Special Report: Measuring municipal bond market liquidity

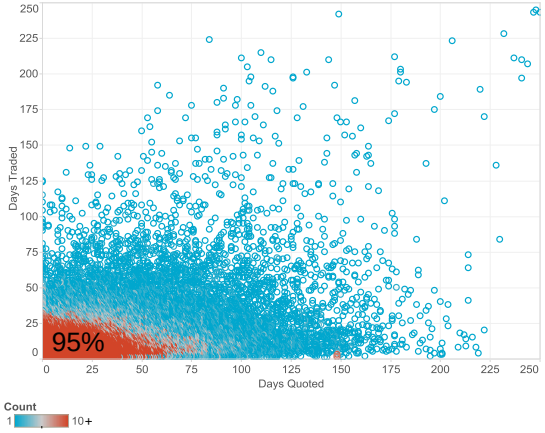
We reviewed trade and quote activity on approximately 570,000 unique municipal bonds from January 2015 through March 2016. The study surveyed the overall quote/trade depth and diversity during that period, as we focused mainly on unique bonds during various periods of time. This study did not factor in trade, quote, or bond issue size, but we want to make it clear that all three can also be used to assess a bond's liquidity profile. We note that since the dataset includes quotes and trades regardless of size, it could potentially overstate liquidity as compared to a round lot portfolio.

Our analysis concluded that municipal bond liquidity was stable during the period and the market was relatively efficient, but there were intermittent periods when liquidity did taper off due to seasonal factors. Here are some of our findings:

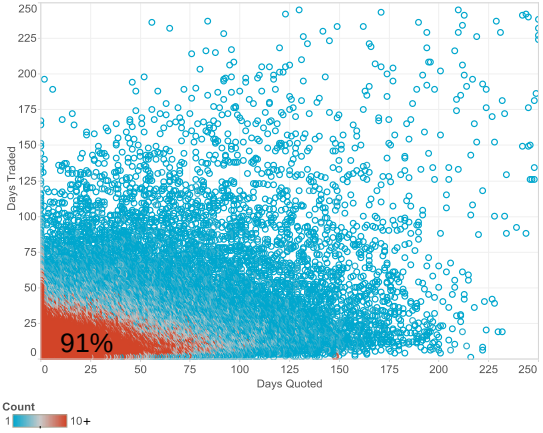
- 483,647 unique bonds traded and 253,194 were quoted in 2015, with approximately 50% of those appearing in the first four months of the year. Almost 99% of the quoted bonds traded at least once, with approximately 2,800 never trading during the year
- There is a direct relationship between the number of unique quotes and bonds that trade on a given day or month, with the correlation almost perfectly linear during a monthly period. The difference likely illustrates some time delay between the negotiation initiated post-quote and when a trade actually takes place
- The number of dealers quoting a bond on a given day is correlated with the likelihood of it trading. Data indicates that increasing the depth from one to four dealers increases the probability of a revenue bond trading from 19% to 66%, based on 2015 data
- New York general purpose and public improvement bonds had the highest likelihood of trading (25%) in 2015 among the 15 most quoted and traded use of proceeds and state combinations revenue bonds that were only quoted once on a given day. In the case of general obligation bonds, Massachusetts bonds had the highest trade rate (22%) based on the same analysis
- There were 250 trading days in 2015 and not a single municipal bond traded every day. However, there were two bonds that traded 248 days: California State 7.55% 4/2039 and Illinois State 5.1% 6/2033 taxable bonds, with neither making the top 10 list of most traded bonds in 2015 by trade count
- Approximately 9,900 bonds traded at least 10 days in 2015, but quotes were not sent via a broad distribution by any dealers during the year. However, there were only 316 bonds that were quoted at least 10 days that never traded during the year

Figure 1: Dispersion of the number of days a bond was traded versus days quoted in 2015

General Obligation



Revenue



Source: Markit, MSRB

Measuring municipal bond market liquidity

The measurement of fixed income liquidity trends is relatively complex compared to equities, with the latter largely traded on exchanges. Liquidity is defined as the speed at which a security can be bought or sold without having a significant impact on its price. However, liquidity trends can be measured very accurately without ever incorporating price into the model. In the case of municipal bonds, dealers are required to send trade sizes and prices to the Municipal Securities Rulemaking Board (MSRB) on a timely basis, but the sheer number of unique bonds in that market can often result in no trading data on specific instruments for the entire life of the security or extended periods of time.

This lack of price transparency requires quantitative modellers to determine degrees of liquidity by extrapolating the small proportion of bonds with trading data across the entire sector based on similarities in cash flow and credit risk. However, there is an inseparable relationship between pre-trade data (quotes) and trading activity, so assessing how the two interact is essential for the construction of accurate liquidity measures. **Figure 1**: Dispersion of the number of days a bond was traded versus days quoted in 2015 shows the dispersion of the number of days traded and quoted for every general obligation (GO) and revenue bond that traded in 2015. The chart indicates that over 95% of GO bonds traded less than 25 days and were quoted less than 75 days in 2015, while 90% of the larger revenue bond universe traded less than 50 days and were quoted less than 100 days that year.

It is important to note that we make several references to bonds that are quoted and traded in the same timeframe and we are never assuming that the dealer quoting the bond actually traded it. However, the data does indicate that the price transparency provided by the quote appears to facilitate the trade to some degree.

Why use quotes to assess liquidity?

