Providing Liquidity in an Illiquid Market: Dealer Behavior in U.S. Corporate Bonds

Michael A. Goldstein
Babson College
320 Tomasso Hall
Babson Park, MA 02457
goldstein@babson.edu
781-239-4402

Edith S. Hotchkiss
Boston College
Fulton Hall, Room 340
Chestnut Hill, MA 02467
hotchkis@bc.edu
(617) 552-3240

May 2017

Abstract

We examine market making behavior of dealers for a sample of 55,988 corporate bonds, many of which trade infrequently. Dealers have a substantially higher propensity to offset trades within the same day rather than committing capital for longer periods, particularly for riskier and less actively traded bonds. Dealers' holding periods do not decline with liquidity, and in fact are lowest for some of the most illiquid bonds. As a result, cross sectional estimates of roundtrip trading costs do not increase as expected liquidity declines. Our results suggest that dealers endogenously adjust their behavior to mitigate inventory risk from trading in illiquid and higher risk securities, balancing search and inventory costs in equilibrium such that observed spreads appear invariant to expected liquidity.

We thank Terrence Hendershott, Charles Himmelberg, Stacey Jacobsen, Norman Schürhoff, participants at the 2015 FINRA-Columbia Fixed Income Conference, 2016 Banque de France and Toulouse School of Economics (TSE) conference on Market Liquidity and Regulation, 2017 Fixed Income and Financial Institutions Conference, and seminar participants at The Queen's University (Belfast), U. Sydney, U. South Australia, U. Auckland, U. Melbourne, Queensland University of Technology, Bond University, Macquarie University, University of Technology-Sydney, and Australia National University.

I. Introduction

Despite the vast number and extremely large dollar volume of U.S. corporate bond issues, many corporate bonds never or rarely trade. While the importance of illiquidity has been extensively studied with regard to corporate bond pricing, the difficulty of market makers in providing liquidity to this over-the-counter market is less well understood. For illiquid bonds, dealers may be unwilling to commit capital in a market where they face both significant inventory risk upon purchasing an asset from a customer and potentially high search costs in locating a counterparty for an offsetting trade. Such risks are magnified when dealers face larger potential price movements on riskier assets and for assets where few buyers arrive naturally.

In this paper, we examine a comprehensive sample of 55,988 U.S. corporate bonds to study how dealers provide liquidity in a market where many issues are infrequently traded and expose dealers to significant inventory risk. We show that dealers' market making behavior endogenously changes based on the riskiness and illiquidity of the assets they trade. Whether we observe dealers taking bonds into inventory depends on factors that drive expected search and inventory costs, including bond characteristics, market conditions, and the competitive structure of the dealer market for a given bond. Despite their low liquidity, we find that dealers are most likely to quickly offset trades, rather than holding bonds in inventory overnight or longer, for the least actively traded and riskier bonds. Our analysis further shows how the choice to provide liquidity is reflected in observed spreads on dealers' trades. Because dealers can mitigate inventory risk by actively searching for a counterparty, observed spreads are often lower for riskier bonds and those with little or no prior trading activity.

Our work draws on theoretical models of dealers' market making behavior, particularly as they relate to search activity and inventory decisions. Standard market microstructure models such as Glosten and Milgrom (1985) and Kyle (1985) generally assume that dealers stand by passively and await the arrival of liquidity traders, who arrive regularly via an external random distribution. In contrast, for over-the-counter markets, Duffie, Gârleanu, and Pedersen (2005) and others show that active search for a counterparty arises endogenously, either by investors looking for competing market makers or by market makers looking for an offsetting trade. The intensity of search affects prices, which are determined by a bargaining process that reflect the investors' and dealers' alternatives to trading immediately. Higher search costs imply worse outside alternatives and worse prices; for example, investors that do not have easy access to multiple market makers sell to the market maker at a larger discount.[1]

Inventory models also consider the dealers' role when there is uncertainty about the arrival of buyers and sellers, but dealers provide liquidity by committing capital when there is an imbalance (Garman, 1976; Stoll, 1978; Amihud and Mendelson, 1980).[2] However, while dealers can provide immediacy to less patient investors, their willingness and/or ability to commit capital can be limited (Hendershott and Seasholes, 2007; Brunnermeier and Pedersen, 2009; Duffie, 2010). Combining the arguments of Duffie, Gârleanu, and Pedersen (2007) with the realities of dealers' capital costs, we argue that dealers face a tradeoff between inventory and search costs which in turn affects the pricing and liquidity offered to customers. When inventory risks are sufficiently high, we expect dealers' search to intensify, such that dealers act more as brokers by pre-arranging matched buy and sell trades. Unlike inventory models, however, this implies that observed spreads will be lower for bonds with greater potential inventory risk if dealers mitigate this risk by searching for counterparties. Our empirical results support these conjectures, particularly for illiquid, risky bonds.

Our empirical analysis first examines measures of trading activity in order to develop proxies for expected liquidity at the time of a dealer purchase. While immediacy can be measured in milliseconds or microseconds for foreign exchange or equities (Chen, Foley, Goldstein, and Ruf, 2017), the concept of immediacy for many bonds can be measured in hours, if not days or weeks. Observations of transaction prices for many bonds are rare: the median bond in our sample has only 0.6 institutional sized trades per

[1] In Duffie, Gârleanu, and Pedersen (2005), market makers are assumed to off-load inventories in a frictionless interdealer market. Duffie, Gârleanu, and Pedersen (2007) do not model market makers, but do incorporate "holding costs" of an investor counterparty, which implies that dealers buy from investors at lower prices when there are fewer alternative buyers, price volatility is higher, or risk aversion of the buyer is higher.

[2] Ho and Stoll (1981) show that additional uncertainty about the return on assets held in inventory affects dealers' willingness to act as a market maker as well as the bid ask spread which compensates for this risk. The empirical implication is that observed spreads are higher when there is a greater risk of price movements during the dealer's holding period and when trades are not expected to be quickly offset. The same is true in Grossman and Miller (1988) and Whitcomb (1988).

month, and many bonds do not trade at all. Unlike prior corporate bond research which largely excludes relatively inactive bonds in order to utilize standard measures of liquidity, we retain less active bonds in our sample and assign all bonds to trading activity deciles based on their trade count and number of non-zero trading days in the 30 day window preceding any dealer purchase.[3] We show that these measures are stable over monthly or yearly periods, such that recent trading activity provides a good proxy for expected near term activity.

Our dataset allows us to identify purchases and sales reported to TRACE by individual (anonymous) dealers, enabling us to identify 28,005,060 dealer roundtrips in which we match a dealer buy transaction to one or more offsetting sell transactions of that dealer in the same bond. We focus our analysis on the 9,031,796 roundtrips starting with a buy trade of at least 100 bonds, as larger trades are important in understanding dealers' inventory risk.[4] For each roundtrip, we observe how quickly the buy transaction is offset (the dealer's holding period), the type of counterparties involved (dealer versus customer), and the roundtrip cost (spread) for the dealer trading the bond. The roundtrip spread is calculated as the difference in the dealer's buy price and weighted average sell price.

As with most datasets, we do not observe when a customer has initially contacted a dealer or the dealer's search activities either before or after a trade, and cannot identify trades that never take place. However, we do observe the resulting dealer trading activity, specifically dealers' decision to take bonds into inventory and holding periods. We consider the factors based on dealer search and inventory models that are expected to explain dealers' observed behavior. Holding periods vary significantly; for roundtrips overall, a surprisingly large portion (57.1%) of dealer roundtrips are completed within the same day, over 70% of which are cases of a "paired" roundtrip where the dealer offsets the buy transaction with a single sell

[3] Both trade count and days traded are related to the (in)frequency of price observations, but do not require multiple transactions per day and thus are appropriate for illiquid bonds, unlike other commonly used measures. For example, calculating the Amihud (2002) measure of price impact or a measure based on Roll (1984) requires multiple trades per day. See further discussion of problems in applying traditional liquidity measures to infrequently traded bonds in Nashikkar and Subrahmanyam (2006), Chen, Lesmond, and Wei (2007), and Section II.A. of this paper.

[4] Dealer roundtrips match dealer purchases of a bond with one or more offsetting sell trades, closest in time, in the same bond to a customer or another dealer. Though we start with a buy of at least 100 bonds, the offsetting sells can be of any size, as dealers may engage in asset size transformation by breaking up institutional size into retail size trades. Details of our methodology for identifying roundtrips is provided in Section II.C.

transaction of the same quantity. For the remaining 42.9% of roundtrips, dealers take bonds into inventory at least overnight, with a median holding period lasting 28 days. Unless the dealer actively searches for a counterparty, bonds with few or no trades in the recent past expose the dealer to greater expected inventory risk. Inventory risk further increases for lower credit quality bonds with risk of larger price movements. Comparing the lowest rated, least actively traded bonds to the highest rated most active bonds, dealers offset trades within the same day for approximately 75% versus less than 55% of roundtrips, respectively.

