Liquidity in U.S. Fixed Income Markets: A Comparison of the Bid-Ask Spread in Corporate, Government and Municipal Bond Markets

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Abstract

We examine the determinants of the realized bid-ask spread in the U.S. corporate, municipal and government bond markets for the years 1995 to 1997, based on newly available transactions data. Overall, we find that liquidity is an important determinant of the realized bid-ask spread all three markets. Specifically, in all markets, the realized bid-ask spread decreases in the trading volume. Additionally, risk factors are important in the corporate and municipal markets. In these markets, the bid-ask spread increases in the remaining-time-to-maturity of a bond. The corporate bond spread also increases in credit risk and the age of a bond. The municipal bond spread increases in the after-tax bond yield. Controlling for other factors, the municipal bond spread is higher than the government bond spread by about 9 cents per $100 par value, but the corporate bond spread is not. Consistent with improved pricing transparency, the bid-ask spread in the corporate and municipal bond markets is lower in 1997 by about 7 to 11 cents per $100 par value, relative to the earlier years. Finally, the ten largest corporate bond dealers earn 15 cents per $100 par value higher than the remaining dealers, after controlling for differences in the characteristics of bonds traded by each group. We find no such differences for the government and municipal bond dealers.

1. Introduction

The U.S. bond market is the largest market in the world, with a total current value of over $10 trillion-- up approximately 400 per cent since 1980. While the New York Stock Exchange (NYSE) equity trading amounts to $26 billion per day, trading volume in all bond markets total roughly $350 billion per day (the Securities and Exchange Commission (SEC) press release 98-81). The vast majority of bond markets transactions occur in over-the-counter dealer markets.

An important issue for academics and market participants is the liquidity and transparency of dealer market transactions. Recent finance literature argues that, at least in the equity markets, dealers may not provide competitive pricing of customer trades, compared to auctions markets. For example, Huang and Stoll (1996) find that execution costs are about twice as high on the NASDAQ dealer markets, compared to a matching sample of NYSE stocks. Roell (1992) shows that the execution costs in the London dealer market are higher than in the continental auctions markets.

The inefficiency of dealer pricing is, perhaps, of even greater concern in bond markets than in equity markets. This is because of the lack of price transparency in the former markets since there is no centralized location reporting quotes or trade prices. For inactively traded bonds, different dealers may provide different quotes for the same bond.[2] The SEC has proposed rules to enhance the transparency of the corporate bond market. One measure would require dealers to report all transactions in U.S. corporate bonds and preferred stocks to the NASD and to develop systems to receive and redistribute transaction prices on an immediate basis (SEC press release 98-81).

In the current paper, we estimate the realized bid-ask spreads in the U.S. corporate, municipal and government bond markets for the years 1995 to 1997, based on newly available transactions data for the bond dealer markets. As of 1993, these three bond markets were about two-thirds of the dollar value of the U.S. debt markets (Fabozzi, 1996). We compare the bid-ask spread across the three markets, after controlling for the risk of trading bonds, the level of their trading activity, the transparency of the market and issuer-

[2] See Schultz (1998) for a description of the pricing mechanism in corporate bond markets. In September 1998, the House Commerce committee and the Finance and Hazardous Materials subcommittee began holding hearings on whether investors have adequate information about prices when considering investments in the bond market. The title of the hearing: "Improving price competition for mutual funds and bonds."

specific characteristics. As the three markets vary with respect to the control factors, a cross-market comparison is a natural experiment in studying the effects of these factors on market liquidity.

In terms of credit risk, U.S. Treasury securities are backed by the full faith and credit of the U.S. government, and so are virtually free of credit risk. Corporate bonds may suffer from significant credit risk. For example, in 1992, high risk or junk corporate bonds (rated below Baa by Moody's) were about 23% of volume (Bencivenga, 1995). 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.[3]

In terms of trading activity, U.S. Treasury securities are the second largest sector of the bond market, after the mortgage market. The total volume of debt and size of any single issue is large, compared to the other bond market sectors. For example, as of 1993, there was $2.3 trillion of Treasury debt outstanding from 210 different issues. By comparison, in the corporate and municipal bond markets, there were $1.4 trillion of debt from 10,000 issues and $802 billion of debt from 70,000 separate issuers, respectively (Fabozzi, 1996). The large issue sizes in the U.S. Treasury markets imply that the secondary market is highly liquid, with large trading volumes and narrow bid-ask spreads, as shown in Fleming and Sarkar (1998). Further, the secondary market in U.S. Treasuries is a round-the-clock market, whereas the corporate and municipal bond markets are not---a further indication of the robust trading activity in U.S. Treasuries.

In terms of market transparency, a recent review of the debt markets by the SEC found that the government bond market is highly transparent, that price transparency has improved in the municipal bond market,[4] but is still inadequate in the corporate bond market.

Our first set of results relate to the distribution of the realized bid-ask spread, defined as the difference between the average buy price and the average sell price per bond per day. The spreads are

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[3] In addition, since the interest payment on most municipal bonds is exempt from federal income tax, and may be exempt from state and local taxes, investors suffer from tax risk. This is the risk that either the Federal income tax will decrease (lowering the value of tax-exemption) or that a tax-exempt issue may be declared taxable by the Internal Revenue Service.

[4] In 1998, with SEC approval, the Municipal Securities Rulemaking Board expanded its daily reporting. Now, if a municipal security trades at least four times on a given day, then the high, low, and average prices and total par value traded will appear on the MSRB's Combined Daily Report at 6:00 a.m. the next day. The Bond Market Association will make that information available for free on its web site. For the first time, individual investors will now have access to prices and volume information. The web site will also have valuable information about credit ratings, insurance, calls, and yields.

reported on the basis of a $100 par value. We find that the mean spread is the highest in the municipal bond market at 22 cents, followed by the corporate bond market at about 21 cents and the government bond market at 11 cents. The spread is generally higher for bonds with lower Moody's ratings, and lower in 1997 than in the earlier years for all markets. In the corporate and municipal markets, the spread appears to have decreased in each successive year of our sample.

Regarding bond characteristics, municipal bonds have the highest time to maturity, and the lowest trading volume of the three markets. Consistent with market perception that the government bond market is the most liquid sector, government bonds have the lowest age since issuance, and the highest trading volume of the three markets. In all markets, the average time to maturity of bonds is intermediate, between 9 and 11 years, while the average age of bonds varies between 2.75 years and 3.5 years.

Next, we study the determinants of the bid-ask spread separately in the corporate, government and the municipal bond markets. Specifically, using the robust Generalized Method of Moments (GMM) estimation technique, we find that liquidity is an important determinant of the realized bid-ask spread all three markets. Specifically, in all markets, the realized bid-ask spread decreases in the trading volume. Additionally, risk factors are important in the corporate and municipal markets. In these markets, the bid-ask spread increases in the remaining-time-to-maturity of a bond. The corporate bond spread also increases in credit risk and the age of a bond. The municipal bond spread increases in the after-tax bond yield. Additionally, the bid-ask spread is lower in 1997 compared to the previous two years--by 7 cents for corporate bonds and 10 cents for municipal bonds. However, this is not the case in the government bond market. The result is consistent with the idea that transparency in the corporate and municipal bond markets has improved, perhaps as a consequence of increased regulatory scrutiny.

In each bond market, there are unique factors important for determining the bid-ask spread for that market only. For corporate bonds, the bid-ask spread increases with the age of the bond since issuance. Also, the estimated bid-ask spread for AAA and AA rated corporate bonds are about 21 cents lower than corporate junk bonds (i.e., bonds rated Ba or below by Moody's). For municipal bonds, the bid-ask spread is

positively related to the annual yield. Since the yield is a before-tax return, we interpret the result to mean that the bid-ask spread is negatively related to the extent of tax subsidy implicit in municipal bond yields.

Is the bid-ask spread different for the three markets, after controlling for its significant determinants? We pool observations from all markets, and estimate a common model. The result shows that the spread in the municipal bond market is higher by 9 cents compared to government bonds, even after the reduction in spreads in 1997, but corporate bond spreads are not. A pair-wise comparison of markets confirms this result. Specifically, the municipal bond spread is higher than the corporate bond spread by 8 cents, but the corporate bond spread is not different from the government bond spread. This result is robust to alternative specifications that take into account the unique determinant of spreads in the government sector.

Following Schultz (1998), we examine whether large dealers earn higher bid-ask spreads compared to smaller dealers. We find that the ten largest dealers earn higher spreads in the corporate and municipal bond markets, but not in the government bond market. The ten largest dealers generally trade different bonds than the other dealers in all three markets. Bonds traded by the ten largest dealers in the corporate and municipal bond markets are significantly riskier (higher duration) and more active (lower bond age) compared to bonds traded by smaller dealers. After controlling for these differences, the ten largest corporate bond dealers earn 15 cents more than other dealers, but the municipal bond bid-ask spread is the same for all dealers. We do not find any differences in the bid-ask spread for the trades of the ten largest institutions compared to those of the smaller institutions.

In related work, Schultz (1998) studies the corporate bond market and Hong and Warga (1998) study the corporate and government bond markets using the same data set as ours. Schultz (1998) finds that the bid-ask spread is lower for larger sized trades and for larger institutions, but that it is not affected by relationships between dealers and institutions. Hong and Warga (1998) find no apparent biases in exchange transactions and dealer-market quotes relative to transactions in the dominant dealer market. The authors conclude that effective spreads (calculated by matching quotes with transactions) for the ABS traded corporate bonds are found to be similar to effective spreads for dealer market transactions, although dealer market spreads exhibit substantially higher variability.

The plan for the rest of the paper is as follows. In section 2, we discuss our data and methodology. In section 3, we describe the sample distributions of the bid-ask spread and various bond characteristics. In section 4, we analyze the determinants of the bid-ask spread in the three markets, and compare the spread across them. In section 5, we study whether the bid-ask spread is different for the largest dealers and institutions. Finally, the conclusions are presented in section 6.