Market makers are an integral part of a functioning municipal bond market and the quotes they send out every day to their clients provide a gauge for several aspects of liquidity. A very simple analogy would to be look at the quote data as a dealer's mass marketing initiative and the trades as their actual revenue. Similar to paid advertising, sending a quote does come at a cost, with a desk's reputation often being more at risk than actual capital. A dealer needs to be careful about the quantity and quality of their broadly distributed quotes, as trading partners don't like to see bids too far below the market or offers well above the market. In the contrary, those same trading partners will often try to hold the trader to execute on their above market bids and below market offers, regardless of whether the levels were intentional or accidental.

There is no way to assess the genesis of each quote, as they are a culmination of a dealer's own inventory and trade axes from a principal perspective, as well as sell orders and client axes from an agent basis. One thing that is sure is that these quotes do not come from a vacuum and each one is sent to spur a conversation

Table 1: Summary of municipal bond liquidity analysis results

	All		General obligation		Revenue		Taxable	
Totals (,000s)	**2015**	**Q1 2016**	**2015**	**Q1 2016**	**2015**	**Q1 2016**	**2015**	**Q1 2016**
Trade count	9,198.6	2,252.0	3,286.7	844.1	5,311.2	1,258.2	600.7	149.7
Unique traded bonds	483.6	218.6	238.2	98.5	217.4	106.9	28.1	13.2
Unique quoted bonds	253.2	104.4	117.4	46.9	121.0	51.8	14.8	5.7
Unique quoted bond/dealer offers (daily)	4,914.9	1,157.0	1,896.9	501.6	2,730.8	604.9	287.2	50.5
Unique quoted bond/dealer bids (daily)	380.8	163.7	129.6	61.3	214.5	87.8	36.7	14.7
Unique quoted bond/dealer markets (daily)	59.5	28.8	20.7	10.5	34.3	15.9	4.5	2.4
Monthly average (,000s)								
Unique traded bonds	113.4	112.4	46.8	47.5	59.8	58.1	6.7	6.8
Unique quoted bonds	52.3	52.1	21.2	22.6	28.0	26.8	3.1	2.8
Daily average								
Trade count (,000s)	36.8	36.9	13.1	13.8	21.2	20.6	2.4	2.5
Unique traded bonds (,000s)	13.1	13.1	4.9	5.1	7.4	7.2	0.8	0.9
Unique quoted bonds (,000s)	17.2	16.6	6.6	7.1	9.5	8.8	1.1	0.8
Ratio of daily traded bonds that were quoted (RTQ)	28%	29%	29%	31%	29%	29%	27%	26%
Ratio of daily quoted bonds that traded (RQT)	22%	25%	22%	23%	22%	24%	21%	29%

Source: Markit, MSRB

on the quoted bond or a similar bond, and these are the conversations that lead to trades.

In a very liquid market, price transparency and dealer inventories would both be higher than usual, so the breadth and volume of quoted bonds should also increase, as traders will be more comfortable with the levels they are quoting. In the case of a lower liquidity environment, quotes would not be as broadly disseminated, as the increased number of quotes could potentially make the trading desk a victim of an off market trade since they will also be at a disadvantage from the lack of price transparency.

Very strong relationship between the number of unique quotes and trades

We compared the number of unique 2015 quoted bonds and traded on both a daily and monthly basis and the data indicates a very strong relationship between quotes and trades (**Figure 2**). The daily count of unique bonds that trade is approximately 75% of the number of uniquely quoted bonds, with revenue bonds typically having the most traded and quoted bonds. However, when you aggregate the data by month, there are more than twice as many unique bonds that are traded versus quoted.

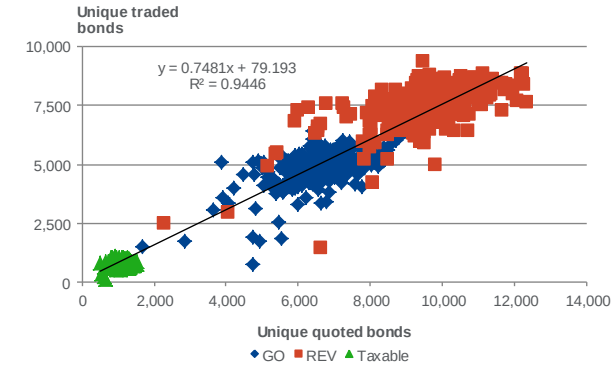
The main difference between the two different time periods is likely driven by the same bond being quoted multiple times during a month, but much fewer bonds traded on multiple days. The data in **Figure 3** is an assessment of how many bonds were traded or quoted 18 or more days during a month. The chart reinforces the fact that it is quite common for a bond to be quoted several days in a given month, as almost every month had at least 1,000 bonds being quoted every day.

The number of trading days will vary by month, but the data indicates that every month did have bonds that were traded and quoted every day. Most months had more than 200 bonds that traded every day with November 2015 having the least (86) bonds that traded every day, which is likely driven by the start of the holiday season and the very low day count. Q1 2016 appears to be in line with the same period last year, with 55 bonds trading every day this February despite have an additional trading day due to the leap year.

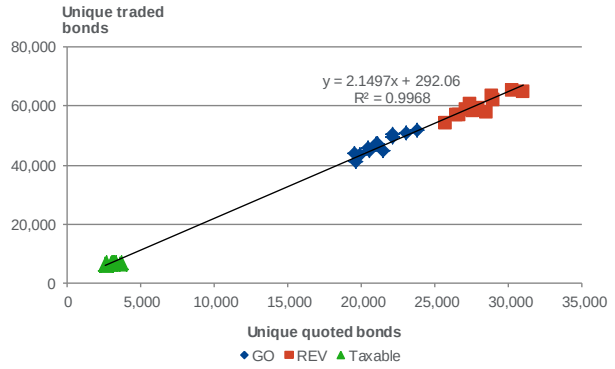
The number of quoted bonds that appeared 18 or more days each month looked very different than the trade data, as there were three months in 2015 (January, February, and April) where over 5,000 bonds were quoted every day during the month. These outliers could indicate an uptick in off market quotes, investors focusing more on new issue, less dealer inventory turnover, or more trades taking place outside of the quoted market.