Absent dealer search, greater inventory risk would increase observed dealer roundtrip spreads, as in Grossman and Miller (1988); however, active dealer search could mitigate this effect. Since the effect of trading activity on dealer behavior may be non-linear in credit quality and quite different around the investment grade/non-investment grade cut-off, we control for credit rating by running separate analyses for four credit rating groups (A and above, BBB, BB, and B and below). Initial OLS results show that spreads do not monotonically increase for lower trading activity deciles relative to more actively traded bonds. Only the extreme lowest decile of less active bonds, many of which have no trades in the prior 30 day period, more consistently have higher observed spreads relative to more active bonds, and even this effect decreases or disappears as credit rating declines. The identity of the counterparty is also important in explaining spreads; spreads are lowest when the dealer both purchases and sells in the interdealer market, indicating the value of locating a customer, and consistent with the model of Duffie, Gârleanu, and Pedersen (2005). These results are consistent with dealers offsetting inventory risk by actively searching for counterparties.

This setting fits naturally within an endogenous switching regression framework, in which a first stage probit is used to predict whether dealer roundtrips are completed within the same day versus over longer holding periods.[5] Our probit models include bond and trade characteristics related to expected price (inventory) risk and dealers' search. Bond characteristics that indicate fewer or better informed potential counterparties, such as older bonds and Rule 144A private placement bonds, have a significantly higher probability of roundtrips being completed the same day. Roundtrip trade characteristics include the size of

[5] See Hendershott and Madhavan (2015), Bessembinder and Venkataraman (2004), and Madhavan and Cheng (1997) for discussion of these models.

the buy trade and identity of the counterparty. If larger trades take longer to unwind and expose the dealer to greater inventory risk, we would expect roundtrips starting from a larger dealer purchase to more likely be completed the same day. We find that large block-size purchases of lower credit bonds are more likely offset within the same day, and that the magnitude of this effect is quite large for lower credit quality bonds. We also find that purchases from another dealer have a substantially lower probability of being held in inventory, suggesting that rather than assuming inventory risk from another dealer, these dealers are compensated for locating a customer to offset the trade (similar in spirit to Duffie, Gârleanu, and Pedersen, 2005). At the same time, more active dealers, measured either by their total reported trade count or volume, may be better connected both to other dealers and to customers, and so able to locate counterparties at lower cost. We find that dealers with a large share of the total market volume provide much of the market's liquidity by taking bonds into inventory.

To understand the relationship between prior trading activity and dealers' behavior, the first stage models also include dummies for each of the five lowest trading activity deciles. Notably, for all credit qualities, bonds in the lowest decile of trading activity prior to the roundtrip have a significantly greater likelihood of roundtrips completed the same day relative to more active bonds. This result suggests that despite (or due to) the low level of trading in these bonds, dealers actively search for and find same-day counterparties. For example, A-rated bonds in the lowest decile of prior trading activity have a 16% higher likelihood that the roundtrip is completed the same day. The coefficients decline as trading activity increases (within the bottom five deciles), remaining strongly positive and significant for the days traded measure and even becoming negative based on trade count. Overall, the first stage models show a strong relationship between our proxies for expected near term liquidity and the probability that dealers take bonds into inventory at least overnight. These results are consistent with stronger dealer search precisely where it is needed most, i.e., for the least active bonds.

The second stage of the endogenous switching regression models estimates two equations explaining roundtrip spreads, one equation for roundtrips completed the same day and one for those completed over longer periods. Regardless of whether roundtrips are completed in the same day or longer, spreads are significantly lower for roundtrips starting from larger dealer buys. Spreads are higher when the dealer transforms a larger buy by breaking up the trade into smaller sized sells, consistent with Edwards, Harris, and Piwowar (2007), Goldstein, Hotchkiss, and Sirri (2007), and others who document higher spreads for smaller trades. Results for the trading activity deciles are largely similar to those using OLS, but provide even stronger evidence that spreads are the same or smaller for infrequently traded bonds except for bonds in the lowest decile. In addition, these regressions show not only that spreads are greater when bonds are taken into inventory, but also that the magnitude of the effect of expected liquidity is greater for roundtrips completed over more than one day. Taken together, our results show that the pattern we observe for spreads is robust to selection effects, and most importantly that our first stage results are helpful in understanding observed spreads.

We also use our second stage estimates to calculate a counterfactual; using roundtrips completed the s*ame day*, we calculate their predicted spread using the coefficients estimated from roundtrips completed in *more than one day*. For example, using deciles either by trade count or days traded, we estimate that roundtrip costs would be 7 basis points higher for bonds rated A and above but as high as 21 basis points higher for BBB rated bonds had they not been completed the same day. Similarly, spreads on roundtrips completed in more than one day for BBB bonds are estimated to be 9 basis points higher than they would be if completed on the same day. Of course, these estimates are based on dealers' arguably optimal decision as to whether to take bonds into inventory, as well as whether to trade at all. Regardless of magnitude, the sign of these estimates is indicative of the tradeoffs in price when dealers provide immediacy, and is consistent with dealers undergoing search to offload inventory quickly and being compensated for retaining bonds in inventory overnight or longer.

The fact that dealer behavior varies with illiquidity is particularly important in understanding the behavior of spreads and other measures of dealer activity in periods of large increases in overall market illiquidity. Prior research has shown large increases in measures of illiquidity for corporate bonds during the financial crisis period. Our base regressions show that dealers are significantly more likely to complete roundtrips within the same day during the financial crisis (defined as the second quarter of 2007 through the second quarter of 2009), and are also somewhat more likely to do so in the post-crisis period relative to pre-crisis period. These findings suggest that during the crisis, dealers engage in more search and provide less liquidity, consistent with the costs of limited capital at this time.[6] Of key interest, however, is whether there is a greater change in dealers' behavior in trading bonds with lower expected liquidity. We re-estimate our first stage probit and find that the relationship between trading activity deciles and the likelihood of completing roundtrips the same day does not change during the crisis period. However, the second stage results show an interesting effect only for the highest rated bonds, where the positive effect of lower trading activity on spreads becomes strongly significant for roundtrips in which bonds are taken into overnight inventory. We find similar results when we examine days of large increases in the VIX index, which have also been shown to experience increases in bond market illiquidity (Bao, Pan, and Wang, 2011; Anderson and Stulz, 2017). These results show that in times of market stress, not only are dealers more likely to quickly offset trades, but also that there is a greater effect of illiquidity on spreads for higher rated bonds that dealers more commonly take into inventory.

Finally, our base results demonstrate important differences for dealers who are not amongst the most active in this market. Less well connected dealers likely face greater search costs and as well as greater costs of holding bonds in inventory. We estimate our two stage model excluding roundtrips of the top ten dealers.[7] We find that the effect of expected liquidity on the likelihood of offsetting a trade within the same day and on spreads is even greater for bonds in the least active trading decile.

In summary, our analysis demonstrates dealers' ability to adjust their market making activity based on the expected liquidity of the bond traded. As a result of this change in behavior, low credit quality bonds which rarely trade can be observed to have lower roundtrip costs than a highly rated active bond for which a market maker chooses to maintain inventory. Dealers mitigate inventory risk by acting more as brokers and

[6] Bao, O'Hara, and Zhou (2017) and Bessembinder, Jacobsen, Maxwell and Venkataraman (2017) focus on the time series of dealer capital commitment in response to regulatory changes including Dodd Frank.

[7] Despite the illiquidity of many bonds, a large number of dealers report trades to TRACE. However, market making is highly concentrated – on average in our sample, 38% of a bond's trading volume is done by the top ten dealers as ranked by dealers' total trading volume.

less as market makers as liquidity declines, but in doing so provide less immediacy to customers looking to trade less active bond issues.[8]

Recognizing that dealers' endogenously adjust their behavior based on the liquidity of the security they trade is important in interpreting any studies that seek to explain observed measures of liquidity either cross-sectionally or over time. Our results also provide some insight into the ongoing debate on the state of corporate bond market liquidity. This literature has produced two seemingly contradictory conclusions: one that liquidity has improved based on observed declines in transactions costs, and the other that dealer capital commitment has declined over time.[9] Our work is empirically consistent with both conclusions, but points to the explanation that dealers take on less risk in observed trades as expected liquidity declines.

Our paper is organized as follows. Section II reviews liquidity measures used for corporate bonds, and describes our data and measures of dealer roundtrips. Section III examines how spreads dealers charge on roundtrip trades vary with increasing degrees of illiquidity and credit risk. Section IV examines dealers' inventory behavior, while Section VI estimates a model of dealer spreads that accounts for the endogeneity of dealers decision to take bonds into inventory. Section VII concludes.

