Municipal Marketability

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We examine the role of various bond characteristics as they relate to the bid-ask spreads and marketability of municipal bond issues. We use transaction prices recently made available through the initiative of the Bond Market Association from data provided by the Municipal Securities Rulemaking Board.

Unlike the market for government or corporate debt, where 90%-plus of trade is at the institutional level, the dollar volume of trade in municipal bonds is more evenly split between institutional- and retail-sized trades, and the vast majority of individual trades occur at the retail level (under $100,000). For the first time researchers can now examine the pricing of retail-sized trades and characterize their bid-ask spread.

Chakravarty and Sarkar [2003] in their study of institutional-sized municipal transactions find that bid-ask spreads are similar to those in the corporate bond market. Still, it is retail-sized trades that have engendered the greatest concern with respect to marketability. Many municipal issues are too small to attract much institutional trading, and there has always been concern among the investment community that prices can move significantly from true value because of wide bid-ask spreads or even mispricing due to poor or noisy information.

We find bid-ask spreads for retail-sized trades average well over 2% of price for both rated and non-rated issues, much higher than spreads in the institutional market. Retail trade marketability measures suggest that municipal bonds have an implicit constraint of more than one month of non-marketability (time to transact at a given price). Institutional-sized trades have implicit marketability constraints of under ten days.

I. DATA SAMPLE

Beginning in 1999, the Bond Market Association (BMA) began providing a web site listing all daily high-low transaction prices in municipal bonds for issues with four or more trades in a given day. More recently, the web site began supplying details of each trade, including whether a given transaction was a customer buy, a customer sale, or an inter-dealer trade.

The Municipal Securities Rulemaking Board (MSRB) now makes available on a historical basis a complete record of all transactions, and we have obtained this record for the month of May 2000 (some 630,000 transactions). Independently we have purchased and organized supporting details for municipal bonds that transacted during this period. Data fields such as Moody's bond rating, pre-refunded status, tax status, and issue amount outstanding are included in the augmented data that are not available from the MSRB.

For each trading day in the period, we collected detailed transaction-by-transaction data, including not only individual transaction price and volume data, but also a time stamp to the nearest minute and an indicator of the nature of the transaction: a customer buy (CB—dealer sale to customer); customer sale (CS—dealer purchase from customer); or interdealer trade (DD).

Transactions must be filtered and examined for fruitful measures of effective bid-ask spread. For this study we estimate several measures of the effective bid-ask spread, all of which provide consistent values. For bonds that trade multiple times in a day, we can average bid-based and ask-based transactions, and report the difference between the two. Since trades at the beginning of the day and trades at the end of the day may occur when the term structure of interest rates has shifted (although May 2000 was a fairly stable month), a better measure might be to take the closest-in-time bid and ask transactions. Finally, we also calculate the closest-in-price bid and ask transactions (e.g., price-time priority versus time-price priority on pair-matching). This last price-time priority measure of the effective bid-ask spread provides a lower bound on the size of the bid-ask spread measurable from the data.

We would like to report mean effective bid-ask spreads by rating and other bond characteristics for the overall sample, by retail-only matches, and finally by institutional-only matches. There are many bonds that essentially trade on a one-off basis (that is, they are sold into the market by a dealer and rarely trade again). While some authors have attempted to capture information from these trades, we are lacking any benchmark transactions to permit us to econometrically estimate a bid-ask spread from these trades.[1]

By restricting our sample to bonds with at least one bid- and one ask-based trade on a given day, we bias the study toward the most liquid municipal issues. This is worth emphasizing, because the results still indicate very wide spreads in the retail market compared to the institutional market. It is likely that even wider spreads would result from any measures of bid-ask spread coming from the municipal issues we ignore as a result of our experimental design.

We explore in Exhibit 1 the effect of our restriction to issues with both a bid- and an ask-based transaction in a given day. We have available to us at least one trade on roughly 103,000 individual municipal issues, and over 630,000 individual transactions.

We group bonds by the type of transaction pairs available (or lack thereof). If a bond has all three types of transactions in a given day (CS, CB, and DD), it is classified as providing an observation in Group 1. Bonds with ask- and bid-based transactions on a given day, but no dealer-to-dealer transaction, are classified as Group 2, and so on.

The groups are mutually exclusive. A bond with one day of trading that throws it into Group 2 may have other days of trading that involve only an ask-based trade, but that bond is not counted in the Group 4 cell.