Figure 2: 2015 unique traded and quoted

Daily



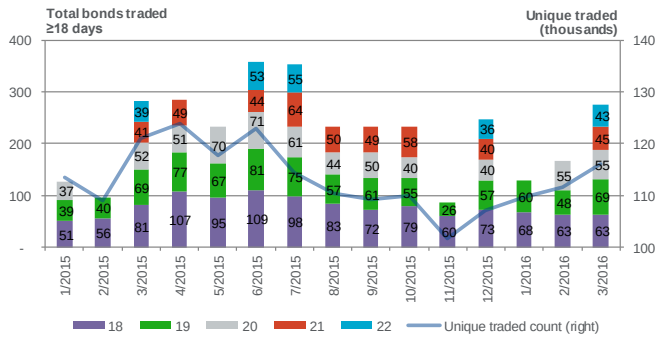
Monthly



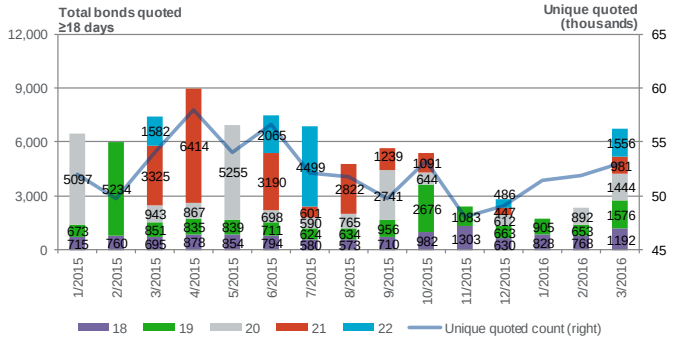
Source: Markit, MSRB

Figure 3: Number of bonds that were traded or quoted 18 or more days in a month

Traded



Quoted



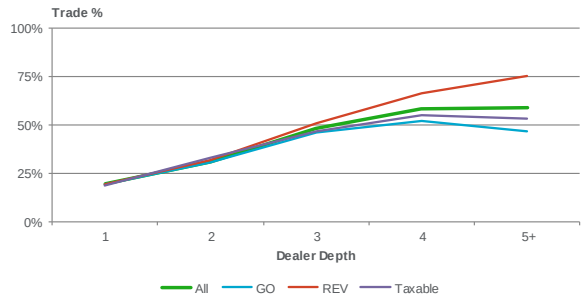
Source: Markit, MSRB

The number of dealers quoting a bond increases the likelihood of it trading significantly

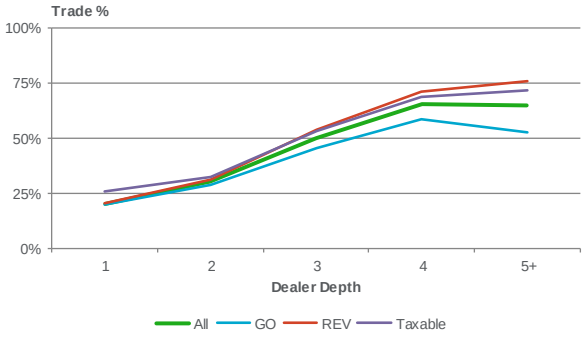
Over 80% of the daily quotes reviewed had only one dealer quoting the bond on a given day. However, the remaining bonds had a much higher likelihood of trading on a given day as the number of dealers quoting a bond increased. Data indicates that there is a direct relationship between the number of dealers quoting a bond and the probability of someone trading the bond that same day (Figure 4). For both 2015 and Q1 2016, all three product categories reported an increase in the percentage of bonds that trade as you increase the number of dealers quoting the bond. In the case of revenue bonds, only 20% of bonds trade the same day as a single quote is sent out, while 75% of the bonds with five or more quotes had traded. It is important to caveat this analysis with the fact that only 0.5% of quoted and traded revenue bonds had five or more dealer quotes on a given day.

Figure 4: Percentage of bonds that trade versus dealer quote depth on trade day

2015



Q1 2016

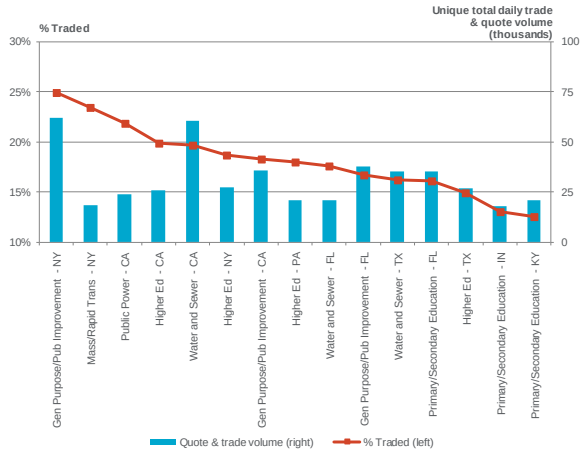


Source: Markit, MSRB

Single dealer quoted New York general purpose revenue bonds have the highest trade percentage for revenue bonds

We reviewed the fifteen revenue bonds with the highest trade and quote volume for each state and use of proceeds (UOP) combination to determine which single quoted bonds had the highest trade percentage on the day they were quoted (**Figure 5**). Data indicates that 25% of New York general purpose/public improvement revenue bonds with only one dealer quoting traded on average during 2015. Mass transit revenue bonds from New York had the second highest trade rate (23%). There is likely some bias in the data that is driven by bond issue size, as the top five state/UOP combinations are all either New York or California issues, but the analysis does show subtle differences in liquidity across issues.