2. Data and Methodology

After describing the data in section 2A, we discuss the theoretical determinants of bid-ask spread in bond markets and our empirical proxies in section 2B.

A. Data Description

Our bond transaction data set is comprised of individual bond transactions by insurance companies. From 1995, the National Association of Insurance Commissioners (NAIC)---the regulatory body overseeing the insurance industry---started requiring the insurance companies to report their securities transactions on the Schedule D filings. Accordingly, the insurance companies must provide information pertaining to the total cost of transaction, the number of bond contracts purchased or sold and the date of transaction. We obtain a record of such transactions from Capital Access International (CAI), who, in turn, obtains it from A.M. Best. CAI then cleans the data by verifying the bonds transacted based on available information.

The basic data set used in the paper comprises of daily bond transaction records of insurance companies. The data is available from January 1, 1995 to December 31, 1997. Each record comprises of the transaction date, an eight-digit bond number that identifies the bond, the total dollar value of the transaction, the number of contracts traded and an indication as to whether the order is a buy or a sell order. The original sample consists of 453,481 individual transactions by insurance companies in the three market sectors: Corporate, Government and Municipal.

We purchase, also from CAI, additional information about the bonds in our sample, including the credit rating of each bond from Moody's and Standard and Poor's (S&P), the credit sector of issuer (e.g.,

whether the bond was issued by an industrial company), the issue date, and maturity date. Hong and Warga (1998) and Schultz (1998) obtain similar information by matching the bond transactions from the CAI data with the Fixed Income Database compiled at the University of Houston with data from Lehman Brothers.

To clean the data of potential errors, we delete the following types of observations from the original sample. One, observations on Saturdays and Sundays and those occurring on June 30, 1995, June 30, 1996, and December 31, 1997 are removed. According to our data vendor, insurance companies may have used these dates for recording transactions which they failed to report in a timely manner. This filter removes 42,177 observations from the data set. Two, all transactions where the actual transaction date is reported as an estimate are deleted. This removes 1,652 observations from the sample. Three, we remove observations on bonds that do not have any ratings information.[5] This removes 25,539 observations. Four, we eliminate observations on bond transactions of non-U.S. issuers. This removes 25,268 observations. Finally, we eliminate all observations where the transaction price per $1,000 face value bond is outside the range $500 to $1500.[6] We do this to minimize incidences of data entry error that may adversely affect our analysis. The final filter removes 2,008 observations.

After instituting the above filters, the sample comprises of 152,452 individual transactions in corporate bonds, 54,518 individual transactions in government bonds and 83,395 individual transactions in municipal bonds over 1995 - 1997.

B. Discussion of the Empirical Determinants of Bond Market Bid-Ask Spreads

In the contingent claims model of Merton (1973), the value of corporate debt 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. Based on research in the equity markets,[7] we expect the bid-ask spread to be related to

[5] We also eliminate observations on bonds with ratings like MIG-1, MIG-2, P-1, P-2, VMIG-1, or VMIG-2. There are no more than 50 such observations in the original data.

[6] The final filter also removes many trades of 500 bonds or less. This may be important because, during the time period examined, CAI rounded the total transaction cost to the nearest thousand dollars by always rounding up to the next highest one thousand dollars. Prices of smaller sized trades will be most affected by the rounding process. Hong and Warga (1998) delete all observations under 500 contracts, but Schultz (1998) does not, on the ground that the difference between the buy price and the sell price (i.e., the realized spread) is independent of rounding errors.

[7] For example, Amihud and Mendelsohn (1986) show that the bid-ask price is a decreasing and convex function of the bid-ask spread.

the bond price and, therefore, to the determinants of debt value as indicated in Merton (1973). We control for the default risk in two ways: by creating dummy variables based on Moody's credit ratings; and, for the corporate sector, by the yield spread, defined as the difference between the bond yield and the 91 day Treasury Bill rate. The yield spread is the market's perception of the credit risk of a corporate bond. 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.

The bid-ask spread is related to the risk of trading a security since it affects dealers' price risk when adjusting their inventory (Grossman and Miller, 1988). To estimate this effect, we use the term to maturity, or the remaining life of a bond, as a proxy for the bond price volatility. Since market yields change over the life of a bond, the price volatility increases with the term to maturity. The maturity term is obtained by calculating the number of years from a bond's transactions date till the maturity date of a non-callable bond. Callable bonds are omitted from our sample.[8]

The risk of trading a bond is also related to its expected liquidity. Greater liquidity makes it easy to buy and sell bonds at short notice, and reduces the price risk dealers face in making inventory adjustments. We use trading volume as a proxy for liquidity, and distinguish between the dollar buy volume per-bond-per-day and the dollar sell volume per-bond-per-day. The practice of many institutions is to hold bonds to maturity and then reinvest the principal. Hence bond sales may be primarily information driven, causing the bid-ask spread to increase (Kyle (1985), Easley and O'Hara (1987)), whereas purchases may be primarily liquidity driven, causing the bid-ask spread to fall. Research on equity trades of institutions also find an asymmetric effect of purchases and sales on transactions costs (see, for example, Keim and Madhavan (1997) and Madhavan and Smidt (1993))**.**

For the corporate bond market, it is often suggested that a younger bond may be traded more frequently, and has lower spreads resulting from greater liquidity.

[8] We also used other measures of bond price volatility, including the Macaulay duration (DURATION), which captures the effect of the change in the price of a bond for a small change in its yield, and convexity (CONVEXITY) to capture the curvature or the convexity of a bond. The three measures, MATURITY, DURATION and CONVEXITY, are highly correlated, and so cannot be used together. We use MATURITY because it the most reliable. DURATION and CONVEXITY may be subject to measurement errors, since we calculate them on the basis of the annual bond yield. The yield is not in our data, and we estimate it using the semi annual coupon payments and the accrued interest payment from the previous coupon interest date.

In the bond markets, each market sector is divided into categories that reflect common economic characteristics. It is implicitly assumed that each issuer category has a different ability to meet their contractual obligations. For the corporate bond market, we use the dummy variables INDSER, BANKFIN and UTILITES to control for bonds issued by the services and industrial sectors, banking and finance companies, and utilities, respectively. For the municipal bond market, we use the dummy variables HCARE and UTILITIES to control for health care and utility bonds, respectively.

Finally, changes in the market structure may affect the bid-ask spread. In particular, if the market has become more transparent over time, the bid-ask spread may increase or decrease, depending upon which trader group is affected most. Theory generally predicts that uninformed traders prefer greater transparency since they are less likely to be pooled with informed traders, whereas large liquidity traders and informed traders like less transparency (Grossman, 1988; Madhavan, 1995; Pagano and Roell, 1996). Dealers also like less transparency, since it reduces price competition with other dealers (Naik, Neuberger and Viswanathan, 1994). We control for changes in the structure of these markets through the dummy variable 1997, which has the value one if a transaction occurred in 1997 and is zero otherwise.

3. Bid-Ask Spreads, Volatility and Liquidity: Descriptive Statistics

A. Bid-ask Spreads in the Corporate, Government and Municipal Bond Markets

We calculate the realized bid-ask spreads per-bond-per-day as follows. For every bond with at least one buy and one sell transaction in a day, we compute the average buying and selling price per bond per day. The spread per bond per day is the difference between the average selling price per bond from the average buying price for that bond. We have 10,462 observations on the bid-ask spread per bond per day in the three market sectors.

The realized spreads are a noisy estimate of transaction costs, since trades take place at different times during the day. Since our data is not time-stamped within a day, we cannot condition on the transactions time. Additionally, the fact that we need to have at least one buy and one sell of a bond on a given day to calculate the spread dictates that our spread estimates are mainly applicable to relatively active

bonds.

Table 1A provides the sample distributions of the bid-ask spread for the three market sectors. All spreads are reported on the basis of a $100 par value. The mean spread is highest for the municipal bond sector at 22 cents, followed by the corporate bond markets at 21 cents, and least for the government bond markets at 11 cents. The mean volume-weighted spread on AAA-rated bonds and junk bonds are 21 cents and 24.33 cents per $100 par value, but the difference is not statistically significant. These numbers are higher than those in Hong and Warga (1998), who report an average volume-weighted spread of 13.28 cents per $100 par value for investment grade corporate bonds, and 19.13 cents for high yield bonds. But, they are lower than the volume-weighted spread of 26.2 cents reported in Schultz (1998).

To check for the robustness of our spread measures, we present, in Table 1B, the corresponding volume-weighted daily dollar spreads. Specifically, the mean volume-weighted dollar spread in the corporate sector is 21.5 cents on a $100 par value basis. Similarly, in the municipal sector, the mean volume-weighted dollar spread is about 22 cents, followed by that in the government sector at about 8 cents. Clearly, these estimates closely resemble the raw spreads reported in Table 1A and, for brevity, we concentrate the remainder of our analysis on the dollar raw spreads alone.

Among the credit sectors, utility sector bonds have higher spreads than the sample average, whereas the industry/services sector s and the banking/financial sectors have lower spreads than the sample average. Industrial and service sector bonds are about 45 per cent of bonds traded in our sample, with banking /finance company and utility issues being about 32 and 14 per cent of the sample, respectively. By comparison, in 1988, industrials and banking/finance companies accounted for about 46% and 37% of new bond offerings.

In the government bond sector, the median raw and volume-weighted spread per bond per day, on the basis of a $100 par, are 11.1 cents and 8.17 cents, respectively. By comparison, in Hong and Warga (1998), the mean volume-weighted spread for Government/Agency securities is 1.84 cents per $100 par value. Our mean *fractional* volume-weighted spread is 0.1 per cent. For 1993, Fleming and Sarkar (1998) compute fractional volume-weighted spreads for all Treasury securities by maturity. Their estimates range

from effectively zero per cent for the 13-week bill to 0.02 per cent for the 30-year Treasury bond. For the 10-year note (closest to the average maturity of our sample), the fractional spread (not reported) is 0.02 per cent.