Only observations falling into Groups 1 and 2 are included in the sample, as no others allow measurement of a bid-ask spread. This constraint can be characterized in terms of the percentage of unique bonds admitted (32.3%), percentage of all transactions (55.2%), and percentage of total dollar volume of municipal trade represented in the sample by these admitted bonds (78.0%). While our percentages are admittedly low on the first two dimensions, the fact that we can estimate the bid-ask spread for bonds that account for 78% of the total dollar volume of trade in all municipal bonds in a given month is encouraging.[2]

We report our results based on bid-ask spreads measured using time-price priority. A bid- and ask-based price occurring closest in time should capture the true underlying bid-ask spread better than transactions occurring farther apart in time. Fortunately, all three measures of bid-

EXHIBIT 1

Sample Statistics—Unique CUSIPs, Trades, and Dollar Trading Volume

GROUP	Trade Classification			Unique Cusips	Number of Trades	Number of Trades			Dollar Volume (B$)		
						CB	CS	DD	CB	CS	DD
G1	CB	CS	DD	8974	190567	114861	31083	44623	12.47	10.76	11.49
G2	CB	CS		24511	160359	92540	56438	11381	84.63	77.49	1.91
G3	CB		DD	4637	20448	10693		9755	1.96		1.80
G4		CS	DD	8399	42624	13844	9694	19086	0.85	1.01	1.88
G5	CB			23245	104214	85722		18492	23.86		4.41
G6		CS		32970	113247	57929	42320	12998	7.83	10.28	1.87
G7			DD	801	1223			1223			0.26
Total:				103537	632682	375589	139535	117558	131.60	99.54	23.63

CB: Customer buy from a dealer; CC: Customer sale to a dealer; or DD: Trade between dealers.
If a bond has a CB and a DD in a day and a CS and DD in another day, it is assigned to Group G3.
Dollar volume of trading expressed in billions of dollars.

ask spread that we estimate (time-price, price-time, average of bid-ask within the day) yield results that are very close and lead to nearly identical substantive conclusions.[3]

In Exhibit 2 we provide summary statistics on various characteristics of the bonds in the sample. Of the individual transactions, there are as many as 38,466 bid-ask spread data points; 33,925 of these represent pairs that have retail-only or institutional-only trades for both the bid and ask (our focus).

Panel C of Exhibit 2 reveals that non-rated issues have mean and median issue amounts that are only about 9% and 10% (respectively) the size of the overall municipal bond sample mean and median. The absence of a rating appears to be size-related; in other words; municipal issues almost always obtain a rating unless the issue is too small to justify the expense.

With one exception, coupons are naturally ordered between lowest for Aaa issues and highest for non-investment grade.[4] Aa issues actually have slightly lower coupons than Aaa issues because many Aaa issues received their high rating through the use of insurance.[5]

II. SIZE OF EFFECTIVE BID-ASK SPREAD

We define the effective bid-ask spread as

$$\frac{[P_{CB} - P_{CS}]100}{[P_{CB} + P_{CS}]/2}$$

where P_{CB} (P_{CS}) is the price at which a customer buys (sells) bonds from a dealer (to a dealer).

Exhibit 3 provides measures of effective bid-ask spread by bond rating for the entire sample, as well as for the sample separated into retail-size and institutional-size trades. In total we have 33,925 individual bid-ask spread pairs. The overall mean spread on these pairs is 2.14% of value; the median is 1.96%. For retail-only trades, the mean and median percentage spreads are 2.46% and 2.23%; for institutional-only the figures are 0.79% and 0.40%.[6]

Rated versus Non-Rated Issues

Non-rated (NR) issues constitute about 4% of our sample. Exhibit 3 reveals that they have bid-ask spreads of somewhere between A and Baa issues. The main differentiating characteristic seems to be their issue size. The interplay of rating, coupon, and bid-ask spread is resolved

EXHIBIT 2

Descriptive Statistics for Variables

Panel A. Age of Bond (Days)

Moody's	N	MEAN	STD	Q3	Median	Q1
Aaa	22458	2242	1612	2862	2326	1086
Aa	5623	2326	1870	2891	2380	989
A	2989	2663	1788	3036	2520	1691
Baa	1228	2828	2252	3150	2534	1623
JUNK	155	3255	2048	3822	2752	2350
NR	1472	2299	2065	2911	1988	916
AGE	33925	2321	1731	2898	2364	1135

Panel B. Time to Maturity (Days)

Moody's	N	MEAN	STD	Q3	Median	Q1
Aaa	22458	4845	2996	7281	4560	2230
Aa	5623	3958	2953	5966	3202	1529
A	2989	4411	2998	6664	3904	1722
Baa	1228	5253	3276	7941	5166	2237
JUNK	155	6048	3027	8170	6452	3501
NR	1472	4466	2979	6730	3940	1915
TTM	33925	4664	3021	7045	4278	2007

Panel C. Amount Outstanding

Moody's	N	MEAN	STD	Q3	Median	Q1
Aaa	21906	181.76	275.44	219.06	84.10	30.51
Aa	5518	193.08	254.70	250.00	92.52	35.00
A	2894	329.54	473.75	541.40	115.40	28.30
Baa	1180	306.65	481.44	407.60	125.26	33.31
JUNK	151	122.83	157.29	153.42	56.30	27.60
NR	1385	16.70	24.78	18.41	8.42	3.50
AMT	33034	193.87	304.49	236.45	81.41	27.58

Panel D. Dollar Trade Volume at Ask ($1,000)

Moody's	N	MEAN	STD	Q3	Median	Q1
Aaa	22458	199.92	1060.95	50.00	25.00	10.00
Aa	5623	234.89	1106.15	100.00	25.00	10.00
A	2989	119.27	722.73	40.00	20.00	10.00
Baa	1228	194.89	874.46	40.00	20.00	10.00
JUNK	155	387.06	1578.83	50.00	25.00	10.00
NR	1472	71.29	320.55	35.00	15.00	10.00
AVOL	33925	193.70	1019.29	50.00	25.00	10.00