Figure 5: 2015 same day trade percentage of single dealer depth revenue bonds

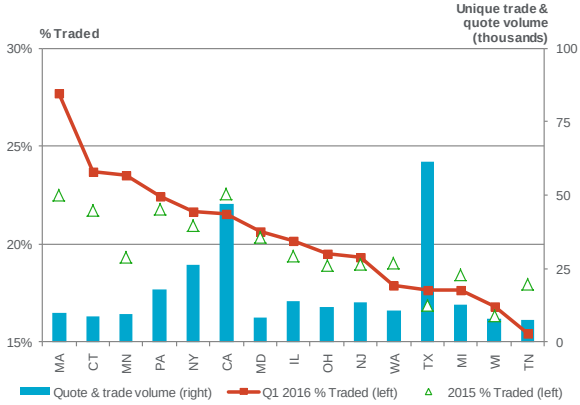


Source: Markit, MSRB

Single dealer quoted Massachusetts GO bonds had the highest trade rate in Q1 2016

We performed the same analysis on the most traded and quoted GO bond groups and determined that for bonds that were only quoted by a single dealer, Massachusetts (28%), Connecticut (24%), and Minnesota (23%) issues had the highest trade percentages in Q1 2016 (**Figure 6**). All of the top three states improved versus the 2015 average, but it is worth noting that the trade and quote volumes for those states were relatively low compared to the other top 15 states, which may have inflated the percentage to some degree. We note that New York and California had the fifth and sixth highest rate, respectively, with both near 22%.

Figure 6: Same day trade percentage of single dealer depth general obligation bonds



Source: Markit, MSRB

Ratios between trades and quotes are relatively stable

Gauging secondary market liquidity on a daily basis can be accomplished by looking at both the ratio of the traded bonds that were quoted (RTQ) and the ratio of the quoted bonds that traded (RQT) on a given day. Both sets of numbers are surprisingly stable, which is likely due to brokers adeptly adjusting the breadth and quantity of bonds they are quoting to match the overall demand on a given day. We note that RTQ and RQT are statistically significant across all three products.

$$RTQ = \frac{T_q}{T_a} \qquad RQT = \frac{Q_t}{Q_a}$$

T_a = total unique traded bonds T_q = total traded bonds with quotes

Q_a = total unique quoted bonds Q_t = total quoted bonds that traded

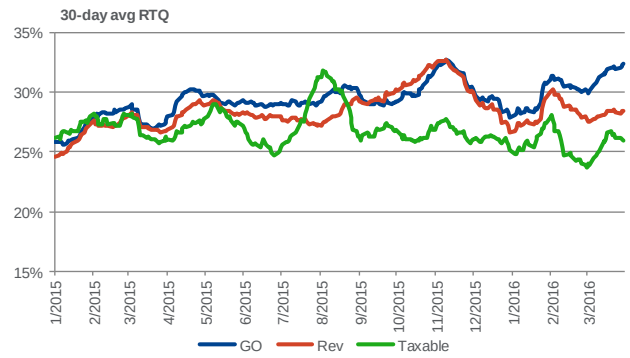
The 30-day average RTQ data indicates that GO and revenue bonds generally do track closely (**Figure 7**), but the latter typically has a slightly higher rate on average. Some of that higher rate could be driven by GO bonds generally having a lower unique bond trade count (**Figure 8**) versus revenue bonds. In the case of taxable bonds, the trade volumes are typically lower and RTQ follows a different path than the other two bond types. Most of the lowest daily RTQs occur the day before a major US holiday, with the exception of 3/10/15, when GOs were 17.7% and revenue bonds were 17.8%, which is the same day as global markets fell sharply over concerns with Greece and the USD hit a new 12-year high vs the euro.

RQT gauges the effectiveness of broadly distributed dealer quotes. The scatter plot does indicate that RQT increases with an increase in the number of trade bonds, which would make sense from a simple mathematical perspective (i.e. trade count is the numerator).

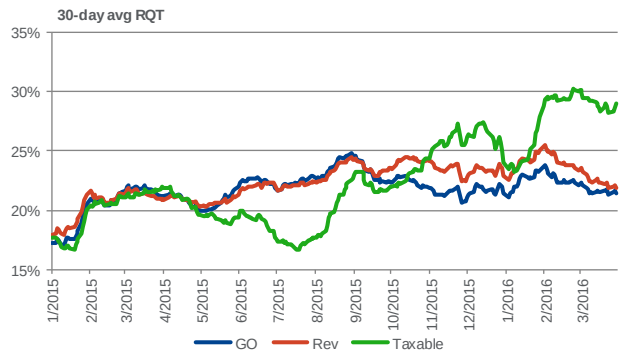
Time series data indicates that GO and revenue bond RQT was highly correlated (over 97%) until last September, when revenue bonds remained 1-2% higher on an absolute basis until late March 2016 when the ratios converged again. This effect could be due to the sharp drop off in municipal bond issuance from August 2015 through February 2016 potentially leading to more trades taking place outside of dealer runs. Similar to RTQ, all of the lowest RQT values all took place the day before or after a major holiday, despite both quote and trade counts being well below average.