II. Data and summary statistics for liquidity

This study uses data provided by FINRA for all corporate bonds reported to TRACE from July 8, 2002 through March 31, 2011. In this section, we first discuss measures of corporate bond liquidity and

[8] The problem of providing liquidity in a market with a large number of assets, many of which rarely trade, is similar to that found in the agency mortgage-backed securities market, where tens of thousands of unique securities have been issued (Gao, Schultz, and Song, 2017). The price dynamics of large selling pressure and costs of immediacy are also demonstrated in recent work by Dick-Nielsen and Rossi (2017) for corporate bonds dropped from the Lehman/Barclay bond index, which occurs most often when bonds are near maturity or are downgraded.

[9] Several papers show improvement in some measures of market liquidity following the introduction of post-trade transparency with TRACE (Bessembinder, Maxwell and Venkataraman, 2006; Edwards, Harris, and Piwowar, 2007; Goldstein, Hotchkiss, and Sirri, 2007; Asquith, Covert, and Pathak, 2013). More recent studies document improvement in price-based liquidity metrics in the post-financial crisis period (Trebbi and Xiao, 2017; Anderson and Stulz, 2017), but a decline in dealer capital commitment (Bessembinder, Jacobsen, Maxwell, and Venkataraman, 2017; Bao, O'Hara, and Zhou, 2017). Dick-Nielsen and Rossi (2016) show that the price of immediacy following forced selling of bonds has substantially increased post-crisis.

define our proxies for expected near term liquidity. We then explain our sample construction and provide description of trading activity and dealer roundtrips.

II.A. Measures of liquidity for corporate bonds

As noted by Nashikkar and Subrahmanyam (2006, p.2), “the absence of frequent trades in corporate bonds makes it difficult to use market micro-structure measures of liquidity based on quoted/traded prices or yields to measure liquidity, as has been done in the equity markets.” Further, many market microstructure models of dealer behavior, such as Kyle (1985) or Glosten and Milgrom (1985), do not explicitly assume frequent trades but do have implicit assumptions about the competitive nature of the market and the frequency of new information arrival, which implies more frequent trading.

Because prior studies of corporate bond markets implement liquidity measures similar to those used for equity markets, the samples studied are often reduced to include only the most frequently traded bonds. For example, implementing an Amihud (2002) measure of price impact as in Dick-Nielsen, Feldhütter, and Lando (2012) and others requires at least two trades per day. Using a daily Roll (1984) or similar measure as in Bao, Pan, and Wang (2011), or measures of round trip trading costs as in Feldhütter (2012) or Feldhütter, Hotchkiss, and Karakaş (2016), requires two or three trades in a day.[10] Chen, Lesmond, and Wei (2007) use the LOT measure from Lesmond, Ogden, and Trzcinka (1999) which relies on zero return days as an estimate of liquidity. However, these authors note that even the LOT measure requires a minimum trading frequency, as “too many zero returns (i.e., where more than 85% of the daily returns over the year are zero) also renders this measure inestimable” (p.123). Over a 30 day period, therefore, the LOT measure requires that there be trading activity on at least 6 days (to create 5 daily returns). Dick-Nielsen, Feldhütter, and Lando (2012) also note that when used on TRACE data, the LOT measure is not reliable and becomes “unrealistically large” (p.3).

[10] Edwards, Harris, and Piwowar (2007) and Harris (2015) estimate a model for transactions costs for a broader set of bonds using a regression based approach. A similar approach is used by Schultz (2001) using pre-TRACE data on institutional trades.

As a result, studies of corporate bond trading focus largely focus on the most liquid bonds. As described in Section II.B, many of the bonds we study trade only once or twice in a given month, if at all. An analysis of dealer behavior in a market where many assets trade infrequently is therefore needed.

II.B. Sample and trading activity summary

Our initial sample includes 61,857 non-convertible bonds which trade at least once during our sample period and which can be matched with Mergent data for bond characteristics. We exclude bonds that do not trade at least once starting 60 calendar days after the bond offering date, bonds that do not have at least one dealer roundtrip (as defined below), and bonds that have no trades of at least 100 bonds, leaving a final sample of 55,988 bonds we use in our analyses.[11] Table 1, Panel A, shows that these bonds on average have a remaining maturity over five years, are over four years past their issuance date, and consist of 11% non-registered Rule 144A bonds. The median bond is A rated, while the mean bond rating is approximately BBB rated (credit rating of 3.8).

We first demonstrate how actively – or inactively – corporate bonds trade. We calculate monthly trading statistics for each bond, assigning zeros to months where bonds do not trade, and excluding periods within 60 days of issuance, redemption, or maturity. Trade count is an important measure when many bonds have little trading activity. From Panel B of Table 1, the median bond trades 3.1 times per month, and institutional sized trades of 100 or more bonds occur only 0.6 times per month. The means are notably higher at 20 trades per month, 6.3 of which are institutional sized, showing the substantial variation in trading frequency. Trading volume is low: the median par amount traded is 717 bonds ($717,000). We also report the number of non-zero trading days within the month (median of 1.3 days), since prior work by Dick-Nielsen, Feldhütter and Lando (2012) and others suggests this measure is priced in observed bond yields. Panel B further shows that bonds on average trade less than half of the months eligible to be reported to

[11] Our final sample includes medium term notes. Results in this paper are insensitive to the exclusion of medium term notes.

TRACE. Our empirical tests divide bonds into deciles based on trading activity, exploiting the large variation in trading activity across bonds.

Bonds also vary in their concentration of trading by dealer. Despite their relative illiquidity, Panel C of Table 1 shows that bonds are traded on average by 55 different dealers over the full sample period.[12] Dealers also actively trade with each other, with an average of 28.0% of trades occurring in the interdealer market. To measure characteristics of the dealers trading a given bond, we identify the top ten and top 1% most active dealers as reported to TRACE by ranking each dealer by their total trade count across all bonds. Similarly, we rank and identify top dealers by trade volume.[13] We then tabulate the proportion of each bond's trading by these top dealers. For example, on average 38.2% of a bond's trading volume is done by the top ten dealers as ranked by dealer trade volume. These statistics show the tremendous concentration of trading by the most active dealers, consistent with recent descriptions of core-periphery networks in OTC bond markets by Hollifield, Neklyudov, and Spatt (2017), Li and Schürhoff (2015), Di Maggio, Kermani, and Song (2017), and others. Our finding that the top 1% of dealers account for about two-thirds of all trading by bond is similar to the finding in Di Maggio, Kermani, and Song (2017) that 50 dealers account for about 80 percent of all transactions.

Given the large variation in trading, we report the distribution of our trading activity measures (trade count and number of days traded) by deciles in Table 2, where decile 1 is the lowest frequency trading group.[14] We combine the most active five deciles (deciles 6-10) into one group, which therefore includes all

---

[12] The anonymous dealer identifiers are grouped so that entities trading with multiple identifiers, such as large broker dealers, are considered a single dealer. After such grouping, there are 2,984 dealers in our dataset.

[13] The top dealers by volume and by trade count do not coincide – of the top ten dealers ranked by trading volume, only three of those are also top ten dealers based on trade count. Dealers with smaller volume and large trade count likely focus their business on retail trading.

[14] We do not use volume to define trading activity deciles for our analysis. Prior literature shows that volume as a measure of liquidity behaves differently than other measures (Johnson, 2008; Anderson and Stulz, 2017) and is not priced in corporate bonds (Dick-Nielsen et al, 2012), and so may not be an appropriate measure. In addition, we do not exclude small trades when we identify roundtrips in the TRACE data and to define trading activity deciles. However, once we have defined these measures, our analysis is based on roundtrips starting from a buy of at least 100 bonds. Lower deciles based on trade volume consist of larger numbers of roundtrips that start from a buy of less than 100 bonds, which are then excluded from our analysis. The remaining roundtrips in low volume deciles which start from buys of at least 100 bonds still consist largely of small volume sell trades and a large proportion of trading by non-top dealers. As such, volume deciles may sort roundtrips by a variable strongly related to spreads. Excluding roundtrips that start from a buy of less than 100 bonds does not notably affect deciles by trade count or days traded.

bonds more active than the median bond, which is itself infrequently traded. Given the low trading frequency of even the median bond, the deciles below the median contain highly illiquid bonds.[15] Results in this paper are qualitatively similar defining trade count deciles using only trades of greater than 100 bonds. Within deciles, we also show how trading activity varies with credit quality.

Both trading activity measures show wide variation in trading frequency from the most to the least active bonds. For example, bonds in the lowest decile of trade count have a median trade count of 0.1 trades per month, versus 12.3 trades per month for the more active group (deciles 6-10), which itself has on average less than a trade every other day. Similarly, days traded per month is 0.1 days for the lowest decile and 4.5 days for the more active group (deciles 6-10), further showing that the lowest deciles include highly illiquid bonds. Though not reported for brevity, we also find that bonds in deciles 6-10 trade on average in 82% of sample period months, while the most infrequently traded bonds in decile 1 trade in only 5% of the sample period months. Interestingly, controlling for trading activity, we do not observe striking differences across rating categories.

