 dummy	-0.07	-0.07	-0.08
	(0.1298)	(0.1231)	(0.1137)
Moody's A2 dummy	-0.03	-0.03	-0.03
	(0.6471)	(0.6156)	(0.6083)
Moody's A3 dummy	0.09	0.10	0.10
	(0.5171)	(0.4975)	(0.4817)
Below Moody's A3 dummy	0.24	**0.24**	**0.24**
	(0.1042)	**(0.0909)**	**(0.0922)**
Utility sector dummy	-0.04	-0.03	-0.03
	(0.1688)	(0.2531)	(0.2273)
Health sector dummy	0.15	0.14	0.14
	(0.2768)	(0.3049)	(0.3052)
1997 transaction dummy	**-0.11**	**-0.10**	**-0.10**
	(0.0001)	**(0.0001)**	**(0.0001)**
Number of observations	1222	1217	1217
Adjusted R-square (per cent)	3.03	4.26	4.25

Table 8
Comparison of the Bid-Ask Spread for Corporate, Treasury and Municipal Bonds

The daily realized bid-ask spread (per $100 par value) for a bond is regressed on bond characteristics, volume, Moody's credit ratings, and dummy variables for the year 1997, for macroeconomic announcement days, for the issuer industry and for the Corporate and Municipal markets. To save on space, the estimates for the issuer industry dummy variables are not reported. 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	All markets	Corporate and Municipal markets	Corporate and Treasury markets	Treasury and Municipal markets
Time to maturity (years)	**0.02**	**0.01**	**0.02**	0.02
	(0.0017)	**(0.0001)**	**(0.0068)**	(0.1481)
Bond age (years)	0.01	**0.01**	0.01	-0.00
	(0.3623)	**(0.0745)**	(0.2483)	(0.7019)
Expected log buy volume	0.05	-0.03	0.06	0.08
	(0.5471)	(0.6167)	(0.5323)	(0.6234)
Unexpected log buy volume	-0.01	**-0.08**	-0.01	0.03
	(0.8486)	**(0.0001)**	(0.6347)	(0.4137)
Expected log sell volume	-0.05	0.04	-0.06	-0.08
	(0.54419	(0.5563)	(0.5166)	(0.6327)
Unexpected log sell volume	**-0.07**	**0.05**	**-0.07**	**-0.13**
	(0.0546)	**(0.0136)**	**(0.0561)**	**(0.0113)**
Macro announcement day dummy variable	0.03	0.01	0.03	0.06
	(0.5084)	(0.8229)	(0.5096)	(0.3430)
Municipal bond market dummy variable	0.06	0.01	---	0.06
	(0.4386)	(0.9261)		(0.4502)
Corporate bond market dummy variable	0.06	---	0.11	---
	(0.5845)		(0.5657)	
Moody's AA dummy	-0.03	-0.04	-0.14	0.01
	(0.3299)	(0.1634)	(0.3440)	(0.6199)
Moody's A1 dummy	0.05	0.04	0.04	-0.05
	(0.2462)	(0.3855)	(0.7730)	(0.3029)
Moody's A2 dummy	**0.08**	**0.09**	0.05	-0.04
	(0.0912)	**(0.0678)**	(0.7316)	(0.5134)
Moody's A3 dummy	0.08	0.07	0.03	0.11
	(0.1449)	(0.1618)	(0.8072)	(0.4043)
Moody's BAA1 dummy	**0.12**	**0.11**	0.08	---
	(0.0314)	**(0.0321)**	(0.5645)	
Moody's BAA2 dummy	0.06	0.07	-0.02	---
	(0.4368)	(0.3559)	(0.9186)	
Moody's Baa3 dummy	0.20	**0.22**	0.14	---
	(0.1455)	**(0.0918)**	(0.4837)	
Moody's Below Baa3 (Junk) dummy	0.15	**0.16**	0.09	**0.23**
	(0.1202)	**(0.0801)**	(0.5806)	**(0.0858)**
1997 Transaction Dummy	**-0.08**	**-0.07**	**-0.06**	**-0.09**
	(0.0039)	**(0.0036)**	**(0.0818)**	**(0.0341)**
Number of observations	4835	3595	3618	2461
Adjusted R-square	1.06	2.25	1.12	1.33

Table 9

The Bid-Ask Spread for Trades without Dealers, by Large Dealers and by Small Dealers

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. 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. A ★★ (★) indicates that the mean spread for large dealers is significantly different from *both* small dealers and direct trades (*only* direct trades) at the 5 percent level. The Kruskal-Wallis chi-square statistic tests for differences in the locations of the spread distributions of dealer and direct trades. The sample consists of public bonds traded by insurance companies during the period January 1995 to December 1997.