Finally, for the municipal bond market, the mean raw and volume-weighted spread is 23 cents and 22.93 cents. Among the different credit sectors, spreads are highest for health-care bonds at 23.83 cents and lower than average for utility bonds at 11.43 cents. Our estimate is consistent with available evidence of spreads for institutional investor spreads in the municipal bond market. According to Fabozzi (1996), dealer spreads vary substantially between institutional investors and retail investors. Fabozzi (1996) reports that spreads for institutional investors rarely exceed 50 cents per $100 par value, while those for retail investors vary between 25 cents on large blocks of actively traded stocks to $4 per $100 par value for odd-lot sales of inactive issues.

B. Volatility and Liquidity in the Fixed Income Markets

Table 2 provides the sample distributions of variables that may help predict the level of spreads in the three markets. We find that volatility, as measured by the time-to-maturity, is highest in the municipal bond sector, and about the same in the other two markets.[9] Trading activity, as measured by the dollar buy and sell volumes, is least in the municipal bond market, followed by the corporate and government bond markets, respectively.

The maturity level is intermediate in all three sectors, consistent with the change in business practices of the insurance companies who place increased emphasis on shorter-term-oriented term life and other policies instead of more traditional whole-life policies and investments in long-term bonds. In the Municipal Bond market, the time-to-maturity is 11.29 years, which is at the upper range of the intermediate maturities. In the corporate bond market, the average time to maturity is 9.18 years, similar to the median

[9] The average Macaulay duration of corporate bonds in our sample is a little more than 6 years, less than the average time-to-maturity, while the average convexity is about 57 years. In the government sector, the average Macaulay duration is a little more than 6 years, and the convexity is about 59 years, comparable to the corporate bond sample. For municipal bonds, both Macaulay duration, at 8.11 years, and convexity, at almost 92 years, are the highest of the three sectors.

time to maturity of 8.48 years reported in Schultz (1998).[10] In the Treasury Bond market, the average time-to-maturity is 8.63 years, slightly less than the corporate bond sector.

The average dollar value of a transaction is the largest in the government sector, at about $7.7 million for purchases and about $8.5 million for sales. In comparison, Fleming and Sarkar (1998) report the trade size for the 10-year Treasury bond note as $5.70 million. For the municipal bond market, the average dollar transaction is about $3.4 million for purchases and $3.9 million for sales. In the corporate bond market, the mean dollar trade is about $4.40 million, both for sales and purchases, which is larger than the median trade size of $1.513 million reported in Schultz (1998). The size of insurance company transactions in our sample appears to be fairly representative of the size of the average dealer market transaction. As evidence, the average size of a corporate bond trade on the New York Stock Exchange was $20,000 in 1997, or less than one-half of one per cent of the size of a corporate bond trade in our sample. This is similar to the trade size of *all* transactions on the over-the-counter market, relative to the exchange markets.

The mean age of the bonds is lowest in the Government bond market, at 2.75 years, and about 3.5 years in the other two markets.

4. A Comparison the Bid-Ask Spread in the Corporate, Government and Municipal Bond Markets

A. Determinants of the Bid-Ask Spread for the Corporate, Government and Municipal Bond Markets using the Generalized Method of Moments (GMM) Estimation

In the previous section, we saw that the three sectors differ in the level of trading activity and measures of risk, and these differences may account for the differences in the spread. For example, the municipal bond sector has the highest mean spread but also the lowest level of trading volume and the highest volatility. In section *B*, we separately examine the set of factors that determine the bid-ask spread in each market. In section *C*, we directly compare the bid-ask spread in the three sectors, based on our results in section *B.*

[10] These numbers compare well with those in the Merrill Lynch Taxable Bond Index, Corporate Master, which reports that the average maturity of corporate issues with $10 million or more outstanding has declined continuously from about 20 years in 1978 to 13 years and 7 months in 1988.

Preliminary diagnostics indicated the presence of significant heteroskedasticity in the error term of an equation of the form of (1). Since the functional form of heteroskedasticity in the error terms is unknown, to proceed ahead with an OLS-type estimation with an assumption of the functional form, would in all likelihood leave us with a mis-specified model with its associated problems. To ensure that our results are robust to this possibility, we estimate the price change regression by the more robust Generalized Method of Moments (GMM) technique proposed by Hansen (1982). Note that, unlike the OLS procedure, the GMM technique demands very weak assumptions on the error term -- only that it have well-defined unconditional moments, including when the moments are conditionally varying. Hence we use the GMM technique to estimate the following regression specification:

$$Spread_t = Intercept + a_1\, Maturity_t + a_2\, Age_t + a_3\, BVolume_t + a_4\, 1997_t + Additional\ Dummy\ variables + error_t \qquad (1)$$

where, for a specific bond on day *t*, the explanatory variables are defined as follows.

***Spread**$_t$*: the daily bid-ask spread for the bond in dollars.

Maturity**$_t$:** the time-to-maturity for the bond in years. A higher value is likely to increase volatility and, therefore, spreads.

Age**$_t$:** the time in years between the bond transaction date and its issuance date.

BVolume**$_t$:** the log of the daily dollar value of purchases for the bond. We do not include both purchases and sales in the same regression, since the two variables are highly correlated. However, in a later specification, we substitute the log of the daily dollar value of sales for *BVolume*.

1997**$_t$:** a dummy variable taking the value one if the bond traded in the year 1997, and 0 otherwise. The transaction year dummy is included to control for structural changes in the market. As stated in the introduction, these markets have been under increasing public scrutiny in the past few years and several regulatory changes have been proposed. It may be that these external events have caused changes in dealer behavior, as Christie et al (1994) have documented for the NASDAQ market.

Additional dummy variables: for both the corporate and municipal sectors, we control for credit risk with

dummy variables for bonds with Moody's ratings in the categories A1 to A3. For example, the dummy A1 is one for bonds rated A1 by Moody's, and zero otherwise. Also, we define a Utility Sector dummy with value one for bonds issued by Utility companies, and zero otherwise.

For the corporate sector alone, we include additional dummy variables for bonds with Moody's ratings BAA1 to BAA3. We also define the dummy variable AAA & AA, which is one for bonds, rated AAA or AA by Moody's, and zero otherwise. We combine these bonds because we only have 48 AAA rated bonds in the corporate bond sample. The omitted rating category is Junk, those bonds rated Ba or below by Moody's.

For the municipal sector alone, we include a dummy variable for bonds with Moody's rating AA, and another dummy variable Below A3, which is one for bonds rated below A3 by Moody's, and zero otherwise. This category combines bonds rated BAA1 and below since the number of bonds in each of the combined categories was too small. The omitted rating category is AAA, those bonds rated AAA by Moody's.

B. GMM Regression Results for Individual Markets

The second column of Table 3, titled Model 1, shows the results of estimating regression (1) for the corporate bond sector. The adjusted R-square is 2.28 per cent and estimated coefficients of all the non-dummy explanatory variables are significant. Two of the estimated dummy coefficients are significant as well. Of the significant estimates, the coefficient on *Maturity* is positive, indicating that the spread increases by 2 cents for every one-year increase in the remaining time to maturity of a bond. The coefficient on *Age* is also positive, indicating that the spread increases by one cent when the bond ages by one more year. An additional $1 million purchase decreases the spread by about 7 cents, consistent with the idea that bond purchases are primarily viewed as liquidity events. Of the credit rating dummies, the coefficient on the combined *AAA/AA* dummy is negative, and indicates that the spread on these bonds is 21 cents lower relative to corporate junk bonds. The remaining credit rating dummies are not significant. Finally, the bid-ask spread for corporate bonds decreased by 7 cents in 1997, relative to the previous two years. The utility sector dummy is not significant.

The second column of Table 4, titled Model 1, shows the results for estimating regression (1) for the government bond sector. The adjusted R-square is essentially zero. While the estimated coefficients have the predicted signs, none are significant. These results indicate that our specification cannot capture the determinants of the realized bid-ask spread in the government sector.

The second column of Table 5, titled Model 1, shows the results for estimating regression (1) for the municipal bond sector. The adjusted R-square is 1.87 per cent. Similar to the corporate bond market, estimated coefficients on the volatility and liquidity variables are significant. The bid-ask spread increases by one cent with every additional year in the *Maturity*, and the spread decreases by 2 cents for an additional $1 million purchase. This further confirms our conjecture that bond purchases are viewed as liquidity events. Similar to the corporate market, the bond spread was lower in 1997 by 11 cents relative to the previous two years. Unlike the corporate sector, the *Age* of the bond is not a significant determinant of the bid-ask spread. Further, none of the credit sector dummies have significant coefficients.

In our second regression specification, we reestimate regression (1) using GMM, but after substituting *SVolume* for *BVolume*, as follows:

$$\mathbf{Spread_t = Intercept + a_1\ Maturity_t + a_2\ Age_t + a_3\ Svolume_t + a_4\ 1997_t}$$
$$\mathbf{+\ Additional\ Dummy\ variables + error_t} \qquad \mathbf{(2)}$$

where $SVolume_t$ is the log of the daily dollar value of sales of a bond on day *t* and the additional dummy variables are the same set described earlier for Model 1.

Our conjecture is that the sale of corporate and municipal bonds may be information driven, leading dealers to widen the bid-ask spread. This conjecture is not supported by the results for the corporate and municipal bond sectors, presented in the third column (titled Model 2) of Tables 3 and 5. The coefficient of *SVolume* is negative and not significant in both markets, and its effect in these two markets is to lower the adjusted R-square. However, the sign and significance of the remaining variables are unaffected in both markets. In the government sector, since there is no private information, we interpret *SVolume* as a liquidity variable. The results are in the third column, titled Model 2, of Table 4. Consistent with our interpretation, the coefficient of *SVolume* is negative and significant, and its effect is to increase the adjusted R-square to

1.04 per cent from zero in Model 1.