Figure 7: Number of bonds that were traded or quoted 18 or more days in a month

Ratio of daily traded bonds that were quoted (RTQ)

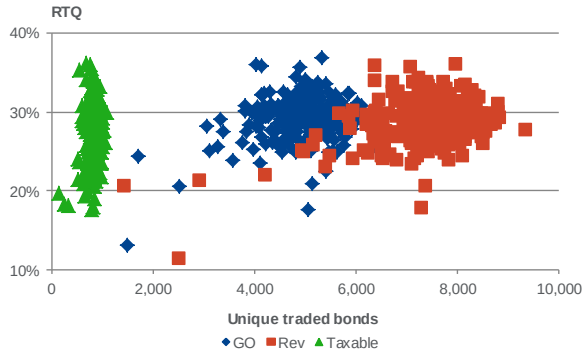


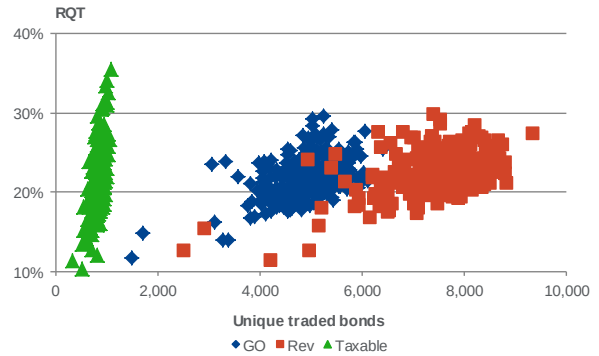
Ratio of daily quoted bonds that traded (RQT)



Source: Markit, MSRB

Figure 8: 2015 RTQ and RQT versus daily unique trade count





Source: Markit, MSRB

Puerto Rico GO issues had both the highest RTQ and RQT in 2015

Data indicates that Puerto Rico GO bonds were among the most liquid bonds in 2015 when measured by RTQ and RQT (**Table 2**). Of the two metrics, the 50.5% daily average RQT was almost double of the next highest state (California 25.8%), indicating that more than half of every Puerto Rico bond that is quoted on a given day typically trades on the same day. North Carolina (35.8%) and Hawaii (35.6%) GO bonds had the next highest RTQ. California (25.8%) and Massachusetts (25.2%) were ranked second and third for RQT.

Puerto Rico in top 3 for revenue bonds for both metrics

Puerto Rico general purpose/public improvement bonds reported the highest average RTQ (44.4%) and second highest RQT (43.6%) in 2015. California public power (41.9%) and New York general purpose/public improvement bonds (40.3%) had the second and third highest average RTQ. New Jersey mass/rapid transit had the highest average RTQ (43.7%) last year.

Table 2: Top 5 2015 general obligation bond RTQ and RQT by state

	Top 5 RTQ			Top 5 RQT	
State	**RTQ**	**RQT**	**State**	**RQT**	**RTQ**
PR	36.1%	50.5%	PR	50.5%	36.1%
NC	35.8%	22.4%	CA	25.8%	30.9%
HI	35.6%	23.6%	MA	25.2%	33.0%
WI	34.9%	17.6%	AR	25.2%	28.1%
MD	34.3%	22.8%	CT	24.8%	33.0%
2015 Average	**29.3%**	**21.8%**			

Source: Markit, MSRB

The aforementioned GO and revenue bond RTQ and RQT data does appear to be aligned with the higher end of the municipal bond liquidity spectrum and does validate the use of those metrics for assessing liquidity. It is important to note that we only included the top 20 traded/quoted state GOs and top 50 UOP-state revenue bonds for the analysis to minimize data anomalies from very low record count categories. For bonds with a very low trade or quote count, both metrics will need to be either supplemented with additional data elements or linked to comparable bonds with more trade/quote data to better assess liquidity.

Figure 9: Top 5 2015 revenue bond RTQ and RQT by use of proceeds and state

	Top 5 RTQ			Top 5 RQT	
UOP-State	**RTQ**	**RQT**	**UOP-State**	**RQT**	**RTQ**
Gen Purpose/Pub Improvement -PR	44.4%	43.6%	Mass/Rapid Trans -NJ	43.7%	36.1%
Public Power -CA	41.9%	26.4%	Gen Purpose/Pub Improvement -PR	43.6%	44.4%
Gen Purpose/Pub Improvement -NY	40.3%	29.6%	Public Power -PR	38.7%	36.3%
Other Transportation -NY	37.5%	29.1%	Water and Sewer -NY	34.3%	28.9%
Public Power -WA	36.8%	23.0%	Gen Purpose/Pub Improvement -NY	29.6%	40.3%
Toll Road and Highway -TX	36.8%	29.1%	Toll Road and Highway -TX	29.1%	36.8%
Mass/Rapid Trans -NY	36.7%	28.8%	Other Transportation -NY	29.1%	37.5%
Public Power -PR	36.3%	38.7%	Mass/Rapid Trans -NY	28.8%	36.7%
Primary/Secondary Education -NJ	36.1%	45.3%	Hospitals -FL	27.1%	27.8%
Mass/Rapid Trans -NJ	36.1%	43.7%	Public Power -CA	26.4%	41.9%
2015 Average	**28.7%**	**22.3%**			

Source: Markit, MSRB

There were no municipal bonds that traded every day in 2015

We were surprised to find that there was no municipal bond that traded every day in 2015 (**Table 3**), with only California St-Federally Taxable Various Purpose General Obligation - 2009 7.55% 4/2039 and Illinois St-GO Pension Funding - 2003 5.1% 6/2033 trading 248 out of 250 days in 2015. Neither bond traded on December 24th, while the California issue did not trade on April 23rd and the Illinois issue on October 1st.