These trading measures are stable through time: Appendix Table A2 shows the stability of trading activity deciles on both a yearly and monthly basis. Depending on the trading activity measure, approximately 85% of bonds in the lowest activity decile 1 remain so in the following year, and 99% of bonds either remain in that decile or move to the nearest trade activity decile. Of bonds in deciles 6-10, 74% to 76% continue in the more actively traded group in the following year. This analysis shows that recent trading activity is a good proxy for expected near future trading activity, whether measured over the prior 30 day period or a longer yearly window.

II.C. Dealer roundtrips

Empirically, the executed transactions we observe are a combination of longer term trades where dealers take on principal risk and short term roundtrip trades where dealers act more as brokers. To identify

[15] We define deciles by pooling bond-month observations over our entire sample period so that our deciles also reflect time series variation in liquidity. Specifically, at times when overall market liquidity is lower, we will observe more roundtrips occurring in the less active trading deciles.

dealer roundtrips, we follow a procedure that matches buys and sells of a dealer that are likely to be related. To more accurately match groups of trades, we include buy and sell transactions of any size since larger dealer buys might be broken up into smaller sell transactions.

We first identify all instances of a buy and sell trade for a given bond of the same quantity, from the same dealer, and within the same day. When a dealer has more than two matching trades within the day, we match the buy and sell closest in time. We refer to these pairs as "paired roundtrips."[16] After identifying paired roundtrips, we next identify instances where a given dealer's buy trade is broken into more than one sale on the same day, by matching the buy trade with two or more sells with total quantity up to the amount of the buy trade. Lastly, we use all remaining transactions as follows. For each remaining dealer buy, we follow subsequent transactions in time order to locate sells of the same dealer and same bond, cumulating up to the quantity of the initial buy. Sells must occur within 60 days of the initial dealer buy and can be of any size.[17]

Thus, a dealer roundtrip consists either of a pair of trades that form a paired roundtrip, a group of trades that form other roundtrips completed in the same day, or other roundtrips completed in more than one day. The important distinction for the third group is that when roundtrips are not completed within the day, the dealer has taken the bonds overnight into inventory. Our methodology produces a dataset of 28,005,060 roundtrips for 55,988 TRACE bonds. Appendix Table A3 shows that the dealer roundtrips we identify cover approximately 93%, either by volume or trade count, of all trades reported to TRACE for these bonds.

Our methodology for identifying paired roundtrips is close in spirit to that of Zitzewitz (2010) and Harris (2015), but differs in two important respects. First, while Zitzewitz (2010) and Harris (2015) assume that nearby trades are from the same dealer, the anonymous dealer codes in our version of the TRACE data

[16] We delete a small number of "wash trades" where the same dealer is reported on both sides of the trade. In all of these cases, the difference in buy and sell prices is zero. Our reported paired roundtrips consist of a single buy and single sell trade of matching quantity, such that these statistics are most comparable to those reported by Zitzewitz (2010) and Harris (2015).

[17] In matching trades within the day, we allow sell trades to precede the buy transaction such that trades matched are closest in time. If a buy trade is matched with a portion of a sell trade of greater quantity, the unused quantity of the sell trade can be used as part of a roundtrip occurring over more than one day. Results are insensitive to our treatment of these portions of sell trades, as the vast majority of same day round trips have a buy quantity exactly matching the total volume of sell trades.

enable us to identify trades of the same dealer. Second, we do not need to limit our analysis to contemporaneous buys and sells in order to infer trades are from the same dealer, and so do not restrict the time within the day between trades.[18] It is important to our analysis of dealer behavior, however, that we also include other roundtrips of a given dealer that involve more than two trades or occur over longer time periods.

Table 3 summarizes characteristics of all dealer roundtrips where the initial buy trade is for at least 100 bonds, which we use as the cutoff for institutional versus retail size trades.[19] Panel A shows that a large proportion of trading occurs in the form of paired roundtrips, which account for 40.5% of all dealer roundtrips. Another 16.6% of roundtrips are completed in the same day but not perfectly paired, with a single dealer's buy offset by a single sell trade of the same quantity. The remaining 42.9% of roundtrips are completed in more than one day, indicating cases where dealers take on overnight inventory risk. We define the dealer's holding period as the weighted average number of days between the initial dealer buy and the subsequent dealer sells. When roundtrips are not completed within the same day, holding periods can be substantially longer than just overnight, with a median of 21 days for such roundtrips. When roundtrips consist of more than two trades, the weighted average holding period measure does not describe the total time until the dealer has no remaining inventory from the initial purchase that started the roundtrip. We therefore report the number of days until the last sell transaction within the roundtrip (length of holding period), which has a median of 28 days for all roundtrips completed in more than one day.[20] We also report the time until the last sell trade in the roundtrip in seconds, which has a mean of 1,515 seconds (about 25

[18] The data used by Zitzewitz (2010) do not identify individual dealers, but the vast majority of paired trades in his sample occur at the same time or at short time intervals. Harris (2015) similarly finds pairs of trades often occur simultaneously. Using our paired roundtrips measure, dealers may retain risk within the day, but purchased bonds are not held in inventory past the current day. Requiring trades to occur within a smaller time interval within the day has an insignificant impact on the descriptive or regression results in this paper.

[19] We expect larger trades to be more informative in understanding dealer inventory behavior, but report characteristics for 18,973,264 smaller roundtrips in Appendix Table A4 for comparison with Zitzewitz (2010) and Harris (2015), whose analyses include a large number of smaller transactions.

[20] Friewald and Nagler (2016) find that dealers' holdings of TRACE bonds have a half life of 5 to 6 weeks, consistent with our findings that some bonds are held in inventory for significant lengths of time. Their study is consistent with inventory models in that dealers use pricing policy to reduce large observed inventory positions; our study considers how the decision to take bonds into inventory is related to pricing, which is dependent on liquidity and risk of the bond.

minutes) and median of 99 seconds for the paired roundtrips, showing that these trades typically occur very close in time. For roundtrips completed over more than one day, on average 3.27 sell trades are matched to each dealer buy, and average trade sizes are relatively large.

Table 3 Panel A also provides initial summary statistics for roundtrip transactions costs, measured as the weighted average of dealer sell prices minus the dealer buy price.[21] We include only observations of spreads where no trades in the roundtrip are reported to TRACE as agency trades, and report the dollar value of spreads in basis points (based on a $100 par value). The overall roundtrip spreads average 38.1 basis points (median 15 bps), and are lowest for the paired roundtrips. We report the dollar value of the spreads in basis points based on a $100 par value (for example, 38.1 basis points is a spread of $3.81 for a $1000 par value bond).

As described in Section I, observed spreads reflect customers' demand for immediacy and dealers' costs of search and inventory (Ho and Stoll, 1981; Grossman and Miller, 1988; Duffie, Gârleanu, and Pedersen, 2005, 2007). Thus we expect inventory behavior, as reflected in the time to completion of roundtrips, and observed spreads to vary with the identity of the dealer's counterparty (a customer or another dealer), characteristics of the dealer, and characteristics of the bond. In Table 3B we report spreads separately based on the type of roundtrip and on whether the dealer buys from a customer or dealer and sells to a customer or dealer (or both when there is more than one sell in the roundtrip). The median spreads reported do not control for bond and other dealer characteristics, but provide some initial indication of important differences based on the type of counterparty. Over half (4,840,283, or 53.6%) of roundtrips originate with a dealer buying from another dealer, demonstrating an active interdealer market.[22] For both paired trades and for other roundtrips completed in the same day, spreads are very low (6 basis points) when a dealer both buys from and sells to another dealer; this is not the case when bonds are taken into a dealer's inventory (median

[21]When the initial purchase is followed by multiple customer sales, we calculate a volume weighted average selling price. As such, this measure differs slightly from estimates of roundtrip trading costs reported in prior studies using the TRACE data including Edwards, Harris, and Piwowar (2007) and Goldstein, Hotchkiss and Sirri (2007).
[22] Li and Schürhoff (2015) follow chains of trades in municipal bonds starting from a dealer's purchase from a customer and tracing through possibly several dealers before a sale to a customer. Since our focus is at the individual dealer level, our measures are based on the trades intermediated by a given dealer rather than when a bond enters and exits the interdealer market.

spread of 0.31 for roundtrips completed in more than one day). We also observe for all types of roundtrips that spreads are highest when the dealer buys from another dealer and sells to a customer. These results suggest either that finding customers is more valuable than being a pass-through in the interdealer market (since rents are not shared with another dealer), or that dealers demand better prices than customers. Uniformly, spreads are higher when dealers take bonds into inventory. Our subsequent regression results explaining spreads are unchanged when we control for broader market movements on days while the bond is in the dealer's inventory.