	Large dealer trades			**Small dealer trades**			**Trades without dealers**		
	Number of trades	Mean bid-ask spread	Standard deviation of spread	Number of trades	Mean bid-ask spread	Standard deviation of spread	Number of trades	Mean bid-ask spread	Standard deviation of spread
Corporate market	915	**0.24★**	1.26	623	**0.20★**	0.61	333	0.00	0.00
Kruskal-Wallis test:									
Large – Small dealers	**χ^2=7.27**	**p=0.0070**							
Large - Direct trades	**χ^2=216.02**	**p=0.0001**							
Small – Direct trades	**χ^2=136.11**	**p=0.0001**							
Test for equality of all means	**F=7.17**	**p=0.0008**							
Treasury market	560	0.08	1.23	452	0.05	1.12	23	0.00	0.00
Kruskal-Wallis test:									
Primary –Secondary dealers	χ^2=1.32	p=0.2493							
Primary – Direct trades	χ^2=1.71	p=0.1909							
Secondary – Direct trades	**χ^2=3.44**	**p=0.0638**							
Test for equality of all means	F=0.10	p=0.9040							
Municipal market	842	**0.21★**	0.43	127	**0.25★**	0.43	57	0.00	0.00
Kruskal-Wallis test:									
Large – Small dealers	χ^2=1.40	p=0.2361							
Large - Direct trades	**χ^2=85.31**	**p=0.0001**							
Small – Direct trades	**χ^2=53.81**	**p=0.0001**							
Test for equality of all means	**F=7.84**	**p=0.0004**							

Table 10
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	9.81	7.56	9.63	7.94	7.44	5.77
Bond age	3.45	4.60	3.47	4.41	5.05	5.96
Macaulay's Duration	6.35	2.73	6.29	2.56	5.41	2.26
Convexity	62.56	61.70	60.02	58.51	43.05	47.04
Buy volume	5.99	6.38	2.18	2.55	2.69	2.11
Sell volume	6.99	6.73	2.63	3.04	2.68	2.08
Coupon rate	7.74	1.46	7.82	1.39	8.10	1.32
Annual yield	7.36	1.22	7.39	1.28	7.20	1.32
Yield spread	2.07	1.19	2.07	1.26	2.06	1.34
% investment-grade bonds	84.43	---	84.27	---	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	11.31	5.58	11.98	5.69	9.39	6.52
Bond age	3.28	3.24	3.13	3.51	6.97	7.04
Macaulay's Duration	8.17	2.73	8.55	2.69	6.84	3.55
Convexity	91.77	61.15	99.80	64.44	73.74	68.51
Buy volume	3.26	3.69	1.81	1.99	1.26	1.27
Sell volume	3.70	3.99	1.91	2.00	1.26	1.28
Yield spread	0.16	0.92	0.11	0.60	0.14	0.76
Coupon rate	5.79	0.95	5.76	0.76	5.66	0.93
Annual yield	5.44	0.91	5.41	0.57	5.23	0.74
% investment-grade bonds	97.13	---	95.20	---	94.74	---

Table 11

The Bid-ask Spread for Bonds Traded in Common by Large Dealers, Small Dealers and Direct Trades

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 bid-ask spread is calculated for bonds traded in common by each pair of the three groups. 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. A ★ indicates that the mean is significantly different at the 10 percent level or less. The sample consists of public bonds traded by insurance companies during the period January 1995 to December 1997.