Panel E. Dollar Trade Volume at Bid ($1,000)

Moody's	N	MEAN	STD	Q3	Median	Q1
Aaa	22458	276.18	1250.35	50.00	25.00	10.00
Aa	5623	333.02	1304.71	100.00	25.00	10.00
A	2989	151.08	771.93	50.00	20.00	10.00
Baa	1228	246.41	1160.42	50.00	20.00	10.00
JUNK	155	330.74	1295.15	60.00	25.00	10.00
NR	1472	85.85	375.68	48.96	20.00	10.00
BVOL	33925	265.49	1198.07	50.00	25.00	10.00

Panel F. Time Difference Between Trade at Bid and Trade at Ask (Minutes)

Moody's	N	MEAN	STD	Q3	Median	Q1
Aaa	22458	79.08	100.11	117.00	39.00	4.00
Aa	5623	72.90	98.18	109.00	31.00	1.00
A	2989	71.37	96.99	103.00	29.00	1.00
Baa	1228	72.85	104.69	103.50	23.00	1.00
JUNK	155	66.18	94.42	92.00	21.00	1.00
NR	1472	65.09	95.01	93.50	19.00	1.00
TD	33925	76.49	99.52	112.00	36.00	2.00

Panel G. Coupon

Moody's	N	MEAN	STD	Q3	Median	Q1
Aaa	22456	5.302	1.559	6.000	5.450	5.000
Aa	5623	5.222	1.538	6.000	5.375	5.000
A	2989	5.615	1.449	6.250	5.850	5.250
Baa	1228	5.766	1.616	6.600	6.000	5.363
JUNK	155	6.969	1.108	7.650	6.800	6.100
NR	1472	6.712	1.622	7.600	6.750	5.900
COUPON	33923	5.402	1.583	6.125	5.500	5.000

NR: non-rated. Panel G is constructed with non-zero-coupon bonds only.

EXHIBIT 3

Descriptive Statistics for Effective Bid-Ask Spreads

Panel A. By Credit Rating and Sizes of Trades

Moody's	Trade Size	N	Mean	STD	Q3	Median	Q1
All	Retail	27318	2.46	1.74	3.44	2.23	1.22
All	Institution	6607	0.79	1.04	1.07	0.40	0.13
All	All	33925	2.14	1.76	3.14	1.96	0.77

Moody's	Trade Size	N	Mean	STD	Q3	Median	Q1
Aaa	All	22458	2.17	1.75	3.20	1.98	0.81
Aa	All	5623	1.79	1.60	2.66	1.49	0.49
A	All	2989	2.20	1.68	3.11	2.02	0.99
Baa	All	1228	2.63	2.05	3.71	2.36	1.02
JUNK	All	155	3.06	2.26	4.61	2.97	1.00
NR	All	1472	2.44	2.02	3.43	2.17	0.98

Moody's	Trade Size	N	Mean	STD	Q3	Median	Q1
Aaa	Retail	18052	2.49	1.72	3.50	2.27	1.25
Aaa	Institution	4406	0.82	1.08	1.14	0.42	0.13

Moody's	Trade Size	N	Mean	STD	Q3	Median	Q1
Aa	Retail	4179	2.19	1.62	3.05	2.01	1.01
Aa	Institution	1444	0.63	0.78	0.83	0.34	0.12

Moody's	Trade Size	N	Mean	STD	Q3	Median	Q1
A	Retail	2618	2.40	1.66	3.22	2.18	1.25
A	Institution	371	0.84	1.06	1.05	0.45	0.16

Moody's	Trade Size	N	Mean	STD	Q3	Median	Q1
Baa	Retail	1036	2.95	2.01	3.96	2.68	1.55
Baa	Institution	192	0.91	1.18	1.18	0.44	0.12

Moody's	Trade Size	N	Mean	STD	Q3	Median	Q1
JUNK	Retail	126	3.43	2.24	4.72	3.23	2.08
JUNK	Institution	29	1.48	1.62	2.44	0.73	0.13

Moody's	Trade Size	N	Mean	STD	Q3	Median	Q1
NR	Retail	1307	2.60	2.03	3.57	2.33	1.09
NR	Institution	165	1.12	1.40	1.93	0.70	0.18

better with a multiple regression approach. In results reported below in a multivariate framework, a regression of bid-ask spread against a variety of variables meant to control for differences among the various rating categories of bonds reveals that after controlling for these factors, the bid-ask spread of non-rated issues falls in line with an average coupon of somewhere between Baa and high-yield issues.

In this case, the univariate measure of bid-ask spread for non-rated municipal bonds is somewhat misleading. The municipal market thus appears to have a fairly predictable link between rating and bid-ask spread. It is a well-developed market in highly rated issues, and there is a penalty for low ratings in the sense that they come with higher transaction costs.