III. Illiquidity and Dealer Roundtrip Spreads

Having shown that a large proportion of bonds trade infrequently (Tables 1 and 2), and having described dealer roundtrip behavior (Table 3), we now examine the relation between spreads on dealer roundtrips and bond trading activity. Dealer roundtrip costs should in theory be related to the risk of holding the bonds in inventory (Grossman and Miller, 1988). One naturally expects it will take longer for a dealer to dispose of a bond with few or no trades in the past 30 days than it will for a bond with greater recent trading activity, particularly given the stability of trading activity deciles (Appendix Table A2). We use the trading activity of the bond over the prior 30 days as a proxy for the dealer's expected holding period risk.[23] For each roundtrip, we calculate trading activity over the 30 calendar day period ending the day prior to the start of the roundtrip. We report spreads for 8,576,027 roundtrips that do not include any trades reported to TRACE as agency trades.

Table 4 reports spreads based on deciles of trading activity in the bond and by credit quality, and demonstrates a striking result that shows the first elements of dealer behavior varying by trading activity. Once we control for credit rating, these univariate comparisons do not show that spreads monotonically decline with increases in trading activity as measured by trade count or days traded, as would be predicted by

[23] Our trading activity deciles are defined across bonds, not for the specific dealer in that bond. For example, the lowest trade count frequency decile is defined using trades of *all* dealers in that bond and not just for the dealer that completes the roundtrip. Since they are based on the entire market, these categories may overstate the liquidity experience for an individual dealer based on prior order flow, and are therefore conservative.

standard inventory models. Using trade count deciles for bonds rated A and above, the median spread for the least liquid decile (decile 1, 0-16 trades in the past 30 days) is 0.10, which is significantly smaller than the median of 0.125 for the most active bonds in deciles 6-10. In fact, the less active deciles 1 through 5 each have a lower median spread than the more active half of the sample. Interestingly, spreads appear quite constant (though medians are statistically different) across deciles for the lowest rated bonds.

In theory, we expect higher spreads for less active bonds if they are more likely to stay in inventory longer, and thus expose the dealer to greater inventory risk. However, active dealer search could affect this relationship if dealers are more likely to undertake costly search for less active bonds. Similarly, as dealer inventory risk increases for less active bonds, the cost of providing immediacy to a customer will be higher, and we expect to observe more pre-arranged trades. Finding that spreads do not monotonically increase with trading activity is consistent with our conjecture that dealers offset inventory risk (which is retained by customers) by actively searching for counterparties.

While strongly suggestive, the univariate results in Table 4 do not consider other factors likely to affect spreads. For example, larger initial purchases by dealers may take longer to unwind, so that dealer inventory risk and therefore spreads should increase with transaction size. We therefore model the weighted average dealer roundtrip spread as:

$$\begin{aligned} Spread = {} & \alpha + \beta_1 * d_1 + \beta_2 * d_2 + \beta_3 * d_3 + \beta_4 * d_4 + \beta_5 * d_5 + \beta_6 \\ & * (buy \geq 5000) + \beta_7 * (1000 \leq buy < 5000) + \beta_8 * (500 < buy < 1000) \\ & + \beta_9 * (ratio\ small\ to\ total\ \#\ sells) + \beta_{10} * Rule144a + \beta_{11} * time\ to\ maturity + \beta_{12} \\ & * buy\ from\ customer + \beta_{13} * (\%\ sale\ volume\ to\ customers) + \varepsilon \end{aligned} \quad \text{(Eqn 1)}$$

Our primary variables of interest are the trading activity decile dummies: d_1 through d_5 indicate the trading activity deciles, where decile 1 is the least active decile and the omitted group is the top five deciles (6 through 10) of more actively traded bonds. Using dummies for trading activity deciles also allows for possible nonlinearities.

We also control for likely non-linear effects of trade size by including three size dummies for the volume of the dealer buy trade, which correspond to the TRACE dissemination volume cap breakpoints (the holdout group includes bond purchases from 100 to 499 bonds).[24] We also include a variable indicating the proportion of sell transactions in the roundtrip that are less than 100 bonds (*ratio small/total # sells*), which is zero for paired roundtrips and often zero for other roundtrips completed within the day. This variable proxies for retail order flow and participation, particularly since many studies suggest that spreads are larger for retail sized trades. We include additional variables to control for bond characteristics and for the type of counterparty, indicating whether the dealer roundtrip begins with a dealer buy from a customer (*buy from customer*), the percentage of the initial buy volume that is sold to customers rather than to another dealer (*% sale volume to customers*), a dummy variable indicating Rule 144a bonds, and a control for the remaining time to maturity.

Table 5 reports these OLS regressions using both trading activity variables and separately by credit rating group. It is clear that spreads do not consistently increase monotonically as trading activity declines, particularly for lower rated bonds, and that this relationship depends on the trading activity measure. For deciles by prior *trade count*, only the higher credit quality bonds in the most illiquid deciles have significantly higher spreads than the more active bonds. For lower rated bonds, spreads are either lower for less active bonds or not significantly different. Using *days traded* as the measure of trading activity, the difference across rating categories is also clear. Bonds rated BBB and below have higher spreads (relative to more active bonds) only for deciles 1, 2, and 5, with the effect clearly strongest for the least active bonds in decile 1.

Coefficients for other included variables generally have signs as expected. Spreads are smaller for roundtrips starting from larger buy trade sizes, and the effect on spreads increases as size increases and as credit rating decreases. Similarly, spreads are substantially larger when the roundtrip includes more sell trades of less than 100 bonds. Roundtrips of riskier bonds with longer times to maturity also have higher

[24] TRACE does not display volumes for trades over $5 million for investment grade and $1 million for non-investment grade bonds during our sample period. Our dataset provides uncapped volumes.

spreads. The OLS regressions also confirm the univariate results that spreads are higher when dealers buy bonds from a customer for all but the lowest rated bonds, and when dealers then sell these bonds to a customer rather than another dealer. This suggests that dealers capture more of the total gains when transacting with customers rather than in the interdealer market.

IV. Dealer holding periods

Our results to this point raise an intriguing question which we further explore – how does dealer behavior change with bonds' trading activity, and can this behavior explain the observed relationship between roundtrip spreads and trading activity? Given the relative illiquidity of many bonds, absent an active search for a counterparty, dealers would likely have to hold bonds in inventory for a significant time until the arrival of a counterparty. Correspondingly, customers facing higher costs of immediacy may hold the bonds until a counterparty is located. As noted in the previous sections, observed roundtrip costs reflect a combination of roundtrips completed within a day, which includes cases where the dealer undergoes costly search to find offsetting trades, and roundtrips which take longer than a day to complete, for which the dealer takes on inventory risk.

In this section, we explicitly examine whether dealers appear to adjust holding periods to mitigate inventory risk, providing less immediacy their counterparties. As shown in Table 3, holding periods can be considerably longer for roundtrips not completed the same day. To investigate, Table 6 reports the percentages of completed roundtrips of each type by rating groups and trading activity deciles. Overall, 41.1% of dealer roundtrips pair a buy trade of at least 100 bonds with a single sell trade of the same quantity on the same day. Another 17.1% are completed in the same day but include multiple sales. The remaining 41.8% of dealer roundtrips not completed within the day involve overnight inventory holding and have a median weighted average holding period of 21 days. Roundtrips for lower rated bonds are more often completed in the same day. For both trading activity measures, less actively traded bonds have the highest frequency of paired roundtrips, and correspondingly the lowest frequency of roundtrips that are not completed within the same day and thus held in inventory at least overnight. Higher trading activity should imply a higher likelihood of finding an offsetting trade in the same day, not less. This description therefore suggests that dealers actively seek or create offsetting trades on the same day for the least active bonds.[25]

To better highlight these relationships for active versus inactive bonds and higher versus lower credit quality bonds, Table 7A repeats this description for the subsamples of bonds rated A and above versus those rated B and below. The notable contrasts are highlighted in the table. Comparing higher rated, more actively traded bonds (deciles 6-10) to lower rated bonds with less trading activity (decile 1), we consistently observe that lower rated less active bonds have a higher incidence of paired roundtrips and lower incidence of roundtrips completed in more than one day. Using trade count for example, 43% of roundtrips for higher rated more active bonds are completed over more than one day, with an average holding period of 21.9 days, while lower rated least active bonds have only 29.7% such roundtrips (with a holding period of 24.9 days). Within rating categories, the incidence of paired roundtrips is substantially higher for the least active bonds. These results strongly suggest that dealers actively search for counterparties for riskier and less active bonds which would otherwise expose the dealer to larger inventory risk.