Panel A: Common and distinct bonds traded without dealers, by large dealers and by small dealers

	Large dealers			Small dealers		
	No. of bonds in common with	No. of bonds distinct with	Percent of common bonds in total	No. of bonds in common with	No. of bonds distinct with	Percent of common bonds in total
Corporate market:						
Small dealers	109	1100	9.02	---	---	---
Direct trades	55	937	5.54	39	681	5.42
Both	15	1374	1.09	---	---	---
Treasury market:						
Secondary dealers	90	98	47.87	---	---	---
Direct trades	13	125	9.42	21	127	14.19
Both	13	175	6.92	---	---	---
Municipal market:						
Small dealers	30	900	3.33	---	---	---
Direct trades	3	886	0.34	0	182	0.00
Both	0	984	0.00	---	---	---

Panel B: The bid-ask spread for common bonds: large dealers, small dealers and direct trades

	Bonds common to								
	Large dealers and small dealers			Large dealers and direct trades			Small dealers and direct trades		
	Number of trades	Mean bid-ask spread	Standard deviation of spread	Number of trades	Mean bid-ask spread	Standard deviation of spread	Number of trades	Mean bid-ask spread	Standard deviation of spread
Corporate market									
Large dealers	124	0.08	0.86	61	**0.28★**	0.71	---	---	---
Small dealers	142	0.13	0.75	---	---	---	57	0.06	0.35
Direct trades	---	---	---	67	0.00	0.00	53	0.00	0.00
Kruskal-Wallis test	χ^2=0.30	p=0.5858		**χ^2=28.49**	**p=0.0001**		**χ^2=5.40**	**p=0.0201**	
Treasury market									
Primary dealers	503	0.08	1.26	50	0.14	0.81	---	---	---
Secondary dealers	375	0.08	1.01	---	---	---	57	0.13	0.45
Direct trades	---	---	---	13	0.00	0.00	23	0.00	0.00
Kruskal-Wallis test	χ^2=1.20	p=0.2732		**χ^2=4.92**	**p=0.0266**		χ^2=0.30	p=0.8745	
Municipal market									
Large dealers	30	0.26	0.29	3	0.32	0.14	---	---	---
Small dealers	31	0.17	0.28	---	---	---	---	---	---
Direct trades	---	---	---	3	0.00	0.00	---	---	---

Table 12
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 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. 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** **(0.0001)**	**-1.55** **(0.0613)**	**1.20** **(0.0005)**
Time to maturity (years)	**-0.003** **(0.0004)**	0.00 (0.9839)	0.00 (0.2551)
Bond age (years)	**0.01** **(0.0001)**	0.00 (0.9788)	**0.01** **(0.0012)**
Expected log buy volume	**0.23** **(0.0001)**	**0.06** **(0.077)**	0.02 (0.5201)
Unexpected log buy volume	**0.02** **(0.0001)**	-0.01 (0.1186)	0.01 (0.5076)
Expected log sell volume	**-0.11** **(0.0001)**	0.05 (0.1363)	**-0.10** **(0.0028)**
Unexpected log sell volume	**-0.01** **(0.0375)**	0.00 (0.2681)	-0.01 (0.2396)
Large institutions dummy	**-0.19** **(0.0001)**	**-0.16** **(0.0396)**	**0.22** **(0.0001)**
Bid-As Spread	**-0.01** **(0.0734)**	0.00 (0.371)	**-0.07** **(0.0001)**
AA and AAA dummy	-0.01 (0.7167)	----	---
AA dummy	----	---	0.01 (0.5879)
A1 dummy	0.01 (0.6304)	----	-0.04 (0.1726)
A2 dummy	0.04 (0.1134)	----	-0.01 (0.8866)
A3 dummy	0.02 (0.3820)	----	0.06 (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

Appendix

Table A1 of Appendix
Determinants of Volume in the Corporate, Treasury and Municipal Markets

Buy and sell volumes are explained by an ARMA(p,q) model and lagged values of time to maturity, bond age, yield spread, the bid-ask spread and an announcement dummy. 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. The sample consists of publicly traded bonds by insurance companies during the period January 1995 to December 1997.