For the final regression specification, we use unique explanatory variables that may help determine the bid-ask spread for a particular sector. Specifically, for the corporate bond market, we replace the credit rating dummy variables with the *Yield Spread*, as follows:

$$\mathbf{Spread_t = Intercept + a1\ Maturiy_t + a2\ Age_t + a3\ Bvolume_t + a41997_t + Yield\ Spread_t}$$
$$\mathbf{+ Utility\ sector\ dummy + error_t} \qquad \mathbf{(3a)}$$

where *Yield Spread*$_t$ is defined as the difference between the yield on the bond on day *t* and the three month Treasury Bill rate on day *t*. We calculate the corporate yield on the basis of the accrued interest convention used in the market. The *Yield Spread* measures the market's valuation of credit risk, and so we expect the bid-ask spread to increase with it.

The results are in column four (titled Model 3) of Table 3. As expected, the estimated coefficient of *Yield Spread* is positive, but not significant. The adjusted R-square improves slightly relative to Model 1, but the 1997 transaction dummy is no longer significant. The sign and significance of the remaining estimates do no change from Models 1 and 2.

For the municipal bond market, we use the additional explanatory variable *Annual Yield*, as follows:

$$\mathbf{Spread_t = Intercept + a_1\ Maturity_t + a_2\ Age_t + a_3\ Bvolume_t + a_4\ 1997_t + Annual\ Yield_t}$$
$$\mathbf{+ Credit\ Ratings\ dummies + Utility\ sector\ dummy + error_t} \qquad \mathbf{(3b)}$$

where *Annual Yield* is just the yield of the bond on day *t*. Since the *Yield* is a before-tax return, we hope to capture tax subsidies embedded in the municipal bonds with this variable. A lower yield implies a higher tax subsidy, which makes the bond more attractive, and so we expect the *Annual Yield* to be positively associated with the bid-ask spread.

The results are in column four (titled Model 3) of Table 5. As predicted, the estimated coefficient of *Annual Yield* is positive and coefficient, indicating that the bid-ask spread decreases by 4 cents for every one per cent decrease in the yield. Estimates that were significant in Models 1 and 2 remain so. The adjusted R-square improves, and the intercept is no longer significant, indicating a better fit for Model 3 compared to the

other Models.

For the government bond market, we substitute the *Time To Maturity* variable with the *Term Structure* variable, as follows:

$$Spread_t = Intercept + a1\ Term\ Structure_t + a2\ Age_t + a3\ Svolume_t + a41997_t + error_t \qquad \textbf{(3c)}$$

where $Term\ Structure_t$ is defined as the difference between the yield on the government bond on day *t* and the three month Treasury Bill rate on day *t*. The *Term Structure* measures the market's valuation of maturity risk, and so we expect the bid-ask spread to increase with it. The result is reported in column four (titled Model 3) of Table 4. Although the adjusted R-square increases significantly from 1.04 per cent in Model 2 to 3.86 per cent, the estimated coefficient of *Term Structure* is not significant, although it has the right sign.

C. A Comparison of the Bid-Ask Spread in the Corporate, Government and Municipal Bond Markets -- A Pooled Regression Approach

In this section, we pool observations across the three market sectors to test whether -- controlling for volatility, credit risk and liquidity -- bid-ask spreads are different in the three sectors. A potential problem with pooling is that it assumes a common set of variables explaining variations in the bid-ask spread in all markets, whereas the results from section *B* indicate some differences in the set of explanatory variables across markets. Our approach is to start with a set of explanatory variables that were found to be significant in all different regression specifications used in the corporate and municipal markets, and later check whether the results are sensitive to different specifications for the government sector. This leads us to use Model 1 as our initial specification.

Accordingly, we estimate (1) with the pooled data. The additional explanatory variables are a dummy for Corporate sector bonds and another dummy for the Municipal sector bonds. The coefficients of these dummies indicate whether corporate and municipal bonds have higher bid-ask spreads than government bonds, after controlling for other factors. To avoid collinearity between these dummies and the intercept, we omit the intercept term. The remaining explanatory variables are the same as before, except for the credit rating dummies. We define a dummy for every rating category except *AAA*. Thus, we start with the *AA* dummy and end with the *Junk* dummy, which includes all ratings categories *Ba* and below.

The results are reported in column two (titled Model 1) of Table 6. The bid-ask spread for municipal sector bonds is higher by 9 cents per $100 par value compared to government bonds, but bid-ask spreads for corporate and government bonds are not statistically different. In addition, bid-ask spreads were lower for all sectors by 7 cents in 1997, compared to the previous two years. Estimates of the time to maturity, the age of the bond, and the *BAA3* dummy are also significant, and have the correct signs.

D. Robustness Checks

From the results in section *5B*, Model 1 is a poor fit in the government sector, but a good fit for the Corporate and Municipal bond sectors. So, we repeat the analysis of section *5C*, except that we pool observations from the Corporate and the Municipal markets only. We drop the Corporate sector dummy and retain the Municipal sector dummy. For consistency, we require that the bid-ask spread in the municipal sector should be about 9 cents higher than in the corporate sector. Further, the remaining estimates should be stable in their signs, magnitude and significance.

The results for this exercise are reported in column three (titled Model 2) of Table 6, and they are consistent with our requirements. The bid-ask spread in the municipal bond sector is significantly higher than that in the corporate sector by 8 cents, and the remaining estimates are robust with respect to sign, magnitude and significance.

As a further robustness check, we reestimate (1) for the Corporate and Government bond markets only, but replacing *BVolume* with *TVolume*, the log of the total daily dollar value of transactions. This substitution is meant to account for the fact that, in the individual market regressions, the estimated coefficient of *BVolume* is negative and significant but the estimated coefficient of *SVolume* is not significant for the Corporate bond market; while the opposite is true for the Government bond market. For this specification, we only use the Corporate sector dummy. For consistency, we require that the coefficient on the Corporate sector dummy should not be different from zero. The results, which are reported in column four (titled Model 3) of Table 6, show that this is indeed the case.

As a final robustness check, we estimate the bid-ask spread in the corporate and municipal markets as a seemingly unrelated regression system (SUR). We use the estimates of the SUR regressions as initial

values in a system-GMM specification. An advantage of the SUR method is that the bid-ask spread in each market can be explained by the set of explanatory variables best suited for that market, and yet the common information in each market is also accounted for by the contemporaneous correlation between the error terms. Thus, by strategically combining the SUR and GMM techniques, we are able to simultaneously account for both the heteroskedastic error terms as well as the contemporaneous correlation in the error terms across the two markets.

To implement the SUR estimation technique, we need to create a new sample based on a single daily average number for each relevant variable in each market sector.[11] This implies that we consider only those days when there is trading in all relevant markets. In the same spirit, the credit ratings are assigned numerical values to obtain an average credit rating for different bonds trading on the same day. As the regression specification, we use Model 1 from Tables 3 and 5. The results (not reported, but available upon request) are qualitatively similar to those found earlier. Specifically, the bid-ask spread that *cannot* be predicted from the SUR/GMM estimation is higher by about 2 cents for the municipal market, relative to the corporate market.

Thus, the extensive robustness tests performed in this section appear to attest to the stability of our regression estimates in the three markets

E. The Factors That Determine Spreads In The Three Market Sectors

In summary, what are the relevant factors determining realized bond spreads in the three market sectors examined in this paper? Liquidity, as measured by *Bvolume/ SVolume* in all three market sectors and also by *Age* in the corporate sector are important determinants of spread. Further, the *Maturity* risk factor appears to be an important determinant of spreads in all three market sectors although its impact on the government sector is relatively indirect compared to the corporate and municipal sectors. Not surprisingly, credit risk is an important determinant of spreads in the corporate and municipal sectors. Finally, the municipal sector has an additional tax factor in *Yield* that significantly determines the spread in this market.

[11] Other relevant details of SUR estimation are provided in Greene (1993).

5. The Effect of Large Institutions and Dealers on the Bid-Ask Spread

In this section, we examine the effects of large institutions and large dealers on the realized bid-ask spreads. Keim and Madhavan (1997) document significant differences in equity trading costs across institutions even after adjusting for differences in trading styles. Cao, Choe and Hathaway (1997) and Corwin (1998) document significant heterogeneity among NYSE specialist firms. In a similar vein, the bid-ask spread for large bond dealers and institutions may differ from smaller dealers and institutions.

Table 7 shows the top Institutions within each market sector with a cumulative market share of just over 50% of the average dollar value of trades over the sample period. Panel A presents the top 20 Institutions in the corporate sector, panel B presents the top 17 Institutions in the government sector and panel C presents the top 15 Institutions in the municipal market. In all three panels, the top 4-5 institutions in each market sector account for over 25% of the dollar-value of all trades. The list of large institutions include some money management firms acting as agents of insurance companies. The CAI transactional database reports the institution doing the trading regardless of whether the institution is a bond-portfolio manager or the end user of the bonds.

Table 8 lists the top bond dealers with at least 50% of the market share of the average trading revenues in each of the three market sectors. The total and average dealer revenues are calculated as the difference between dealer sales and dealer purchases. It takes fewer dealers than institutions to account for a 50% market share, which suggests that there may be greater concentration among dealers than among institutions in each of the market sectors.

A. The Bid-Ask Spread for the Ten Largest Dealers and the Others

We calculate the bid-ask spread for the top-10 dealers by dollar value traded and those for the remaining dealers in each market sector. For bonds with at least one buy and one sell per dealer each day, we subtract the average sell price of each bond per day per dealer from the average buy price of the same bond over the same day by the same dealer. The average bid-ask spread per top-10 dealer per bond per day

is calculated by averaging the bid-ask spread per dealer per bond per day over all top-10 dealers. The average bid-ask spread for the non-top-10 dealers is similarly calculated.