Individual dealers will also differ in their ability to locate counterparties (search costs), their ability to manage inventory, and therefore the cost of immediacy offered to customers. A number variables can possibly proxy for dealer's size and position in the dealer network, as described in Di Maggio, Kermani, and Song (2017). We consider whether the dealer is a top ten dealer based on trading volume or trade count (*top ten dealer: volume, trade count*; see Table 3), and whether more than half of the dealer's trades are for less than 100 bonds (*small trade dealer*). Table 7B compares roundtrip completion of top volume to other dealers, and shows that top dealers have a lower frequency of paired roundtrips (results are similar and not reported for brevity using *top ten dealer: trade count* or top 1% dealers). As noted above and described in related literature, market trading is extremely concentrated with these top dealers. While they may pre-arrange trades, they are also most likely to already have bonds in inventory, or can take bonds into inventory

[25] The incidence of other same day roundtrips is increasing in trading activity. Particularly for more actively traded bonds, this group is most likely to include roundtrips that may not have been prearranged but for which the dealer is still able to offset within the same day. See discussion in Section V.A. with respect to robustness of our results to classification of these roundtrips.

and quickly offset the trade because they are active market makers. From Table 7B, we observe these top dealers still match trades more often for the less active bonds; however, compared to other non-top dealers they have a lower frequency of paired roundtrips and more roundtrips completed in more than one day. The holding period for these roundtrips is also longer than for other dealers, particularly for less active bonds (for example, 21.3 days for top dealers versus eight days for other dealers for the lowest trade count decile). These results point to large differences in behavior for the top dealers that account for a substantial proportion of trading in this market. Finally, Table 7B shows that dealers with a large proportion of small trades are more similar to other dealers, though for less active bonds have shorter holding periods on roundtrips completed in more than one day.

V. Dealer Search, Holding Periods, and Spreads

Our findings thus far are consistent with the conjecture that dealers actively mitigate their risk by managing their holding periods. Searching for a counterparty or pre-arranging a counterparty prior to trade is costly, but reduces the risk of taking the bond into inventory. Should the dealer forego a search or should the search fail, the bond then enters the dealer's inventory.

The problem facing the dealer is similar in spirit to the electronic versus voice choice for trading corporate bonds in Hendershott and Madhavan (2015).[26] We model the choice of holding period and roundtrip spreads using endogenous switching regressions. The first stage selection model is estimated as a probit, where the dependent variable is an indicator for roundtrips completed within the same day. The second stage regressions examine the resulting spreads based on whether the roundtrip is completed within a day versus the bonds are held at least overnight in inventory. As above, we examine the effects of trading activity deciles, controlling for credit quality and for bond and dealer characteristics.

V.A. Dealer Endogenous Search

[26] Hendershott and Madhavan (2015) show the use of electronic auctions is concentrated in bonds most likely to be more liquid (i.e. higher quality, younger, shorter term, and larger issues).

The first stage model includes variables we expect to be related to the decision to undergo costly search for a counterparty, which would result in a roundtrip being completed as a paired trade or otherwise within the same day. Factors that increase expected inventory risk should be associated with a higher likelihood dealers search for counterparties, as providing immediacy to the counterparty is more costly. Dealers are more likely to undertake such search for bonds with lower expected trading activity, which are more likely to stay in inventory longer and expose the dealer to greater inventory risk. Similarly, inventory risk should increase with transaction size since larger transactions could take longer to unwind. We also expect that Rule 144A bonds with less potential buyers, longer maturity bonds with greater interest rate risk, smaller issue sizes, less actively traded older bonds (Goldstein and Hotchkiss, 2009), and bonds of unlisted companies to have higher inventory risk but also greater search costs. Holding bond characteristics constant, top dealers are expected to both have lower search costs and to more readily manage inventory costs; thus they may be more willing to take bonds into inventory when unable to readily locate a counterparty.

For the first stage probit model, the dependent variable equals one for paired roundtrips or other roundtrips completed within the same day:

$$\begin{aligned}
\Pr(same\ day = 1\,) \\
&= \alpha \\
&+ \beta_1 * d_1 + \beta_2 * d_2 + \beta_3 * d_3 + \beta_4 * d_4 + \beta_5 * d_5 + \beta_6 \\
&* (buy \geq 5000) + \beta_7 * (1000 \leq buy < 5000) + \beta_8 * (500 < buy < 1000) + \beta_9 \\
&* Rule144a + \beta_{10} * time\ to\ maturity + \beta_{11} age + \beta_{12} * Issue\ Size + \beta_{13} \\
&* buy\ from\ customer + \beta_{14} * \%\ customer\ sales + \beta_{15} * (top\ ten\ dealer{:}\, volume) \\
&+ \beta_{16} * (top\ ten\ dealer{:}\, trade\ count) + \beta_{17} * Ln(\#Dealers) + \beta_{18} \\
&* (aggregate\ inventory\ change) + \beta_{19} * (stock\ listing) \\
&+ \beta_{20} * (crisis) + \beta_{21} * (post\ crisis) + \varepsilon_1
\end{aligned}$$

(Eqn 2)

The primary coefficients of interest dummies are for the trading activity deciles (d1 to d5), again omitting the most active deciles 6 to 10. We include two variables to account for the size of the dealer, indicating that the dealer is one of the ten largest across all TRACE dealers either by total trading volume or by total trade count. Search costs are also expected to be lower when more dealers trade the bond; we include the natural log of the number of dealers trading in the bond. Finally, we include the change in total inventory across all dealers in the bond over the past 30 days, to account for whether dealers overall have increased their capital commitment to the bond; this may indicate lower search costs or dealers willingness to hold the bond in inventory.[27]

The results of the selection equation are reported in Table 8.[28] Across both trading liquidity measures (number of trades and days traded) and all four credit rating categories, dealers are more likely to complete transactions within a day for the *least* active bonds. The coefficient for decile 1 (least active bonds) is economically much larger relative to more active bond deciles. Calculating marginal effects from the reported coefficients and using days traded as the measure of trading activity, roundtrips for A rated bonds (B and below rated bonds) in decile 1 have a 16% (14%) higher likelihood of being completed the same day. Also using days traded deciles, for all rating groups, the likelihood of completion the same day declines monotonically through decile 4 as trading activity increases. Since the likelihood of a counterparty arriving should decrease for less active bonds, making a dealer roundtrip within a day less likely, these results strongly suggest that dealers undertake costly search to find counterparties in order to mitigate risk. Other reported variables affect selection as well. As credit quality falls, roundtrips starting from a larger buy trade

---

[27] Although it cannot be used to estimate selection effects for the second stage model, we also run a multinomial logit in order to further understand differences between paired roundtrips and other roundtrips completed the same day. The dependent variable indicates each of the three types of roundtrips, where the holdout group is paired roundtrips. As expected, paired roundtrips have a higher likelihood relative to other same day roundtrips for lower trading activity deciles. Coefficients for roundtrips completed over more than one day (versus paired roundtrips) are similar to those in Table 8. The multinomial logit results suggest that combining paired roundtrips with other same day roundtrips yields a conservative description of the differences in dealer behavior across trading activity deciles.

We also re-estimate our endogenous switching regression models, either dropping other same day roundtrips from our analysis or combining these roundtrips with roundtrips completed in more than one day. Results using this alternative classification are similar to those reported in Section V.B. The specifications we report, however, better represent the comparison of roundtrips based on whether the dealer takes on overnight inventory.

[28] To reduce the effect of outliers, for all subsequent analyses we eliminate roundtrips where the bond price is greater than \$150 or less than \$10, and outliers of calculated spreads at the 1% level.

are more likely completed the same day. Older bonds of lower credit quality companies and Rule 144A bonds also have a higher probability of completion the same day.

The probability that a dealer completes a roundtrip within a day strongly increases if the bond is initially purchased from another dealer (negative coefficient on the indicator variable *buy from customer*), though this effect is notably smaller for lower rated bonds. It stands to reason that a dealer is less likely to purchase from another dealer unless there is a high likelihood to find another customer for the bond, so that within day roundtrips are more likely when the dealer buys from another dealer. When dealers sell to customers, the effect depends more on credit quality; roundtrips for the lowest rated bonds which have a larger the percentage of the sale to a customer are least likely to be completed the same day.