	Constant	MA1	AR1	AR2	Lag of Maturity	Lag of Age	Lag of Yield Spread	2nd lag of Yield Spread	Lag of Bid-ask spread	2nd lag of Bid-ask spread	Announcement dummy
Panel A: Corporate bond market											
Log buy volume	13.75	0.84	0.98	-0.06	0.01	0.00	-0.81	1.89	0.04	0.01	0.09
	(12.42)	(18.92)	(19.75)	(-2.32)	(1.41)	(0.35)	(-0.79)	(1.61)	(1.10)	(0.49)	(1.06)
Log sell volume	12.88	0.77	0.89	---	0.01	-0.00	0.88	-0.22	0.03	0.03	0.08
	(11.95)	(21.10)	(33.83)		(1.88)	(-0.22)	(0.90)	(-0.19)	(1.08)	(1.21)	(0.93)
Panel B: Municipal bond market											
Log buy volume	12.93	0.92	1.10	-0.12	0.01	0.00	-0.25	----	0.00	----	0.01
	(7.16)	(36.03)	(27.17)	(-3.64)	(1.11)	(0.33)	(-0.73)		(0.05)		(0.11)
Log sell volume	12.29	0.92	1.13	-0.15	0.01	-0.01	-0.40	----	0.11	----	0.01
	(6.43)	(36.19)	(27.98)	(-4.50)	(1.25)	(-0.63)	(-1.10)		(1.35)		(0.12)
Panel C: Treasury bond market											
Log buy volume	14.38	-0.87	-0.83	----	-0.02	-0.02	----	----	0.06	----	-0.11
	(142.78)	(-8.93)	(-7.55)		(-2.96)	(-0.35)			(2.56)		(-0.88)
Log sell volume	14.48	0.97	0.97	---	-0.00	-0.04	----	----	-0.01	----	0.11
	(136.99)	(15.61)	(17.68)		(-0.20)	(-2.18)			(-0.37)		(0.95)

Table A2 of Appendix
Seemingly Unrelated Regressions for Corporate, Treasury and Municipal Bond Transactions

We report results from a Seemingly Unrelated Regression (SUR) model 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 0.10 level or higher 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)
Test for equality of intercepts	Chi-square = 2.54	p = 0.28	
Number of observations	313	313	313
Adjusted R-square	4.15	-0.66	6.11

Table A3 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, direct or non-dealer trades, Moody's credit ratings, the issuer industry, 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 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 markets	Treasury market	Municipal market
Intercept	0.71	0.27	0.29
	(0.4711)	(0.9506)	(0.5214)
Time to maturity (years)	**0.01**	-0.01	**0.01**
	(0.0004)	(0.4357)	**(0.0292)**
Bond age (years)	**0.01**	-0.01	0.00
	(0.0260)	(0.7579)	(0.8204)
Expected log buy volume	-0.05	0.14	**-0.18**
	(0.6135)	(0.4092)	**(0.0548)**
Unexpected log buy volume	**-0.08**	-0.03	-0.02
	(0.0003)	(0.1626)	(0.6315)
Expected log sell volume	0.00	-0.15	**0.17**
	(0.9647)	(0.6251)	**(0.0343)**
Unexpected log sell volume	**0.06**	**-0.07**	-0.00
	(0.0191)	**(0.0618)**	(0.9192)
Macroeconomic announcement day dummy	-0.06	-0.03	0.02
	(0.3485)	(0.6948)	(0.6297)
Large dealer dummy	0.05	0.10	-0.04
	(0.5697)	(0.4953)	(0.3997)
Direct trade dummy	**-0.17**	-0.05	**-0.20**
	(0.0169)	(0.8366)	**(0.0001)**
AA and AAA dummy	-0.14	----	---
	(0.2308)		
AA dummy	---	---	0.00
			(0.9327)
A1 dummy	-0.02	----	**-0.08**
	(0.8413)		**(0.0912)**
A2 dummy	0.03	----	0.00
	(0.7921)		(0.9918)
A3 dummy	0.06	----	0.17
	(0.5107)		(0.2759)
BAA1 dummy	0.08	----	---
	(0.4101)		
BAA2 dummy	0.02	----	---
	(0.8461)		
Baa3 dummy	0.04	----	---
	(0.7283)		
Below A3 dummy	----	----	0.28
			(0.1463)
1997 Transaction Dummy	**-0.06**	-0.02	**-0.10**
	(0.0798)	(0.7850)	**(0.0007)**
Number of observations	1813	993	1042
Adjusted R-square	2.94	0.67	4.97

Table A4 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. A ★ indicates that the mean is significantly different at the 10 percent level or less. 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 trades	Mean bid-ask spread	Standard deviation of spread	Number of trades	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 bonds traded by small and large institutions

	No. of common bonds	No. 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: The bid-ask spread for large and small institutions: Common bonds

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

Table A5 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, direct or non-dealer trades, Moody's credit ratings, the issuer industry, 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 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 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)
A3 dummy	-0.07	----	0.44
	(0.6105)		(0.1548)
BAA1 dummy	-0.05	----	---
	(0.7305)		
BAA2 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 A6 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 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. *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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