Panel A of Table 9 presents the bid-ask spread for the ten largest dealers and the remaining dealers in each market sector, identified from the lists in Table 8. We use a Wilcoxon non-parametric test of equality of medians to test whether the bid-ask spread is statistically different between the two dealer groups. In the Corporate sector (panel A), the mean bid-ask spread is 26 cents for the ten largest dealers and 13 cents for the other dealers, and the difference is significant at the 0.01 level. In the Municipal sector, the mean bid-ask spread is 20 cents for the ten largest dealers and 19 cents for the others, a difference also significant at the 0.01 level. Finally, in the Government sector, there is no statistical difference between the bid-ask spread of the top-10 dealers and the rest.

B. The Bid-Ask Spread for the Ten Largest Institutions and the Others

Panel B of Table 9 presents the bid-ask spread for trades of the top-10 institutions and those of other institutions, in each market sector. The top-10 institutions in each market sector are identified from Table 7. The bid-ask spread is not statistically different (at the 0.10 level) for the ten largest institutions and others in the corporate and government sectors. For example, in the Corporate sector, the mean bid-ask spread is about 14 cents for the top-10 and 15 cents for the non-top-10 institutions. In the Government sector, the mean bid-ask spread is 4 cents for with top-10 institutions and 9 cents for the others. In the municipal sector, the mean bid-ask spread is 25 cents for the top-10 institutions and about 16 cents for the non-top-10 institutions. Although the numbers for the municipal sector are distinct from the other two market sectors, it should be emphasized that, before drawing any definitive conclusions, a multivariate analysis of the bid-ask spreads, controlling for its various determinants, needs to be performed. We do this in section 5D.

C. Characteristics of Bonds Traded by the Ten Largest Dealers and Others

From panel A of Table 9, we see that the spreads associated with the top-10 dealer transactions are

significantly higher that those associated with the non-top-10 dealers. It is likely that this difference could arise from a significantly different (and riskier) universe of bonds traded by the top-10 dealers.

To investigate if the top-10 dealer population does indeed trade a different universe of bonds than does the non-top-10 population, we present in Table 10 a break down of the percentage of common and distinct bonds transacted by each group of dealers within each market sector. Table 10 shows that, in the Corporate sector, only about 8% of the bonds are common to both groups, the ten largest dealers and the others. In the Government and municipal sectors, the per cent of commonly traded bonds are about 30% and 2%, respectively. Thus, the top-10 dealers appear, for the most part, to be dealing in bonds that are distinct from those traded by the rest of the dealers.

To investigate if the top-10 dealer population trade inherently riskier bonds compared to the non-top-10 dealers, we present, in Table 11, summary statistics of the specific bond characteristics traded by the two groups of dealers for each market sector. In the corporate sector (panel A), bonds traded by the top-10 dealers have higher yields, higher duration, higher convexity, longer time to maturity, lower age and somewhat lower coupon rates. In the government sector, characteristics of bonds traded by the top-10 dealers and the rest do not appear to be different. In the municipal sector (panel C), the annual duration of the top-10 dealer executed bonds is higher, and the bonds are younger. Thus, the evidence suggests that, in the corporate and municipal sectors, the top-10 dealers execute bonds that are riskier but more active (younger) than the non-top-10 dealers. However, the evidence for the municipal bonds is weaker than that for corporate bonds. While riskier bonds would command higher spreads, younger bonds are more liquid and, ceteris paribus, would argue for lower spreads. The resultant higher spreads observed for the top-10 dealer executed bonds would then be the net of the two counteracting forces.

D. Is the Bid-Ask Spread Higher for Large Dealers and Institutions?

In Table 12, we examine whether the ten largest dealers earn higher spreads, after controlling for

differences in the characteristics of bonds traded by the dealer groups. We regress the realized bid-ask spread per bond for each dealer on a dummy variable that equals one if the dealer belongs to the Top 10 group, and is zero otherwise. In addition, we include variables that proxy for the risk and liquidity of the bonds. The regression specifications are the ones earlier found to provide the best explanation of the bid-ask spread in each sector (see Tables 3 to 5). To be specific, they correspond to model one for the corporate and municipal sectors, and model 2 for the government sector.

The results show that the ten largest corporate bond dealers earn 15 cents per $100 par value more than the other dealers, after controlling for bond characteristics. This result does not change when we also control for the other bond characteristics reported in Table 11, such as duration, convexity, the coupon rate and the annual yield. In the other two markets, the differences between the bid-ask spreads of the ten largest dealers and the rest are not significant.

The results for large institutions (not reported) are consistent with the results in Panel B of Table 9. After controlling for bond characteristics, the bid-ask spread is not different for the ten largest institutions compared to the others.

In summary, our multivariate results substantiate the univariate results of section C and attest to the robustness of our conclusions.

6. Conclusion

In the current paper, we estimate the liquidity of the U.S. corporate, municipal and government bond markets for the years 1995 to 1997, based on newly available transactions data pertaining to the bond dealer markets. Since these three markets vary with respect to transparency and risk, a cross-market comparison is a natural experiment in studying the effects of these factors on market liquidity.

We find that, on a $100 par value basis, the mean spread is the highest in the municipal bond market at about 22 cents, followed by the corporate bond market at about 21 cents and the government bond market at about 11 cents. The spread is generally higher for bonds with lower Moody's ratings, and lower in

1997 than in the earlier years for all markets. In the corporate and municipal markets, the spread appears to have decreased in each successive year.

We examine the determinants of the realized bid-ask spread using the GMM technique and find that liquidity is an important determinant of the realized bid-ask spread all three markets. Specifically, in all markets, the realized bid-ask spread decreases in the trading volume. Additionally, risk factors are important in the corporate and municipal markets. In these markets, the bid-ask spread increases in the remaining-time-to-maturity of a bond. The corporate bond spread also increases in credit risk and the age of a bond. The municipal bond spread increases in the after-tax bond yield. Additionally, the bid-ask spread is lower in 1997 compared to the previous two years--by 7 cents for corporate bonds and 10 cents for municipal bonds. However, this is not the case in the government bond market. The result is consistent with the idea that transparency in the corporate and municipal bond markets has improved, perhaps as a consequence of increased regulatory scrutiny. Finally, in a pooled regression framework, we find that the municipal bond spread is higher than the government bond spread by about 9 cents per $100 par value, but the corporate bond spread is not.

We also find that the bid-ask spread for the ten largest dealers in our sample is statistically higher than that of other dealers in the corporate and the municipal bond markets. After controlling for differences in characteristics of bonds traded by the large dealers and others, we find that the corporate bond dealers earn 15 cents per $100 par value higher than the other dealers but, in the municipal bond market, the bid-ask spread is not different for the large dealers.

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Table 1A. Distribution of the Raw Bid-Ask Spread (in Dollars) of Corporate, Government and Municipal Bonds, 1995-97.

	CORPORATE SECTOR					GOVERNMENT SECTOR					MUNICIPAL SECTOR				
Panel A															
	Num of distinct bonds	Num of obs	Mean	Median	Std Dev	Num of distinct Bonds	Num of obs	Mean	Median	Std Dev	Num of distinct bonds	Num of obs	Mean	Median	Std Dev
Whole Sample	1779	2499	0.2113	0.0400	1.0003	225	1932	0.1107	0.0452	1.7250	1118	1172	0.2218	0.1003	0.4059
1995	540	625	0.2996	0.1328	1.5059	89	526	0.1296	0.0288	2.2080	307	308	0.3217	0.2161	0.5114
1996	701	1033	0.1882	0.0000	0.8115	72	738	0.1508	0.0418	1.9278	380	391	0.2134	0.1000	0.4152
1997	538	841	0.1739	0.0450	0.6883	64	668	0.0514	0.0503	0.8157	431	473	0.1636	0.0684	0.2938
Panel B															
For Moody's AA Bonds	192	256	0.1071	0.0000	0.8663						384	414	0.2299	0.1269	0.3993
For Moody's A Bonds	749	1069	0.2058	0.0000	0.6390						127	133	0.1817	0.1200	0.3976
For Moody's Junk Bonds	280	374	0.2314	0.1093	1.5392										
Panel C															
Industrial/Service	798	1169	0.2051	0.0685	1.0100										
Banking/Finance	562	775	0.1728	0.0000	0.6088										
Utility	252	330	0.2622	0.1000	1.0100						222	236	0.2127	0.1259	0.2923
Health Care											21	24	0.3923	0.0978	0.6565

Note:

- All spreads across the market sectors are statistically distinct at the 0.01 level (from Wilcoxon non-parametric tests).
- Spreads in panel B are not statistically different from one another at the 0.10 level (from Wilcoxon non-parametric tests).

Table 1B. Distribution of the Volume-weighted Raw Bid-Ask Spread (in Dollars) of Corporate, Government and Municipal Bonds, 1995-97.

	CORPORATE SECTOR					GOVERNMENT SECTOR					MUNICIPAL SECTOR				
Panel A															
	Num of distinct bonds	Num of obs	Mean	Median	Std Dev	Num of distinct Bonds	Num of obs	Mean	Median	Std Dev	Num of distinct bonds	Num of obs	Mean	Median	Std Dev
Whole Sample	1779	2499	0.2150	0.0400	0.9967	225	1932	0.0813	0.0389	1.7953	1118	1172	0.2209	0.1000	0.4031
1995	540	625	0.2997	0.1328	1.4877	89	526	0.0844	0.0220	2.2346	307	308	0.3191	0.2149	0.5033
1996	701	1033	0.1986	0.0000	0.8211	72	738	0.1241	0.0381	2.0732	380	391	0.2137	0.1000	0.4161
1997	538	841	0.1724	0.0461	0.6889	64	668	0.0315	0.0484	0.8041	431	473	0.1629	0.0684	0.2925
Panel B															
For Moody's AA Bonds	192	256	0.1249	0.0000	0.8083						384	414	0.2291	0.1283	0.3984
For Moody's A Bonds	749	1069	0.2065	0.0000	0.6508						127	133	0.1813	0.1200	0.3972
For Moody's Junk Bonds	280	374	0.2433	0.1154	1.5452										
Panel C															
Industrial/Service	798	1169	0.2078	0.0800	1.0089										
Banking/Finance	562	775	0.1769	0.0000	0.5894										
Utility	252	330	0.2663	0.1000	1.0159						21	24	0.3904	0.0982	0.6455
Health Care											222	236	0.2110	0.1228	0.2928

Note:

- All spreads across the market sectors are statistically distinct at the 0.01 level (from Wilcoxon non-parametric tests).
- Spreads in panel B are not statistically different from one another at the 0.10 level (from Wilcoxon non-parametric tests).