Insured versus Uninsured Issues

About 83% of Aaa issues in our sample are insured, while the majority of Aa issues (or lower) are not. To examine whether insurance plays an important role in determining the bid-ask spread, we compare bid-ask spreads of uninsured and insured issues. Panel B of Exhibit 3 shows that the spread tends to increase with the credit ratings for the uninsured issues, whatever the size of trades. We also find that the average bid-ask spread of uninsured Aaa issues is 1.64%, while that of insured Aaa issues is 2.27%. Insurability does not guarantee true equal credit, which is reflected by the fact that insured issues of equal rating are treated as riskier from the dealer's perspective.

Marketability

We measure the marketability of a municipal bond from the perspective of the time it might reasonably take to sell a given issue. We use a model of marketability proposed by Longstaff [1995] to determine how many days a bond is effectively non-marketable according to the bond's bid-ask spread and a measure of volatility.

Longstaff's model of marketability assumes a financial instrument is unable to trade for a specific period of time.

EXHIBIT 3 (continued)

Descriptive Statistics for Effective Bid-Ask Spreads

Panel B. By Insurance and Credit Rating

	Uninsured Issues						Insured Issues					
	N	Mean	STD	Q3	Median	Q1	N	Mean	STD	Q3	Median	Q1
Aaa	3634	1.64	1.52	2.48	1.35	0.43	18824	2.27	1.77	3.33	2.05	0.93
Aa	5517	1.78	1.60	2.64	1.49	0.49	106	2.07	1.78	3.29	1.99	0.50
A	2916	2.21	1.68	3.11	2.02	0.99	73	2.01	1.84	3.04	1.77	0.63
Baa	1216	2.64	2.05	3.72	2.38	1.02	12	2.13	1.78	2.66	1.85	0.82
JUNK	154	3.06	2.27	4.61	2.97	1.00	1	3.27		3.27	3.27	3.27
NR	1471	2.44	2.02	3.43	2.17	0.99	1	0.10		0.10	0.10	0.10

	Uninsured & Retail Size Trades						Insured & Retail Size Trades					
	N	Mean	STD	Q3	Median	Q1	N	Mean	STD	Q3	Median	Q1
Aaa	2706	1.97	1.50	2.77	1.86	0.94	15346	2.59	1.74	3.60	2.37	1.36
Aa	4112	2.18	1.61	3.05	2.00	1.01	67	2.55	1.90	3.80	2.61	1.09
A	2559	2.40	1.65	3.22	2.18	1.26	59	2.08	1.97	3.22	1.77	0.49
Baa	1028	2.96	2.01	3.96	2.69	1.54	8	2.73	1.89	3.54	2.17	1.85
JUNK	125	3.43	2.25	4.72	3.23	2.08	1	3.27		3.27	3.27	3.27
NR	1306	2.60	2.03	3.57	2.35	1.09	1	0.10		0.10	0.10	0.10

	Uninsured & Institution Size Trades						Insured & Institution Size Trades					
	N	Mean	STD	Q3	Median	Q1	N	Mean	STD	Q3	Median	Q1
Aaa	928	0.66	1.11	0.75	0.28	0.10	3478	0.86	1.07	1.23	0.48	0.15
Aa	1405	0.61	0.76	0.80	0.33	0.12	39	1.23	1.19	2.30	0.75	0.31
A	357	0.80	1.05	1.02	0.42	0.15	14	1.71	1.16	2.74	1.73	0.72
Baa	188	0.91	1.19	1.17	0.43	0.11	4	0.94	0.64	1.46	0.82	0.42
JUNK	29	1.48	1.62	2.44	0.73	0.13						
NR	165	1.12	1.40	1.93	0.70	0.18						

By pricing the option to trade the instrument at its maximum price during the non-marketable period, he is able to deduce an upper bound for the bid-ask spread. He argues this is a meaningful one as the model accords well with observed instruments. Longstaff examines several financial instruments, including restricted stock and Treasury issues.

We can take advantage of the marketability measures for Treasury securities provided in Longstaff by focusing our attention on Aaa pre-refunded issues. These municipal bonds can be expected to have volatilities that are close to those of Treasury securities, as the bonds are backed in full by Treasury bonds. As Panel C of Exhibit 3 shows, pre-refunded issues represent 8,020 of the total of 33,925 bid-ask spread observations. Bid-ask spreads of 1.55% (mean) and 1.37% (median) overall suggest a degree of liquidity corresponding to a bond that has an effective constraint of 30 to 60 days of non-marketability according to Longstaff [1995].[7]

Retail-only trades of pre-refunded bonds have mean and median bid-ask spreads of 1.78% and 1.66%, and institutional-only trades means and medians of 0.46% and 0.26%. These figures suggest that the implicit constraint for selling a retail-sized quantity of municipal securities versus institutional-sized quantities is on the order of two months. Recall that this comparison is fairly clean, given that the securities involved are risk-free.

Because most of the transactions in our original sample are retail-sized, it should be no surprise that many transactions also appear as one-off, and that many of the bonds in our sample have no more than one bid-ask pair for which we can calculate a spread.