It is also clear that top dealers more often take bonds into inventory, measuring top dealers either by their trading volume or number of trades. Since top dealers have larger networks and more flow, they have more ability to manage inventory and less costly search. Presumably larger dealers also have more capital, further enabling them to carry inventory. There is not a consistent relation between completion the same day and the number of dealers in the bond. Similarly, an increase in aggregate dealer inventory in the bond has no significant relation to the likelihood of dealers finding same-day counterparties. Bonds of companies with publicly listed stock, where inventory can arguably be better managed through hedging or for which there is more production of publicly available information (and less likely information asymmetry), are more often taken into inventory. Lastly, roundtrips observed during the financial crisis period, and to a smaller degree after this period, have a substantially greater likelihood of being completed the same day. The increase in roundtrips completed the same day during the crisis is consistent with recent studies showing a reduction in aggregate bond inventory during the crisis (Choi and Shachar, 2016; Dick-Nielsen and Rossi, 2017). Interestingly, the effects are greater for higher rated bonds; calculating marginal effects using either trading activity measure, the probability of completion the same day for high rated bonds rises by 11% (7%) for the crisis (post-crisis) period. We further examine the relationship between dealers' behavior and prior trading activity during the crisis in Section VI.B. below.

V.B. Dealer Roundtrip Spreads Controlling for Selection

The second stage of our endogenous switching model consists of two equations for spreads of roundtrips completed the same day or over longer holding periods. For each rating category, we estimate the weighted average dealer spread on roundtrip *i* as:

$$Spread_{(same\ day=1,i)} = \alpha + \beta_1 * d_1 + \beta_2 * d_2 + \beta_3 * d_3 + \beta_4 * d_4 + \beta_5 * d_5 + \beta_5 * d_5 + \beta_6 * X_i * InvMillsRatio_{1i} + \mu_1$$

(eqn 3)

$$Spread_{(same\ day=0,i)} = \alpha + \beta_1 * d_1 + \beta_2 * d_2 + \beta_3 * d_3 + \beta_4 * d_4 + \beta_5 * d_5 + \beta_5 * d_5 + \beta_6 * X_i * InvMillsRatio_{0i} + \mu_2$$

(eqn 4)

where same day = 1 if I(same day* > 0), as estimated from the first stage probit (equation 2), and corr(ε,μ) = ρ (same day* is the unobservable latent variable; see Maddala, 1983). Each equation includes the inverse Mills ratio from the stage 1 probit. The vector of control variables X_i includes indicator variables for trade size, bond characteristics previously used to explain transactions costs, and variables for the type of counterparty (buy from customer, and % sale volume to customers). The second stage regressions also include the variable *ratio of small to total # of sells*, indicating the proportion of sales in the roundtrip that are below 100 bonds.

Results are reported in Table 9. The coefficient for the inverse Mills ratio shows whether spreads are significantly different than they would be if roundtrips were randomly completed in the same day or not, and varies with the trading activity measure and credit rating. The first stage regressions show that trading activity and other characteristics are strongly related to whether bonds are taken into inventory. Table 9 shows that our interpretation of earlier results (across ratings) for trading activity deciles continues to hold even after accounting for the selection effect. As before, for both trade count and days traded, above decile 1, the spreads do not consistently vary with trading activity, particularly as credit rating declines. Spreads are generally smaller for roundtrips completed in the same day than for those held in inventory overnight or longer.[29]

The second stage estimates can be used to compute the counterfactuals - what is the expected spread on a roundtrip actually completed the same day if it were instead brought into inventory and held longer? For roundtrips completed the same day, this is calculated as the observed spread minus the spread predicted using the estimated coefficients from equation 4 (roundtrips completed in more than one day). We report the mean difference as "observed minus predicted from > 1 day" in Table 9. For both trading activity measures, this shows that spreads would have been larger (predicted is greater than observed) if the dealer had not found a same-day counterparty and instead had taken the bond into inventory. For example, for trade count (Panel A), spreads are predicted to be 7 basis points greater had the roundtrip not been completed in the same day for bonds rated A and above, and 12.6 basis points higher for bonds rated B and below (all reported means in the table are significantly different from zero at the one percent level). Similarly, "observed – predicted from same day" shows that for bonds rated BBB and below, roundtrips that took longer than a day are predicted to have lower spreads had the dealer found a counterparty that day. For bonds rated A or above, the predicted spreads would be slightly higher had the roundtrip been completed the same day (1.76 or less basis points), possibly because it is easier for dealers to find a counterparty for higher rated bonds.

The regression coefficients in these specifications compare of dealer behavior for bonds in each of the lower deciles of trading activity to those with above sample median trading activity (deciles 6-10). Table 4, however, shows that bonds with trading activity above the sample median often have trade counts hundreds of times greater those in the lowest decile, and can trade most days in the prior month versus trading zero or few days. We therefore re-estimate our model but include only the decile 1 trading activity dummy (deciles 2-10 are the holdout group). We also re-estimate our model but comparing roundtrips in decile 1 to all roundtrips in deciles 2 through 5 by excluding roundtrips in deciles 6 to 10 from the sample.

[29] An exception is the least active, lowest rated bonds using trade count (decile 1 for bonds rated B and below).

Results are shown in Appendix Table A5, reporting only coefficients for the decile 1 indicator based on trade count and for the inverse Mills ratio (interpretation of coefficients for other included variables remains similar to those in Tables 8 and 9). Similar analysis using deciles by days traded produces nearly identical results. Together with our base specifications, these results quite clearly point to differences in dealer behavior for the least active decile of bonds, even in comparison to other relatively inactive issues. Notably, the selection effects in Appendix Table A5 are strongly significant when comparing decile 1 to all others.

Overall, our results are consistent with a dealer search model in which customers face a tradeoff between immediacy and execution cost. Absent search, dealers would require a higher spread as compensation for bonds more likely to remain longer in inventory. When dealers search and successfully find a counterparty, we observe a lower roundtrip spread. However, dealers may face high search costs or even fail to locate a counterparty, particularly for bonds rated BBB and below. Our results show that as liquidity and credit quality decrease, search intensifies (Table 6); if search versus expected inventory costs are balanced in equilibrium, the empirically observed roundtrip spreads will not be consistently related to liquidity.

VI. Market stress and non-top dealers

In this section, we provide an analysis of dealer behavior in periods of market stress, defined as the financial crisis period and days of large changes in the VIX index. We also examine how behavior differs when non-top dealers trade relatively inactive bonds.

VI.A. Results during periods of market stress

We first consider whether dealer behavior differs in periods of market stress by examining roundtrips during the financial crisis period, which we define as the second quarter of 2007 through the second quarter of 2009. Table 8 shows a significantly higher propensity to complete roundtrips the same day during the crisis period. We examine how this change impacts less actively traded bonds by including interactions of the crisis dummy with each trading activity decile; equivalent results are obtained by limiting our sample to roundtrips that occur during the crisis period (not reported). We report only results using trade count deciles of trading activity for brevity. Results using days traded are qualitatively similar to those discussed here.

The first stage probit results largely repeat those already reported in Table 8 (and so are not repeated here), but additionally show that coefficients for the interacted terms are not significantly related to the propensity to complete roundtrips within the same day relative to more active bonds. The second stage results, reported in Panel A of Table 10, show a more positive effect of the trading activity deciles 1 to 5 in the crisis period for spreads on roundtrips of the highest rated bonds when bonds are taken into inventory. Taken together, these results show that for the highest rated bonds during the crisis period, dealers more often complete roundtrips without taking on inventory risk, and when dealers do take on inventory risk there is a greater effect of illiquidity on spreads. The differences (observed – predicted from > 1 day) for the A & above and BBB rated bonds, respectively, show that spreads are estimated to be 7 and 21 basis points higher had the roundtrip been completed over a longer dealer holding period, similar to that of our base specification.

To examine whether the impact of market stress on dealer behavior is observed more broadly during our sample period, we provide a similar analysis interacting the trading activity deciles with an indicator for days of large changes in the VIX. As in Anderson and Stulz (2017), we define days of large VIX changes as those where the increase is in the top 95^{th} percentile of changes over our sample period. Results are again extremely similar for both trading activity measures, and are reported for the second stage model using deciles by trade count in Table 10, Panel B. Similar to our results for the crisis period, we find that the interactions are important for higher rated bonds for roundtrips completed in more than one day, in this case for bonds BBB and above.

These results provide interesting insights into changes in dealer behavior in periods where liquidity has been shown to steeply decline (Bao, Pan, and Wang 2011; Dick-Nielsen, Feldhhütter, and Lando, 2012; Friewald, Jankowitsch, and Subrahmanyam, 2012). The effects for higher rated bonds are consistent with other work examining the crisis period that argues that higher rated securities become information sensitive at such times, so that market behavior becomes more similar to that for lower rated securities (Dang, Gorton, and Holstrom, 2013; Benmelech and Bergman, 2017). In a period where dealers are less willing or able to provide capital, even higher rated bonds that might otherwise be taken into inventory may be traded only when dealers successfully find a counterparty to quickly offset their risk. Further, even when observed roundtrips occur within the same day, dealers may buy bonds from customers at a greater discount to provide this service.[30]

VI.B. Analysis of non-top dealers

Roundtrips will be completed the same day when a dealer first locates an offsetting counterparty, but they may also reflect trades where the dealer maintained inventory in the bond but was able to quickly offset the trade. Further, given the concentration of trading with the largest dealers in the market, our prior results suggest that behavior differs for less well connected dealers facing greater search costs and likely higher inventory risk. Therefore, in Table 11 we report coefficients for the decile indicators in the two stage model, using only roundtrips of dealers which are not *top ten: volume* dealers. In comparison to our earlier results, we observe an even stronger likelihood that dealers complete roundtrips in the same day for bonds in decile 1, particularly as rating declines. We also observe a larger effect of the decile 1 dummy for spreads of high yield bonds. Moving to more active (but still relatively inactive) trading deciles and to lower rated bonds, the less active deciles either have spreads that are lower or insignificantly different from the more active bonds, and the selection effects become stronger. In summary, dealers' endogenous switching to complete roundtrips in the same day, and the resulting impact on observed spreads, is of large importance when non-top dealers trade riskier bonds, and can result in an equilibrium where observed spreads appear invariant to expected liquidity.