Table 2. Distribution of Bond Characteristics in the Corporate, Government and Municipal Sectors, 1995-1997.

Panel A: Corporate Bonds

VARIABLE	Num. Distinct Bonds	Num. obs	MEAN	STD	MAX	Q3	MED	Q1	MIN
Annual yield	1776	2499	0.0735	0.0136	0.2332	0.0778	0.0710	0.0668	-0.0315
Duration	1776	2466	6.1239	2.5824	20.5000	7.1823	5.7664	4.2878	1.4430
Convexity	1776	2466	57.0012	57.9699	417.6770	61.7884	38.1697	20.9619	2.6335
Time to maturity	1792	2486	9.1777	7.4128	99.3425	9.7589	7.1164	4.8356	1.1890
Bond age	1792	2437	3.5765	4.6010	67.7753	4.3973	2.8630	1.5014	-0.6247
Coupon rate	1792	2477	0.0777	0.0148	0.1400	0.0875	0.0763	0.0675	0.0000
Average price	1805	2499	1022.28	72.45	1473.67	1058.25	1011.00	990.91	500.00
Dollar Buy volume	1805	2499	4.4229	7.6329	159.4490	5.3230	2.1160	0.9670	0.0600
Dollar sell volume	1805	2499	4.4457	5.4586	46.5220	5.3030	2.3560	1.0050	0.0010

Panel B: Government Bonds

VARIABLE	Num. Distinct Bonds	Num. obs	MEAN	STD	MAX	Q3	MED	Q1	MIN
Annual yield	209	1886	0.0635	0.0061	0.1141	0.0666	0.0629	0.0595	0.0475
Duration	209	1885	6.0749	2.9393	14.0636	7.1264	5.7506	3.9997	0.9790
Convexity	209	1885	58.7678	68.6032	289.7408	60.4080	37.6792	18.1126	1.3734
Time to maturity	222	1923	8.6256	7.2009	30.1083	9.2137	6.5562	4.3068	0.8356
Bond age	222	1666	2.7498	2.6225	20.9644	3.7507	2.2685	0.8658	-0.0164
Coupon rate	222	1893	0.0667	0.0096	0.1338	0.0725	0.0650	0.0600	0.0470
Average price	226	1932	1019.48	65.46	1417.40	1037.97	1008.78	993.00	509.34
Dollar buy volume	226	1932	7.7370	22.3724	365.7170	5.4015	1.6135	0.4830	0.0010
Dollar sell volume	226	1932	8.4548	23.5339	354.3880	6.6950	2.0780	0.7215	0.0010

Panel C: Municipal Bonds

VARIABLE	Num. Distinct Bonds	Num. obs	MEAN	STD	MAX	Q3	MED	Q1	MIN
Annual yield	1170	1229	0.0544	0.0086	0.1521	0.0568	0.0532	0.0500	0.0391
Duration	1170	1229	8.0922	2.7928	15.1074	10.1596	8.3730	5.9035	1.4620
Convexity	1170	1229	90.5676	60.9117	333.1750	126.4541	82.7718	39.5389	2.7886
Time to maturity	1170	1229	11.1836	5.5722	32.2877	14.4370	10.8000	6.7247	1.1918
Bond age	1170	1229	3.5109	3.6658	35.8247	4.0849	2.8685	1.6603	0.0137
Coupon rate	1170	1229	0.0577	0.0093	0.1263	0.0620	0.0565	0.0515	0.0313
Average price	1170	1229	1022.81	58.30	1386.64	1057.37	1020.09	994.21	540.05
Dollar Buy Volume	1170	1229	3.0384	3.4637	38.5240	4.3535	1.9505	1.0015	0.0200
Dollar sell volume	1170	1229	3.4732	3.9299	38.4880	4.9250	2.1245	1.0265	0.0030

Table 3. Determinants of the Bid-Ask Spread for Corporate Bond Transactions, 1995-1997.

The dependent variable is the bid-ask spread per bond per day denominated in dollars per $100 par value. The estimates and standard errors for parameter significance are obtained from a Generalized Method of Moments (GMM) regression. The p-values of parameter significance are in parentheses under the respective estimates. All coefficient estimates significant at the 0.10 level or higher are indicated in bold.

Independent Variables	**Model 1**	**Model 2**	**Model 3**
	Estimated Coefficients (Two tailed p-value)	**Estimated Coefficients (Two tailed p-value)**	**Estimated Coefficients (Two tailed p-value)**
Intercept	0.6 (0.0006)	0.09 (0.64)	**0.41 (0.0153)**
Time to maturity (years)	**0.02 (0.0001)**	**0.02 (0.0001)**	**0.02 (0.0001)**
Bond age (years)	**0.01 (0.0287)**	**0.01 (0.0132)**	**0.01 (0.0922)**
Log of Buy Volume	**-0.07 (0.0003)**	---	**-0.06 (0.0018)**
Log of Sell Volume	---	-0.002 (0.9)	---
Yield Spread	---	---	0.05 (0.17)
Moody's AAA & AA dummy	**-0.21 (0.0369)**	**-0.18 (0.08)**	---
Moody's A1 dummy	-0.07 (0.4369)	-0.05 (0.62)	---
Moody's A2 dummy	-0.07 (0.44)	-0.07 (0.46)	---
Moody's A3 dummy	-0.08 (0.35)	-0.09 (0.33)	---
Moody's BAA1 dummy	-0.02 (0.79)	-0.04 (0.67)	---
Moody's BAA2 dummy	-0.1 (0.32)	-0.12 (0.23)	---
Moody's Baa3 dummy	0.07 (0.65)	0.06 (0.7)	---
Utility Sector Dummy	0.03 (0.67)	0.01 (0.84)	0.04 (0.56)
1997 Transaction Dummy	**-0.07 (0.093)**	***-0.05 (0.18)***	-0.06 (0.1012)
Number of observations	2399	2399	2380
Adjusted R-square (per cent)	2.28	1.54	2.38

Table 4. Determinants of the Bid-Ask Spread for Government Bond Transactions, 1995-1997.

The dependent variable is the bid-ask spread per bond per day denominated in dollars per $100 par value. The estimates and standard errors for parameter significance are obtained from a Generalized Method of Moments (GMM) regression. The p-values of parameter significance are in parentheses under the respective estimates. All coefficient estimates significant at the 0.10 level or higher are indicated in bold.

Independent Variables	**Model 1**	**Model 2**	**Model 3**
	Estimated Coefficients (Two tailed p-value)	**Estimated Coefficients (Two tailed p-value)**	**Estimated Coefficients (Two tailed p-value)**
Intercept	0.14 (0.54)	0.91 (0.0031)	0.42 (0.18)
Time to maturity (years)	0.01 (0.52)	0.01 (0.37)	---
Bond age (years)	0.01 (0.65)	-0.002 (0.95)	-0.03 (0.41)
Log of Buy Volume	-0.01 (0.62)	---	---
Log of Sell Volume	---	**-0.11** **(0.0125)**	**-0.11** **(0.009)**
Term Structure	---	---	0.63 (0.15)
1997 Transaction Dummy	-0.10 (0.18)	-0.10 (0.17)	-0.15 (0.12)
Number of observations	1666	1666	1642
Adjusted R-square (per cent)	-0.04	1.04	3.86

Table 5. Determinants of the Bid-Ask Spread for Municipal Bond Transactions, 1995-1997.

The dependent variable is the bid-ask spread per bond per day denominated in dollars per $100 par value. The estimates and standard errors for parameter significance are obtained from a Generalized Method of Moments (GMM) regression. The p-values of parameter significance are in parentheses under the respective estimates. All coefficient estimates significant at the 0.10 level or higher are indicated in bold.

Independent Variables	**Model 1**	**Model 2**	**Model 3**
	Estimated Coefficients (Two tailed p-value)	**Estimated Coefficients (Two tailed p-value)**	**Estimated Coefficients (Two tailed p-value)**
Intercept	**0.36 (0.0001)**	**0.22 (0.0028)**	0.18 (0.13)
Time to maturity (years)	**0.01 (0.0132)**	**0.01 (0.0375)**	**0.005 (0.0934)**
Bond age (years)	-0.003 (0.31)	-0.002 (0.50)	-0.004 (0.22)
Log of Buy Volume	**-0.02 (0.0887)**	---	**-0.02 (0.08)**
Log of Sell Volume	**---**	-0.0003 (0.98)	**---**
Annual Yield	**---**	**---**	**0.04 (0.04)**
Moody's AA dummy	0.003 (0.91)	$-0.3*10^{-4}$ (0.99)	0.01 (0.73)
Moody's A1 dummy	-0.07 (0.16)	-0.07 (0.14)	-0.07 (0.16)
Moody's A2 dummy	0.01 (0.91)	0.005 (0.95)	$3*10^{-4}$ (0.9957)
Moody's A3 dummy	-0.01 (0.92)	-0.01 (0.85)	-0.03 (0.65)
Below Moody's A3 dummy	0.06 (0.79)	0.06 (0.41)	0.03 (0.65)
Utility Sector Dummy	-0.03 (0.27)	-0.03 (0.23)	-0.03 (0.33)
1997 Transaction Dummy	**-0.11 (0.0001)**	**-0.11 (0.0001)**	**-0.10 (0.0001)**
Number of observations	1171	1171	1170
Adjusted R-square (per cent)	1.87	1.56	2.34

Table 6. Comparison of the Bid-Ask Spread for Corporate, Government and Municipal Bond Transactions, 1995-1997.