III. DETERMINANTS OF EFFECTIVE BID-ASK SPREADS

Our primary objective is to examine the contribution of *specific* factors to both the bid-ask spread and its variation across bonds of different credit ratings. The bond-specific variables available to us include time to maturity, coupon rate, number of shares outstanding, credit rating, pre-refunded status, putability, callability, and state and federal tax status. The trading-specific vari-

EXHIBIT 3 (continued)
Descriptive Statistics for Effective Bid-Ask Spreads

Panel C. By Prerefunded Status and Credit Rating

	Not Prerefunded						Prerefunded					
	N	Mean	STD	Q3	Median	Q1	N	Mean	STD	Q3	Median	Q1
Aaa	16591	2.38	1.84	3.53	2.21	0.99	5867	1.55	1.29	2.22	1.37	0.59
Aa	4826	1.85	1.66	2.84	1.53	0.48	797	1.41	1.15	2.04	1.21	0.50
A	2212	2.38	1.76	3.34	2.19	1.07	777	1.69	1.29	2.31	1.49	0.79
Baa	1034	2.81	2.10	3.96	2.57	1.22	194	1.69	1.35	2.43	1.65	0.57
JUNK	135	3.12	2.35	4.63	2.97	0.98	20	2.69	1.59	3.82	2.76	1.17
NR	1107	2.69	2.13	3.67	2.54	1.09	365	1.68	1.40	2.30	1.47	0.70
ALL	25905	2.32	1.84	3.43	2.10	0.88	8020	1.56	1.28	2.23	1.39	0.61

	Not Prerefunded & Retail Size						Prerefunded & Retail Size					
	N	Mean	STD	Q3	Median	Q1	N	Mean	STD	Q3	Median	Q1
Aaa	13200	2.76	1.79	3.82	2.60	1.51	4852	1.78	1.27	2.40	1.66	0.90
Aa	3536	2.28	1.67	3.24	2.05	1.02	643	1.65	1.14	2.27	1.50	0.89
A	1924	2.60	1.74	3.55	2.41	1.50	694	1.83	1.28	2.44	1.67	0.98
Baa	879	3.13	2.06	4.18	2.90	1.73	157	1.96	1.32	2.75	1.92	0.99
JUNK	106	3.56	2.32	4.88	3.25	2.19	20	2.69	1.59	3.82	2.76	1.17
NR	980	2.88	2.12	3.88	2.79	1.55	327	1.76	1.42	2.44	1.61	0.75

	Not Prerefunded & Institution Size						Prerefunded & Institution Size					
	N	Mean	STD	Q3	Median	Q1	N	Mean	STD	Q3	Median	Q1
Aaa	3391	0.92	1.16	1.36	0.50	0.15	1015	0.46	0.62	0.63	0.26	0.09
Aa	1290	0.65	0.81	0.87	0.34	0.13	154	0.39	0.40	0.54	0.26	0.11
A	288	0.94	1.16	1.28	0.49	0.16	83	0.48	0.44	0.72	0.38	0.15
Baa	155	0.99	1.25	1.45	0.45	0.12	37	0.57	0.79	0.59	0.36	0.09
JUNK	29	1.48	1.62	2.44	0.73	0.13	38	0.99	0.88	1.60	0.85	0.29
NR	127	1.15	1.53	2.00	0.64	0.10	1015	0.46	0.62	0.63	0.26	0.09

ables include the time difference between the trade at the bid and at the ask and the number of shares transacted at the bid and at the ask.

Basic Model

The basic regression is:

$$SPREAD_{it} = \beta_0 + \beta_1 AGE_{it} + \beta_2 TTM_{it} + \beta_3 AMT_{it} + \beta_4 AVOL_{it} + \beta_5 BVOL_{it} + \beta_6 TIMEDIFF_{it} + \beta_7 COUPON_i + \beta_8 INSURE_i + \beta_9 PUT_i + \beta_{10} AMTAX_i + \beta_{11} FEDTAX_i + \beta_{12} STTAX_i + \beta_{13} GOB_i + \beta_{14} AA_i + \beta_{15} A_i + \beta_{16} BAA_i + \beta_{17} JUNK_i + \beta_{18} NR_i + \beta_{19} CALL_i + \beta_{20} PREREF_i + u_{it}$$

where, for a specific bond i on day t:

$SPREAD_{it}$ = effective spreads, measured by

$$\frac{[P_{CB} - P_{CS}]100}{[P_{CB} + P_{CS}]/2}$$

where P_{CB} (P_{CS}) is the price at which a customer buys bonds from a dealer (or sells bonds to a dealer);

AGE_{it} = age of bond, measured by number of days elapsed since the issuance date;
TTM_{it} = time to maturity, expressed in units of days;
AMT_{it} = dollar amount of outstanding;
$AVOL_{it}$ = trade volume at the ask;
$BVOL_{it}$ = trade volume at the bid;
$TIMEDIFF_{it}$ = time difference between CB and CS in a given day for the bond;
$COUPON_i$ = coupon rate of the bond;