All bonds on the list matured in 2033 or later, volatility in long rates likely drove the higher number of days traded. It was also interesting that Puerto Rico issues dominated the list, as the distressed nature of the security and a steady stream of media coverage has expanded the issuer's investor base into deeper credit investors.

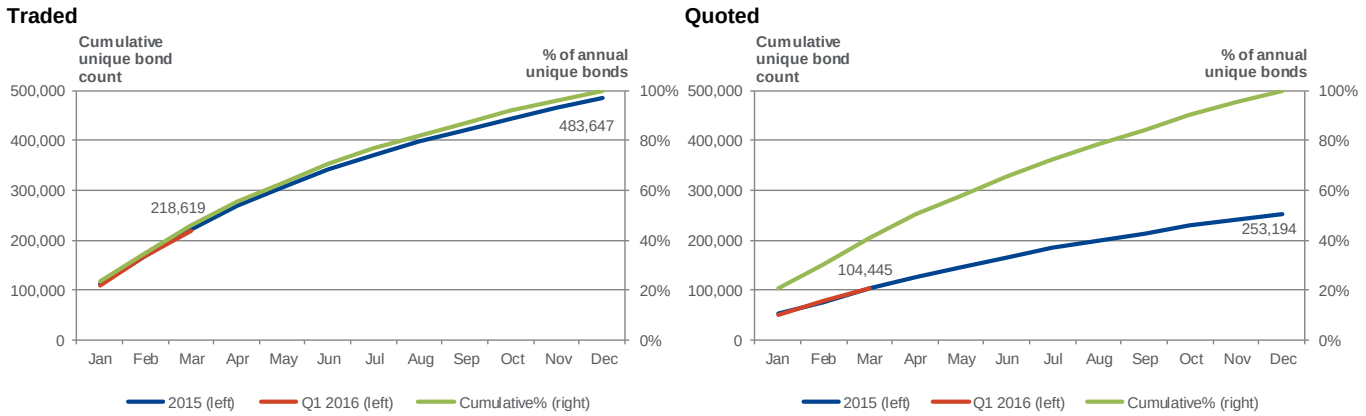
The New Jersey St Transportation Tr Fd Auth-Transportation Program - 2014-Aa 4.25% 6/2044 was the most traded municipal bond by trade count in 2015, despite only trading 242 days and being quoted only 123 days. In fact, the tenth most traded security traded 3,484 times in 2015, meaning that only three bonds in the table also made it onto the most traded list.

Table 3: 2015 Most traded municipal bonds by number of days traded

CUSIP	Issue	Type	Days Traded	Days Quoted	2015 Total Trade Count	2015 Markit High Price	Date	2015 Markit Low Price	Date
13063A5G5	California St-Federally Taxable Various Purpose General Obligation - 2009 7.55% 4/2039	Taxable	248	213	2,005	161.68	1/30/15	140.39	9/8/15
452151LF8	Illinois St-GO Pension Funding - 2003 5.1% 6/2033	Taxable	248	187	3,096	103.77	1/30/15	90.41	11/9/15
74514LB89	Puerto Rico Comwlth-Public Improvement Refunding - 2012-A 5.0% 7/2041	GO	245	248	5,446	70.25	6/4/15	58.45	6/30/15
79020FAM8	St John Baptist Parish La Rev-Fixed Rate Revenue - Marathon Oil Corporation 2007-A 5.125% 6/2037	Revenue	245	210	4,053	106.27	1/9/15	100.66	12/17/15
745190DH8	Puerto Rico Comwlth Hwy & Transn Auth Transn Rev -Transportation Revenue - 1998-A 4.75% 7/2038 (insured)	Revenue	245	130	2,923	97.78	1/16/15	77.18	8/27/15
74514LE86	Puerto Rico Comwlth-GO 2014-A 8.0% 7/2035	GO	243	250	3,296	87.16	1/5/15	66.20	6/30/15
74514LB63	Puerto Rico Comwlth-Public Improvement Refunding - 2012-A 5.125% 7/2037	GO	243	247	2,571	71.00	5/28/15	58.75	6/30/15
44420PAA2	Hudson Yds Infrastructure Corp N Y Rev-Hudson Yards Senior Revenue Fiscal 2007 - 2007-A 4.5% 2/2047 (insured)	Revenue	243	171	1,908	105.46	1/28/15	100.52	9/29/15
531127AC2	Liberty N Y Dev Corp Rev-Revenue - Goldman Sachs Headquarters Issue 2005 5.25% 10/2035	Revenue	242	244	2,369	124.40	1/30/15	112.91	5/20/15
74514LD20	Puerto Rico Comwlth-Public Improvement Refunding - 2012-A 5.0% 7/2035 (insured)	GO	242	149	2,284	100.79	3/19/15	88.25	7/1/15
646136U66	New Jersey St Transportation Tr Fd Auth-Transportation Program - 2014-Aa 4.25% 6/2044	Revenue	242	123	6,696	102.82	1/28/15	92.20	9/16/15