The dependent variable is the spread per bond per day denominated in dollars per $100 par value. Model 1 includes transactions from Corporate, Government and Municipal bond markets. Model 2 includes transactions from the Corporate and Municipal Markets only. Model 3 includes transactions from the Corporate and Government Markets only. The estimates and standard errors for estimating parameter significance are obtained from a Generalized Method of Moments (GMM) regression. The p-values of parameter significance are in parentheses under the respective estimates. All coefficient estimates significant at the 0.10 level or higher are indicated in bold.

Independent Variables	**Model 1**	**Model 2**	**Model 3**
	Corporate, Government and Municipal Markets	Corporate and Municipal Markets	Corporate and Government Markets
Time to maturity (years)	**0.01 (0.0019)**	**0.02 (0.0001)**	**0.02 (0.0001)**
Bond age (years)	**0.01 (0.0179)**	**0.01 (0.0004)**	**0.01 (0.0237)**
Log of Buy Volume	-0.003 (0.52)	-0.01 (0.15)	---
Log of Total Volume	---	---	-0.02 (0.25)
Municipal Sector dummy	**0.09 (0.1)**	**0.08 (0.0306)**	---
Corporate Sector dummy	0.06 (0.35)	---	0.21 (0.35)
Moody's AA dummy	-0.03 (0.25)	-0.01 (0.67)	-0.11 (0.42)
Moody's A1 dummy	0.03 (0.57)	0.07 (0.12)	0.04 (0.75)
Moody's A2 dummy	0.02 (0.63)	0.07 (0.13)	0.03 (0.84)
Moody's A3 dummy	0.02 (0.77)	**0.09 (0.09)**	0.01 (0.97)
Moody's BAA1 dummy	0.06 (0.21)	**0.14 (0.0046)**	0.06 (0.65)
Moody's BAA2 dummy	-0.01 (0.9)	0.07 (0.34)	-0.02 (0.86)
Moody's Baa3 dummy	**0.25 (0.0479)**	**0.5 (0.0001)**	0.15 (0.41)
Moody's Below Baa3 (Junk) dummy	0.1 (0.3)	0.15 (0.11)	0.09 (0.55)
Utility Sector Dummy	-0.01 (0.78)	-0.05 (0.21)	0.02 (0.77)
1997 Transaction Dummy	**-0.07 (0.0106)**	**-0.08 (0.0019)**	-0.06 (0.16)
Number of observations	5273	3570	2399
Adjusted R-square	0.0052	0.0083	0.0158

Table 7. Institutions With at least 50% Share in the Corporate, Municipal and Government Bond Markets, 1995-1997.

The revenues per Institution are calculated as the dollar value of the sells minus the dollar value of purchases over the sample period. The average revenue per transaction is simply the total dollar value divided by the number of transactions by the same institution over the sample period.

Panel A: Corporate Bond

Institutions Rank	Number of trades	Number of sells	Mean Trade Value ($ 000's)	Total Trade Value ($ Billions)	Percent Of Trades	Cumulative Percent Of Trades	Total Revenue ($ Billions)	Average Revenue per Transaction $
1	4483	1527	6939.843	31.111	6.593	6.593	-13.742	-3065.37
2	2868	1041	9440.052	27.074	5.737	12.330	-9.526	-3321.39
3	3190	1126	5681.945	18.125	3.841	16.171	-4.788	-1500.88
4	4571	1967	3837.325	17.540	3.717	19.888	-4.149	-907.60
5	1870	804	9379.765	17.540	3.717	23.605	-3.957	-2115.97
6	5736	2495	2332.558	13.380	2.835	26.440	-2.038	-355.22
7	1462	504	8382.967	12.256	2.597	29.037	-3.942	-2696.41
8	1660	645	6728.141	11.169	2.367	31.404	-3.374	-2032.37
9	2124	746	5206.334	11.058	2.343	33.748	-3.484	-1640.27
10	1441	565	6938.254	9.998	2.119	35.866	-2.817	-1955.12
11	1602	522	5837.174	9.351	1.982	37.848	-3.608	-2251.94
12	2554	1041	3268.584	8.348	1.769	39.617	-0.627	-245.57
13	1556	460	4932.760	7.675	1.626	41.243	-3.096	-1989.82
14	2246	878	3221.875	7.236	1.533	42.777	-1.339	-596.20
15	1271	369	5560.609	7.068	1.498	44.275	-3.192	-2511.20
16	1186	559	5917.658	7.018	1.487	45.762	-1.539	-1297.98
17	1057	446	5760.658	6.089	1.290	47.052	-1.230	-1163.72
18	1786	664	3307.946	5.908	1.252	48.304	-1.611	-901.92
19	609	34	9434.007	5.745	1.217	49.522	-5.089	-8357.12
20	1431	696	3879.611	5.552	1.176	50.698	-0.615	-429.87
TOTAL	44703	17089		239.243				

Table 7 continued

Panel B: Government Bond

Institutions Rank	Number of trades	Number of sells	Mean Trade Value ($ 000's)	Total Trade Value ($ Billions)	Percent Of Trades	Cumulative Percent Of Trades	Total Revenue ($ Billions)	Average Revenue per Transaction $
1	698	347	36118.506	25.211	11.276	11.276	-0.318	-455.43
2	564	281	30554.606	17.233	7.708	18.984	-5.527	-9800.50
3	1119	553	8225.391	9.204	4.117	23.100	-2.862	-2557.21
4	521	268	15942.946	8.306	3.715	26.815	-1.507	-2892.37
5	852	384	9487.086	8.083	3.615	30.431	0.613	719.39
6	520	261	15164.540	7.886	3.527	33.958	-1.079	-2074.12
7	323	157	16848.053	5.442	2.434	36.392	-0.378	-1171.16
8	416	166	9978.678	4.151	1.857	38.248	-1.275	-3065.17
9	203	72	19135.847	3.885	1.737	39.986	-1.611	-7936.17
10	448	182	8426.243	3.775	1.688	41.674	-1.371	-3059.52
11	341	151	10902.472	3.718	1.663	43.337	-0.536	-1572.81
12	995	370	3477.354	3.460	1.548	44.884	-1.041	-1045.75
13	593	304	4931.875	2.925	1.308	46.193	0.151	254.68
14	217	82	12683.180	2.752	1.231	47.423	-0.624	-2874.43
15	243	64	10401.370	2.528	1.130	48.554	-1.018	-4190.10
16	489	189	4997.534	2.444	1.093	49.647	-0.680	-1391.43
17	257	129	8725.735	2.243	1.003	50.650	-0.286	-1111.69
TOTAL	8799	3960		113.244				

Panel C: Municipal Bond

Institutions Rank	Number of trades	Number of sells	Mean Trade Value ($ 000's)	Total Trade Value ($ Billions)	Percent Of Trades	Cumulative Percent Of Trades	Total Revenue ($ Billions)	Average Revenue per Transaction $
1	1266	665	7575.847	9.591	5.935	5.935	-1.564	-1235.04
2	1613	526	5769.999	9.307	5.759	11.694	-4.124	-2556.77
3	3032	1	2667.245	8.087	5.004	16.698	-8.084	-2666.33
4	1701	216	4566.777	7.768	4.807	21.505	-6.413	-3769.88
5	3401	1267	2105.080	7.159	4.430	25.936	-2.024	-594.99
6	1511	154	4112.828	6.214	3.846	29.781	-4.941	-3269.98
7	3069	1070	1832.609	5.624	3.480	33.261	-1.087	-354.12
8	1312	375	4055.886	5.321	3.293	36.554	-2.756	-2100.86
9	1111	360	4275.799	4.750	2.940	39.494	-2.171	-1954.47
10	1073	340	3332.809	3.576	2.213	41.707	-0.952	-887.00
11	516	255	6424.506	3.315	2.051	43.758	0.036	69.09
12	867	138	3674.307	3.186	1.971	45.729	-2.470	-2848.66
13	1013	497	2720.936	2.756	1.706	47.435	-0.290	-286.44
14	652	246	3961.571	2.583	1.598	49.033	-0.779	-1195.47
15	680	222	3518.868	2.393	1.481	50.514	-0.748	-1099.79
TOTAL	22817	6332		81.632				

Table 8. Dealers With at least 50% Share in the Corporate, Municipal and Government Bond Markets, 1995-1997.

The revenues per dealer are calculated as the dollar value of the sells minus the dollar value of purchases over the sample period. The average revenue per transaction is simply the total dollar value divided by the number of transactions by the same dealer over the sample period.