$INSURE_i$ = dummy for insurance that takes a value of 1 if insured, and 0 otherwise;
PUT_i = dummy for bond putability that takes a value of 1 if insured, and 0 otherwise;
$AMTAX_i$ = dummy for bond subject to alternative minimum tax that takes a value of 1 if subject and 0 otherwise;
$FEDTAX_i$ = dummy for bond subject to federal income tax that takes a value of 1 if subject and 0 otherwise;
$STTAX_i$ = dummy for bond subject to state income tax that takes a value of 1 if subject and 0 otherwise;
GOB_i = dummy for general obligation bond that takes a value of 1 and 0 otherwise;
Aa_i = dummy for Aa rated bond that takes a value of 1 and 0 otherwise;
A_i = dummy for A rated bond that takes a value of 1 and 0 otherwise;
Baa_i = dummy for Baa rated bond that takes a value of 1 and 0 otherwise;
$JUNK_i$ = dummy for junk rated bond that takes a value of 1 and 0 otherwise;
NR_i = dummy for non-rated bond that takes a value of 1 and 0 otherwise;
$CALL_i$ = dummy for bond callability that takes a value of 1 if callable and 0 otherwise; and
$PREREF_i$ = dummy for pre-refunded bond that takes a value of 1 and 0 otherwise.

Since the residuals of the equation are not homoscedastic, the use of heteroscedasticity-consistent standard errors is advised. Furthermore, formal diagnostic tests confirm the presence of significant heteroscedasticity in the residuals.[8] For this reason, we use the generalized method of moments (GMM) to estimate the equation.

Exhibit 4 reports the estimated values of the model coefficients by retail versus institutional category. Most variables that appear statistically significant have consistent signs across models. We restrict our discussion to the variables that play an important role in the determination of bid-ask spreads.

Relative Importance of Bid-Ask Spread Determinants

In common English usage, *significant* means important, while in statistics it means probably resulting from something other than mere chance. In regression analysis, an estimated parameter may be accurately measured, yet unimportant in terms of its economic impact. Kruskal and Majors [1989] lament that many researchers inappropriately use statistical significance as the measure of relative importance for the explanatory variables in a model. Soofi, Retzer, and Yasai-Ardekani [2000] also note that when model parameters are known (e.g., population data, simulation study), there is no uncertainty involved, and inference such as statistical significance of estimated parameters may be irrelevant.

Yet an assessment of the relative importance of a set of explanatory variables may still be of interest. High statistical significance doesn't necessarily mean that an explanatory factor is important in explaining the behavior of the dependent variable. Furthermore, even if two variables both have p-values lower than 0.01, the p-values do not provide information as to which variable is more important of the two.

Many measures of relative importance—statistical significance, regular and partial correlation coefficients in multiple regression, and standardized regression coefficients—have been suggested as measures of relative importance in the literature. Of these measures, the one presented by Kruskal [1987] has drawn the most attention and has been extended into various disciplines. Kruskal proposes obtaining relative importance measures by averaging the squared partial correlation coefficients over all orderings of the explanatory variables. In models where the explanatory variables may be correlated with each other, however (such as in our case), R^2 is not additively decomposable into squared partial correlations. Thus these measures cannot be considered as shares of the joint contribution of the individual variables.

To overcome this shortcoming, Soofi, Retzer, and Yasai-Ardekani [2000] propose the use of squared *semipartial* correlation coefficients in quantifying relative importance measures, instead of squared partial correlation coefficients. More specifically, relative importance measures are obtained by averaging the squared semipartial correlations over all orderings of explanatory variables. This retains the desirable property of the additivity of R^2.

Statistical significance measures such as t-statistics, F-statistics, and P-values are sample size-dependent. It may thus be misleading to judge the statistical significance of estimated parameters by looking at associated t-statistics, especially when there are many observations in a regression. A large sample size can drive the standard error of parameter estimates spuriously low, which consequently

Exhibit 4
GMM Estimates of Effective Bid-Ask Spreads by Size of Trade

	Retail			Institution		
Variable	Coeff.	Std. Err		Coeff.	Std. Err	
Intercept	2.842	0.069	***	1.350	0.104	***
AGE	6.9E-06	1.0E-05		1.8E-05	1.4E-05	
TTM	1.8E-04	4.6E-06	***	8.0E-05	7.5E-06	***
AMT	2.2E-10	4.0E-11	***	6.3E-11	4.1E-11	
AVOL	-1.0E-05	9.3E-07	***	-9.9E-08	1.4E-08	***
BVOL	-1.0E-05	8.1E-07	***	-2.6E-08	8.7E-09	***
TIMEDIFF	2.2E-03	1.1E-04	***	1.5E-03	1.6E-04	***
COUPON	-0.231	0.008	***	-0.181	0.018	***
INSURE	0.145	0.036	***	0.056	0.040	
PUT	-0.188	0.203		-0.276	0.136	**
AMTAX	-0.019	0.042		-0.068	0.068	
FEDTAX	0.123	0.132		0.519	0.224	***
ST.TAX	-0.113	0.028	***	-0.050	0.031	
GOB	-0.049	0.023	**	0.009	0.026	
Aa	-0.041	0.041		-0.106	0.041	***
A	0.197	0.048	***	0.100	0.064	
Baa	0.509	0.071	***	0.163	0.097	*
JUNK	1.262	0.241	***	0.493	0.298	*
NR	0.645	0.069	***	0.484	0.131	***
CALL	0.536	0.029	***	0.297	0.038	***
PREREF	-0.870	0.025	***	-0.452	0.037	***
R-Sq	0.279			0.239		
Adj R-Sq	0.278			0.236		

Standard errors calculated using Hansen's [1982] generalized method of moments.