Source: Markit, MSRB

Figure 10: Monthly cumulative number of unique bonds that were traded or quoted

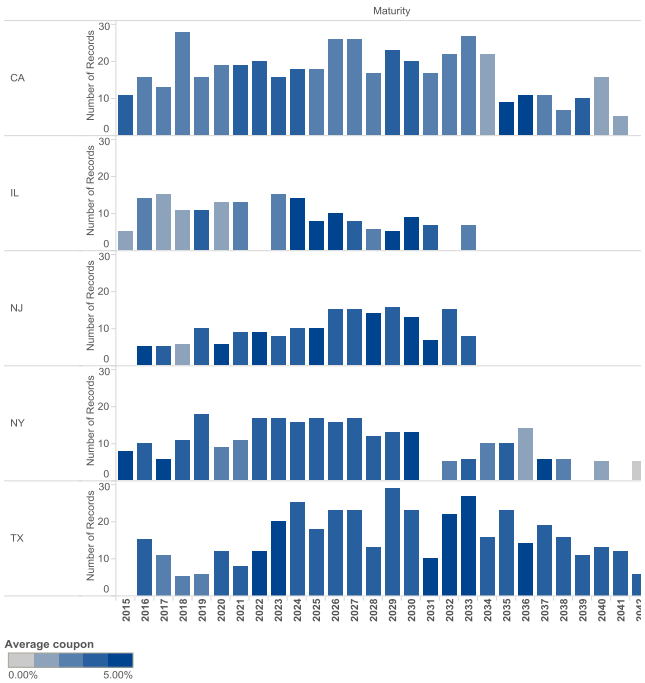


Source: Markit, MSRB

The first quarter of both 2015 and 2016 had an almost identical number of unique bonds that were traded or quoted

We tracked the cumulative number of unique traded and quoted in 2015 and the data indicates that Q1 2016 is on track with the prior year (**Figure 10**). That indicates that the breadth of traded bonds in Q1 2016 is very similar to the same period in 2015, despite the additional distress in the global equity markets for the first two months of this year. One trend that stood out across both datasets is that by April of 2015 over 50% of the entire year's traded and quoted bonds had appeared at least once. It is also worth noting that the monthly pace of new unique traded bonds is 3-4% faster than new quoted bonds until both converge to near 95% in November.

Figure 11: GO bond count by state and average coupon for bonds that traded ≥10 days and were never quoted



Source: Markit, MSRB

Almost 10,000 bonds traded at least 10 days in 2015, but were not broadly quoted the entire year

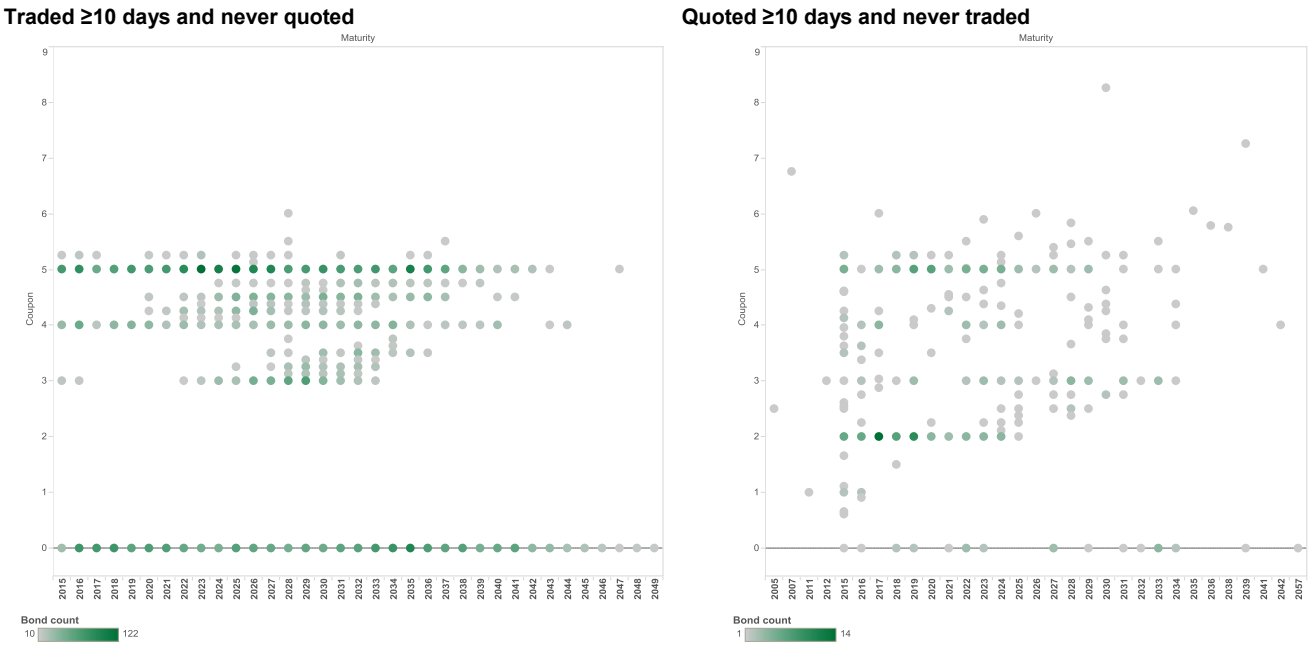
There were only 316 bonds that were quoted more than 10 days in 2015, but never traded. On the contrary, there were approximately 9,900 bonds that traded at least 10 days in 2015, but quotes were not sent via a broad distribution by any dealers during the year. Given the number of unique bonds that traded in 2015, that is only 2% of the number of bonds that traded, however it does indicate the portion of the market that is traded more "quietly" or is inadvertently neglected by the broader dealer community.

California and Texas GO bonds had the most bonds that traded and were not quoted

We reviewed the bond count and average coupon for GO bonds that traded and were never quoted (**Figure 11**) and California and Texas bonds had the highest count for the category, with most maturity buckets having more than 20 bonds that fit the criteria. 2035 maturity California issues had the highest average coupon (4.68%), while New York and Illinois each had two maturity groups with average coupons higher than 4.5%.