Panel A: Corporate Bonds

Dealer Rank	Number Of Trades	Total Market Value Of Trades ($ Billions)	Percent Of Trades	Cumulative Percent Of Trades	Total Revenue ($ Billions)	Average Revenue per Transaction $
1	14505	43.868	9.296	9.296	14.840	1023.09
2	9809	36.020	7.633	16.929	11.721	1194.94
3	9339	33.748	7.152	24.081	13.424	1437.44
4	7770	31.692	6.716	30.797	6.834	879.52
5	7538	29.015	6.149	36.945	8.137	1079.44
6	5474	21.935	4.648	41.593	6.708	1225.39
7	4977	20.355	4.313	45.907	9.502	1909.15
8	6316	19.947	4.227	50.134	3.139	496.92
9	5254	19.669	4.168	54.302	2.430	462.51
10	7290	17.328	3.672	57.974	4.089	560.96
TOTAL	78272	273.567				

Panel B: Government Bonds

Dealer Rank	Number Of Trades	Total Market Value Of Trades ($ Billions)	Percent Of Trades	Cumulative Percent Of Trades	Total Revenue ($ Billions)	Average Revenue per Transaction $
1	4492	16.611	7.430	7.430	4.369	972.52
2	2505	16.479	7.370	14.800	3.124	1247.24
3	2712	13.095	5.857	20.657	1.470	541.94
4	1901	11.898	5.322	25.979	3.572	1879.24
5	1759	10.134	4.533	30.511	3.332	1894.31
6	1574	9.178	4.105	34.616	0.539	342.52
7	3286	9.128	4.083	38.699	1.622	493.58
8	1466	8.159	3.649	42.348	0.757	516.70
9	1228	7.326	3.277	45.624	2.123	1728.73
10	1302	6.814	3.047	48.672	0.818	628.12
11	932	5.832	2.608	51.280	1.216	1304.74
TOTAL	23157	114.653				

Table 8 continued

Panel C: Municipal Bonds

DealerRank	Number Of Trades	Total Market Value Of Trades ($ Billions)	Percent Of Trades	Cumulative Percent Of Trades	Total Revenue ($ Billions)	Average Revenue per Transaction $
1	4646	15.371	9.511	9.511	6.327	1361.76
2	5579	14.084	8.715	18.226	6.897	1236.28
3	5347	11.054	6.840	25.066	5.946	1112.09
4	2901	8.873	5.490	30.557	6.380	2199.37
5	2975	7.653	4.736	35.293	3.172	1066.29
6	4017	7.165	4.434	39.726	3.423	852.09
7	2370	6.768	4.188	43.914	2.482	1047.23
8	1732	6.523	4.036	47.951	3.328	1921.21
9	2142	4.333	2.681	50.632	2.685	1253.39
10	1869	4.076	2.522	53.154	1.140	609.72
TOTAL	33578	85.899				

Table 9. The Bid-Ask Spread for the 10 Largest Dealers and Institutions and Others in the Corporate, Municipal and Government Bond Markets, 1995-1997.

We calculate the bid-ask spread per dealer (institution) per bond per day by subtracting the average sell price for each bond per day per dealer (institution) from the average buy price for the same bond over the same day by the same dealer (institution). We require at least one buy and one sell per bond per dealer (institution) within a day. The average spread per top-10 dealer (institution) per day is calculated by averaging the bid-ask spread per dealer (institution) per bond per day over the top-10 dealers (institutions). The average bid-ask for the non-top-10 dealers (institutions) is similarly calculated.

Panel A: The Bid-Ask Spread for the 10 Largest Dealers and Other Dealers

	TOP 10 DEALERS				OTHERS			
	N	MEAN	STD	MEDIAN	N	MEAN	STD	MEDIAN
Corporate	750	0.2571	1.1928	0.1489	1113	0.1330*	0.8284	0.0000
Government	560	0.0436	0.8117	0.0333	468	0.0887	1.5052	0.0127
Municipal	368	0.2043	0.3822	0.1203	637	0.1942*	0.4031	0.0803
Pooled across all Sectors	1678	0.1742	0.9466	0.1041	2218	0.1412*	0.9325	0.0000

Panel B: The Bid-Ask Spread For the 10 Largest Institutions and Other Dealers.

	TOP 10 INSTITUTES				OTHERS			
	N	MEAN	STD	MEDIAN	N	MEAN	STD	MEDIAN
Corporate	419	0.1374	0.8123	0.0000	1339	0.1477	1.1551	0.0000
Government	209	0.0374	1.3360	0.0217	907	0.0870	1.3391	0.0250
Municipal	144	0.2547	0.6159	0.1855	694	0.1576*	0.3506	0.0545
Pooled across all Sectors	772	0.1322	0.9565	0.0500	2940	0.1313	1.0909	0.0000

Note:

*: statistically distinct at the 0.01 level using a Wilcoxon sign rank test of equality of the medians
**: statistically distinct at the 0.05 level using a Wilcoxon sign rank test of equality of the medians
***: statistically distinct at the 0.10 level using a Wilcoxon sign rank test of equality of the medians

Table 10

Panel A: Bonds Traded by the 10 Largest Dealers and Other Dealers in the Corporate, Municipal and Government Markets, 1995-1997.

Market Sector	Distinct Bonds Of Top 10 Dealers	Distinct Bonds Of Remaining Dealers	Aggregated Distinct Bonds	Common Bonds	Common Bonds as a Percentage of Distinct Bonds
Corporate	610	1005	1615	130	8
Government	118	143	261	78	30
Municipal	367	664	1031	16	2

Panel B: Bonds Traded by the 10 Largest Institutes and Other Institutes in the Corporate, Municipal and Government Markets, 1995-1997.

Market Sector	Distinct Bonds Of Top 10 Dealers	Distinct Bonds Of Remaining Dealers	Aggregated Distinct Bonds	Common Bonds	Common Bonds as a Percentage of Distinct Bonds
Corporate	295	854	1149	43	4
Government	64	169	233	51	22
Municipal	95	578	673	3	1

Table 11. Characteristics of Bonds Traded by the 10 Largest Dealers and Other Dealers in the Corporate, Municipal and Government Markets, 1995-97.

Panel A: Corporate Sector

	Top-10 Dealers	Remaining Dealers
	Distinctive bond characteristics	Distinctive Bond Characteristics
	Median (Std. Deviation)	Median (Std. Deviation)
Annual Yield	0.0719 (0.0150)	0.0705** (0.0123)
Annual Duration	6.2160 (2.8787)	5.3719* (2.5701)
Annual Convexity	45.1072 68.6274	33.1960* 56.6898
Time to maturity (years)	8.0507 (8.7492)	6.5425* (7.0210)
Bond age (years)	2.3671 (2.9533)	3.2973* (5.6562)
Coupon rate	0.0750 0.0156	0.0770** 0.0140
Percentage of Moody's Investment grade bonds	85	89
Percentage of Moody's junk bonds	15	11

Panel B: Government Sector

	Top-10 Dealers	Remaining Dealers
	Distinctive Bond Characteristics	Distinctive Bond Characteristics
	Median (Std. Deviation)	Median (Std. Deviation)
Annual Yield	0.0646 (0.0066)	0.0667 (0.0075)
Annual Duration	4.5430 (2.9334)	4.3592 (3.4947)
Annual Convexity	23.3232 (61.5752)	21.4583 (74.7867)
Time to maturity (years)	5.6630 (6.6915)	4.9699 (8.1410)
Bond age (years)	5.3822 (4.6822)	3.6096** (5.5297)
Coupon rate	0.0688 (0.0166)	0.0690** (0.0118)

Table 11 continued

Panel C: Municipal

	Top-10 Dealers	Remaining Dealers
	Distinctive Bond Characteristics	Distinctive Bond Characteristics
	Median (Std. Deviation)	Median (Std. Deviation)
Annual Yield	0.0534 (0.0090)	0.0530 (0.0089)
Annual Duration	8.5660 (2.8565)	8.2420*** (2.8969)
Annual Convexity	85.6467 (65.3419)	79.9138 (61.7796)
Time to maturity (years)	10.8781 (5.8288)	10.5781 (5.8330)
Bond age (years)	2.6342 (2.9045)	3.1260* (4.3597)
Coupon rate	0.0563 (0.0096)	0.0570 (0.0096)
Percentage of Moody's Investment grade bonds	96	99
Percentage of Moody's junk bonds	4	1

Note:

The pairwise tests correspond to the "top 10" sample and the "Remaining Dealers" sample in each case.

*: statistically distinct at the 0.01 level using a Wilcoxon sign rank test of equality of the medians
**: statistically distinct at the 0.05 level using a Wilcoxon sign rank test of equality of the medians
***: statistically distinct at the 0.10 level using a Wilcoxon sign rank test of equality of the medians

Table 12. Is the Bid-Ask Spread Different for the 10 Largest Dealers and Institutions? The Corporate, Municipal and Government Bond Markets, 1995-1997.

The dependent variable is the bid-ask spread per dealer per bond per day denominated in dollars per $100 par value. The estimates and standard errors for parameter significance are obtained from a Generalized Method of Moments (GMM) regression. The p-values of parameter significance are in parentheses under the respective estimates. All coefficient estimates significant at the 0.10 level or higher are indicated in bold.

Independent Variables	**Model 1**	**Model 2**	**Model 3**
	Corporate Bond Market	**Government Bond Market**	**Municipal Bond Market**
Intercept	**0.55 (0.0888)**	**1.3 (0.0088)**	**0.38 (0.0241)**
Time to maturity (years)	**0.02 (0.0001)**	-0.01 (0.476)	**0.01 (0.0464)**
Bond age (years)	**0.013 (0.0332)**	-0.01 (0.7217)	-0.00 (0.7988)
Log of Buy Volume	**-0.05 (0.0250)**	---	-0.01 (0.3660)
Log of Sell Volume	---	**-0.08 (0.025)**	---
Top 10 Dealer dummy	**0.15 (0.0017)**	-0.01 (0.8996)	0.01 (0.6718)
Moody's AAA and AA dummy	-0.09 (0.4263)	---	---
Moody's AA dummy	---	---	0.01 (0.7253)
Moody's A1 dummy	0.02 (0.8779)	---	-0.07 (0.1556)
Moody's A2 dummy	0.04 (0.6771)	---	0.04 (0.6440)
Moody's A3 dummy	0.09 (0.4059)	---	0.04 (0.5726)
Moody's BAA1 dummy	0.10 (0.3125)	---	---
Moody's BAA2 dummy	0.02 (0.8711)	---	---
Moody's Baa3 dummy	0.22 (0.2405)	---	---
Below Moody's A3 dummy	---	---	0.01 (0.8841)
Utility Sector Dummy	0.07 (0.3707)	---	-0.02 (0.5746)
1997 Transaction Dummy	**-0.07 (0.0659)**	-0.02 (0.7744)	**-0.11 (0.0001)**
Number of observations	1799	863	1005
Adjusted R-square (per cent)	2.38	0.93	1.72