***, **, and * statistically significant at the 1%, 5%, and 10% levels, respectively.

Exhibit 5
Estimates of Relative Importance of Explanatory Variables

Variable	Retail	Institution
AGE	2.22%	1.95%
TTM	32.36%	19.85%
AMT	0.87%	0.15%
AVOL	7.99%	13.93%
BVOL	6.50%	8.55%
TIMEDIFF	7.64%	6.95%
COUPON	10.13%	23.54%
INSURE	0.83%	0.96%
PUT	0.05%	0.08%
AMTAX	0.83%	0.20%
FEDTAX	0.04%	1.17%
ST.TAX	0.36%	0.05%
GOB	2.03%	0.70%
Aa	0.69%	1.51%
A	0.13%	0.15%
Baa	0.97%	0.25%
JUNK	0.62%	0.54%
NR	0.82%	1.61%
CALL	8.55%	8.58%
PREREF	16.37%	9.29%

raises the t-statistics of estimates.[9] This is especially true in market microstructure studies that deal with many observations.

For all these reasons, we apply the relative importance measures proposed by Soofi, Retzer, and Yasai-Ardekani [2000]. In doing so, we can answer the questions:

1. Which explanatory variables are most influential in explaining the size of the bid-ask spread?
2. Are there systematic differences in what influences the bid-ask spread when broken down by retail and institutional trades?

Empirical Results of Relative Importance of Explanatory Variables

To examine how important the explanatory variables are in explaining the size of the bid-ask spread, first we use the regression model to obtain the squared semipartial correlation coefficient of each variable. The regressions are run with all possible permutations of explanatory variables (i.e., over all orderings of explanatory variables). Since the estimates of relative importance are obtained by averaging all the squared semipartial correlation coefficients of explanatory variables, no assumption about the inclusion ordering of explanatory variables to the regression is needed to assess relative importance.

The estimates of the relative importance of explanatory variables in the determination of bid-ask spreads are shown in Exhibit 5. Six underlying factors measured by seven variables account for the vast majority of explanatory importance. Time to maturity (TTM), trade volume (AVOL and BVOL), time difference between when the ask and bid price are measured (TIMEDIFF), COUPON, the callability flag (CALL), and pre-refunded status (PREREF) jointly account for about 90% of the relative explanatory power in both retail and institutional models.

Time to maturity relates to the duration or interest rate volatility of the bond. The positive sign on the coefficient indicates that, all else equal, more volatile instruments show wider bid-ask spreads. Retail transactions appear to be more sensitive to this source of risk than institutional transactions.

Trade volume is jointly measured by AVOL (volume at the ask price) and BVOL (volume at the bid price), and the negative coefficients on these variables indicate that the larger the transaction, the narrower the bid-ask spread. While volume appears to play a larger role in institutional trades, it must be remembered that retail trades are defined by the limit of $100,000, so there is much more limited variation in this variable than will be found in the institutional sample. Both time to maturity and volume effects found are consistent with the theory and previous evidence.

The time difference between the bid and ask transaction allows us to capture effects due to non-synchronous measurement of the bid and ask price. In our sample the data indicate that spreads are somewhat narrower when the bid and ask are measured at periods close in time. This does not necessarily indicate any systematic effect, and is sensitive to actual interest rate movements within the day the spread is measured. In an ideal setting, the bid and the ask would be measured simultaneously, and the variable TIMEDIFF would not play a role. For our purposes, it is a control variable.

Coupon plays a very large role in the institutional sample, and a significant but relatively less important role in the retail sample. Institutional trades relate strongly to the management of pension funds, and there is a strong preference for higher-coupon issues (in a given risk class). These are generally longer-maturity bonds (hence the higher coupon), and the market has evolved so that transaction costs (i.e., the bid-ask spread) are lower for these types of instruments.

The callability flag (CALL) has a positive coefficient, indicating a wider bid-ask spread.[11] Callable bonds have shorter effective maturities, and hence lower effective duration and volatility than non-callable issues. This argues that the call variable should have a negative coefficient if the predominant effect of callability is to reduce effective maturity. Since we see the opposite result, it is likely that dealers have a preference (again—all else equal) for non-callable issues, which translates into narrower bid-ask spreads. Non-callable issues make up a greater percentage of the sample for institutional trades than for retail trades.

Pre-refunded bonds (PREREF) have a negative coefficient and hence narrower bid-ask spreads (again all else equal). This result is to be expected, given that there is less of an inventory holding risk problem for dealers for these types of bonds.

IV. CONCLUSIONS

We study a unique data set of daily transaction prices for municipal bonds along with bond-specific details such as credit rating, bond insurance, and pre-refunded status. We evaluate the costs of transacting in this market by examining bid-ask spreads and marketability (liquidity). Our research differs from previous studies because we are able to separately examine retail- versus institutional-sized trades.