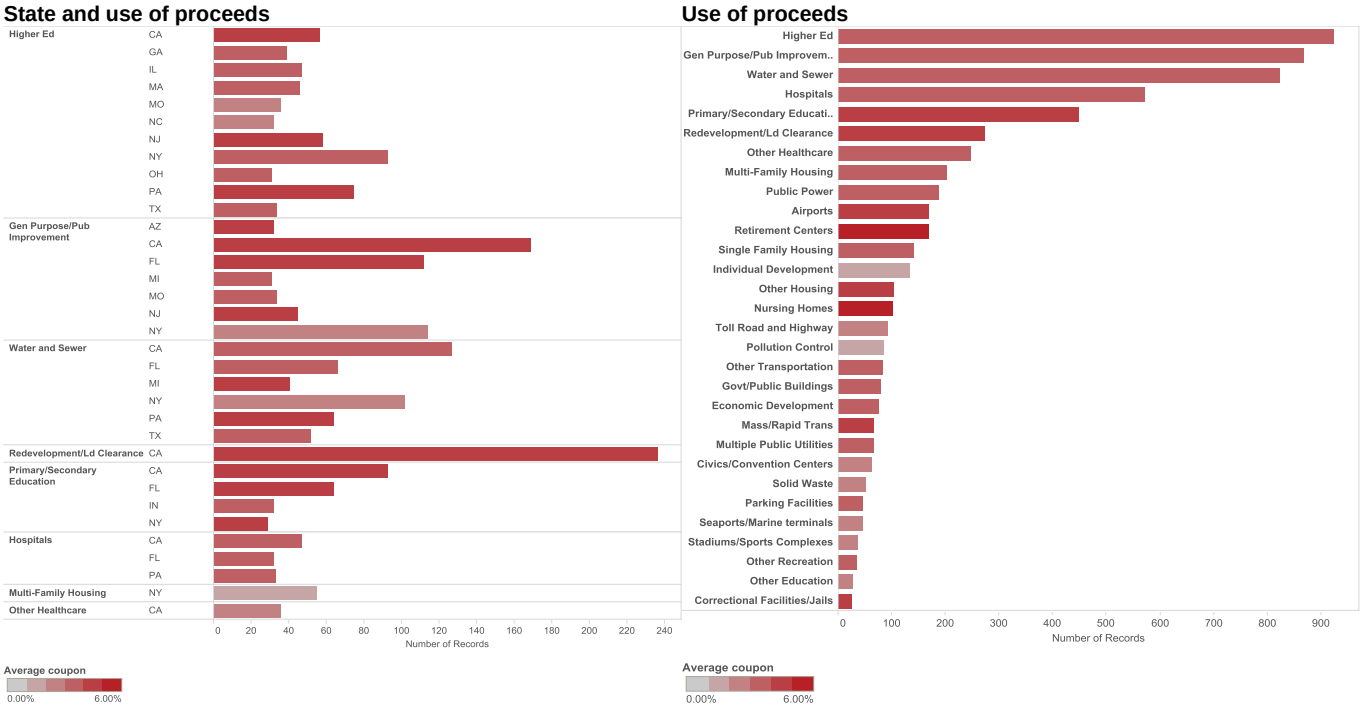
Figure 12 shows the coupon and maturity dispersion of the bonds that were traded ≥10 days and never quoted or quoted ≥10 days and never traded. The greatest density of traded and not quoted bonds was the 5% coupon, with 2023, 2024, 2025, and 2035 maturity buckets each having over 100 bonds. In fact, the 5% and zero coupon bonds made up the majority of bonds that were never quoted. 2% coupon bonds across the 2015-2019 maturities and 5% coupons across 2019-2024 maturities dominated the much smaller quoted and never traded group.

Figure 12: Count of 2015 never trade or quoted bonds by coupon and maturity



Source: Markit, MSRB

Figure 13: Revenue bond state/UOP bond count and average coupon for bonds that traded ≥10 days and were never quoted



Source: Markit, MSRB

California redevelopment and land clearance revenue bonds were traded and not quoted the most

California issues also dominated the revenue bond category, with 237 of its redevelopment and land clearance revenue bonds trading despite never being broadly quoted for the entire year (**Figure 13**). California was the leader across most UOP categories, with the exception of higher education, where it ranked third (57) to New York (93) and New Jersey (58).

When not including state, higher education (924), general purpose/public improvement (868), and water and sewer (868) revenue bonds had the most bonds that traded, but were never quoted. Nursing home bonds had the highest average coupon, 5.77%, among the UOP category.

2016 liquidity appears to be in line with 2015 so far

Our analysis only touches the surface of measuring municipal bond liquidity, but the data does indicate that this year is not starting off much differently than 2015 despite the increased global economic concerns at the onset of the year. The data also shows that the breadth of bonds traded and quoted in Q1 2016 is similar to the same period last year and the overall market appetite for bonds offered by dealers per RTQ and RQT actually remains slightly above last year's daily average.

As mentioned earlier, we did not mandate quote or trade size minimums for this analysis, but we do see the value of adding such filters to future analyses. Our evaluation and research team has access to quote data from MBIS, but we did not include it for this analysis and it is safe to assume that the data would likely increase the RTQ across all categories and potentially increase the RQT given the additional unique quoted bonds.

The valuation and measurement of both liquidity and best execution for municipal bonds will always be dependent on the pre-trade price transparency of dealer quotes and the actual traded prices. The framework outlined in this study can be expanded to accurately accomplish those same risk management endeavors by simply adding in various other metrics like rating, bond yield, and issue size to name a few. The electronifcation and the algorithimization of the way people trade and invest in the municipal bond market is likely to start catching up very soon with equities and other fixed income markets, and that type of progress will require the same extensive quote and trade price historical datasets that pricing analysts have already been using to accurately price the sector for several years.

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