We find retail-sized trades are associated with bid-ask spreads averaging nearly 2.5% of the market value of a bond. These bid-ask spreads associated with retail-sized trades are on average three to five times as high as those found in the institutional market. Retail trade marketability measures suggest that municipal bonds have an implicit constraint of more than one month of non-marketability, compared to under ten days for institutional-sized trades.

The market is fairly well structured in terms of trading costs by bond rating. Lower-grade issues are costlier to transact, and non-rated issues fall somewhere between Baa and high-yield. The major structural determinants of the bid-ask spread are volatility (time to maturity), trade volume, coupon, callability, and pre-refunded status.

ENDNOTES

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[1]Schultz [2001] employs term structure-adjusted month-end bid quotes from Lehman Brothers to match with ask-based transactions in an attempt to capture information from unmatched trades in a study of corporate bond transactions. The data necessary to do this are unavailable for municipal bond transactions. We have recently been made aware of a study by Harris and Piwowar [2004] that attempts to measure bid-ask spread in the municipal market with econometric techniques requiring the implicit matching of trades across several months."

[2]We also exclude from our analysis all floating-rate municipal issues. These bonds trade almost exclusively at par at both the bid and ask. An explicit commission structure presumably compensates dealers in these securities. Also, 79 bonds with ambiguous ratings were eliminated. These bonds appear to have been rated at some time in their life, but we could not verify their status as of the month the data were analyzed.

[3]Results using these alternative measures are available upon request.

[4]Zero-coupon bonds are excluded from the summary statistics for coupon in Panel G.

[5]Insurance applies to 83.14%, 2.08%, 2.98%, 1.45%, 0.89%, and 0.16% of Aaa, Aa, A, Baa, junk, and non-rated (NR) issues in our sample, respectively.

[6]In Chakravarty and Sarkar [2003], institutional trades of municipal bonds yielded mean bid-ask spreads of 0.23%, compared to our mean of 0.79%. This can be attributed to the fact that Chakravarty and Sarkar follow the approach in Hong and Warga [2000] of eliminating transactions below $500,000 in par value to compensate for potential data-reporting errors generated by their data source. That data error problem does not apply in our data set. Our definition of an institutional trade is any trade over $100,000 in par value, and this probably accounts for the higher estimate of institutional-sized bid-ask spreads.

[7]Table 1 of Longstaff [1995] reports upper bounds for percentage discounts for lack of marketability. We choose the column for two-year Treasury securities, which corresponds with a volatility of 0.05. The average security we are dealing with has a time to maturity exceeding ten years, so using 0.05 should serve as a lower-bound estimate of the true volatility. Treasury volatilities grow at a very slow rate for maturities of two years and above, so there should not be a great bias. Our linkage of the bid-ask spread to a non-marketability measure comes from Longstaff's interpretation of the percentage discount for lack of marketability as an endogenous measure of the highest possible bid-ask spread or transaction cost for a security.

[8]Both the White test and the Breusch-Pagan test reject the null hypothesis of homoscedasticity at the 1% significance level for all versions of the model.

[9]To avoid complications associated with high t-values, Griffiths et al. [2000] conduct a posterior odds ratio test as an alternative way to determine a critical t-value.

[10]See Kalimipalli and Warga [2002] for a discussion of these effects on bonds.

[11]Callable issues constitute about 75% of the overall sample of 33,925. There are only 95 observations derived from issues with a put provision.

REFERENCES

Chakravarty, S., and A. Sarkar. "Trading Costs in Three U. S. Bond Markets." *The Journal of Fixed Income*, June 2003.

Griffiths, Mark, Brian F. Smith, D. Alasdair S. Turnbull, and Robert W. White. "The Costs and Determinants of Order Aggressiveness." *Journal of Financial Economics*, 56 (2000), pp. 65-88.

Harris, Lawrence, and Michael Piwowar. "Secondary Trading Costs in the Municipal Market." SEC Manuscript, 2004.

Hansen, Lars Peter. "Large Sample Properties of Generalized Method of Moments." *Econometrica*, 50 (1982), pp. 1029-1054.

Hong, Gwangheon, and Arthur Warga. "An Empirical Study of Bond Market Transactions." *Financial Analysts Journal*, March/April 2000, pp. 32-46.

Kalimipalli, Madhu, and Arthur Warga. "Bid-Ask Spread and Volatility in the Corporate Bond Market." *The Journal of Fixed Income*, March 2002.

Kruskal, William. "Relative Importance by Averaging over Orderings." *The American Statistician*, 41 (1987), pp. 6-10.

Kruskal, William, and Ruth Majors. "Concepts of Relative Importance in Recent Scientific Literature." *The American Statistician*, 43 (1989), pp. 2-6.

Longstaff, Francis A. "How Much Can Marketability Affect Security Values?" *Journal of Finance*, 50 (5) (1995), pp. 1767-1774.

Schultz, Paul. "Corporate Bond Trading Costs: A Peek Behind the Curtain." *Journal of Finance*, 56 (2) (2001), pp. 677-698.

Soofi, Ehsan S., Joseph J. Retzer, and Masoud Yasai-Ardekani. "A Framework for Measuring the Importance of Variables with Applications to Management Research and Decision Models." *Decision Sciences*, Summer 2000, pp. 595-625.