[30] See also Bao, O'Hara, and Zhou (2017) and Bessembinder, Jacobsen, Maxwell, and Venkataraman (2017) for discussion of dealer capital commitment during the financial crisis and subsequent periods.

VII. Conclusion

Corporate bond dealers frequently trade highly illiquid bonds, and many corporate bonds trade rarely if at all. For many bonds, one or two trades over the past 30 days across all dealers is not unusual; for an individual dealer, trading is even less frequent. However, little is known about dealer behavior in markets where many assets trade infrequently. Standard market microstructure models, which model dealers as passive order takers waiting for customers to arrive, suggest that dealers will hold less actively traded assets in inventory for a long time, subjecting the dealer to greater price risk and likely requiring a large bid-ask spread as compensation. Applied to the corporate bond market, a dealer that cannot immediately sell to another investor or dealer is exposed to inventory risk, but search activity can mitigate this risk. Therefore, we expect market makers to increase their search intensity for less actively traded and lower credit quality bonds, acting more as brokers and correspondingly providing less immediacy to customers by committing their own capital.

Using a comprehensive sample of U.S. corporate bonds having trades reported to TRACE, we find that dealers are significantly less likely to take less actively traded bonds into inventory. We estimate an endogenous switching regression model to estimate spreads on dealer roundtrip trades. This model accounts for the fact that dealers can adjust their behavior when faced with a tradeoff between costly search versus costly inventory holdings. Collectively, our empirical results are consistent with a dealer search model in which customers face a tradeoff between immediacy and execution cost. Overall, we find that dealers balance search and inventory costs in such a way that dealer roundtrip costs do not increase with expected illiquidity.

Our results that dealers' behavior endogenously changes based on expected liquidity are important in interpreting a number of recent studies that seek to explain observed trading costs for corporate bonds, either cross-sectionally or over time. Similarly, the response of dealers to other recent developments that potentially impact market liquidity needs to be considered in evaluating overall changes in market quality. For example, Choi and Huh (2017) suggest that buy-side institutions are becoming more important liquidity providers. Our analysis provides guidance as to how expected dealer behavior and observed trading costs may respond to innovations affecting market liquidity.

Our results also speak to the debate regarding the impact of transparency on corporate bond liquidity. Some market participants suggest that comparisons of spreads or other measures of liquidity in pre- and post-dissemination regimes overlook the question of whether dealers become more reluctant to commit capital for making markets in illiquid securities in transparent markets (Bessembinder and Maxwell, 2008). However, even in an opaque market, dealers appear to search for counterparties to mitigate risk as illiquidity increases. To the extent dealers already commit little capital to less actively traded issues, concerns that capital is withdrawn from this portion of the market due to increases in transparency become less relevant.

REFERENCES

Amihud, Y., 2002, Illiquidity and stock returns: cross-section and time-series effects, *Journal of Financial Markets* 5, 31–56.

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

Anderson, M. and R. Stuz, 2017, Is post-crisis bond liquidity lower? Working paper, George Mason University and Ohio State University.

Asquith, P., T. Covert, and P. Pathak, 2013, The effects of mandatory transparency in financial market design: Evidence from the corporate bond market, Working paper, MIT.

Bao, J. and O'Hara, M. and Zhou, X., 2017, The Volcker Rule and Market-Making in Times of Stress. Available at SSRN: https://ssrn.com/abstract=2836714 or http://dx.doi.org/10.2139/ssrn.2836714

Bao, J., Pan, J., Wang, J., 2011. The illiquidity of corporate bonds, *Journal of Finance* 66, 911-946.

Benmelech, E. and N. Bergman, 2017. Debt, Information, and Illiquidity, Working Paper, Northwestern University and MIT.

Bessembinder, H., K. Venkataraman, 2004, Does an electronic stock exchange need an upstairs market? *Journal of Financial Economics* 73, 3-36.

Bessembinder, H., W. Maxwell, and K. Venkataraman, 2006, Optimal Market Transparency: Evidence from the Initiation of Trade Reporting in Corporate Bonds, *Journal of Financial Economics* 82:2, 251-288.

Bessembinder, H., and W. Maxwell, 2008, Markets: Transparency and the Corporate Bond Market, *Journal of Economic Perspectives* 22:2, 217-234.

Bessembinder, H., S. Jacobsen, W. Maxwell, and K. Venkataraman, 2017, Capital Commitment and Illiquidity in Corporate Bonds. Available at SSRN: https://ssrn.com/abstract=2752610

Brunnermeier, M., and L. Pedersen, 2009, Market liquidity and funding liquidity, *Review of Financial Studies* 22, 2201-2238.

Chen, H., S. Foley, M. A. Goldstein, and T. Ruf, 2017, The value of a millisecond: harnessing information in fast, fragmented markets, University of New South Wales, working paper, Babson College.

Chen, Long, D. A. Lesmond and J. Z. Wei, 2007, Corporate yield spreads and bond liquidity, *Journal of Finance* 62, 119-149.

Choi, J., and Y. Huh, 2017, Customer liquidity provision: Implications for corporate bond transactions costs, Working paper, University of Illinois at Urbana-Champaign and Federal Reserve Board.

Choi, J., and O. Shachar, 2016, Did liquidity providers become liquidity seekers?: Evidence from the

CDS-Bond Basis during the 2008 financial crisis, Working paper, University of Illinois at Urbana-Champaign and Federal Reserve Bank of New York.

Dang, T., G. Gorton, and B. Holmström. 2013, Ignorance, debt and financial crises, working paper, Yale University

Dick-Nielsen, J., Feldhütter, P., Lando, D., 2012. Corporate bond liquidity before and after the onset of the subprime crisis. Journal of Financial Economics 103, 471-492.

Dick-Nielsen, J. and Rossi, M., 2017. The Cost of Immediacy for Corporate Bonds" Available at SSRN: https://ssrn.com/abstract=2139403 or http://dx.doi.org/10.2139/ssrn.2139403

Di Maggio, M., A. Kermani, and Z. Song, 2017. The Value of Trading Relationships in Turbulent Times. *Journal of Financial Economics*, forthcoming.

Duffie, D., N. Gârleanu, and L. Pedersen, 2005. Over-the-counter markets. *Econometrica*, Vol. 73, No. 6 (November), 1815-1847.

Duffie, D., N. Gârleanu, and L. Pedersen, 2007. Valuation in Over-the-Counter Markets. *Review of Financial Studies* 20:5, 1865-1900.

Duffie, D., 2010. Presidential Address: Asset Price Dynamics with Slow-Moving Capital. *Journal of Finance* 65, 1237-1267.

Edwards, A., L. Harris, and M. Piwowar, 2007. Corporate Bond Market Transparency and Transactions Cost. *Journal of Finance* 62, 1421-1451.

Feldhütter, P., 2012. The same bond at different prices: identifying search frictions and selling pressures. *Review of Financial Studies* 25, 1155-1206.

Feldhütter , E. Hotchkiss, and O. Karakaş, 2016, The value of creditor control in corporate bonds. *Journal of Financial Economics* 121, 1-27.

Friewald, N., Rainer Jankowitsch, and M. Subrahmanyam, 2012. Illiquidity or credit deterioration: A study of liquidity in the U.S. corporate bond market during financial crises. *Journal of Financial Economics*, 105, 18-36.

Friewald, N. and F. Nagler, 2016, Dealer inventory and the cross-section of corporate bond returns, Working paper, Norwegian School of Economics and Vienna Graduate School of Finance.

Gao, P., P. Schultz, and Z. Song, 2017. Liquidity in a market for unique assets: specified pool and to-be-announced trading in the mortgage-backed securities market. *Journal of Finance*, forthcoming.

Glosten, L. R. and P. R. Milgrom, 1985. Bid, ask and transaction prices in a specialist market with heterogeneously informed traders. *Journal of Financial Economics*, Volume 14, Number 1, 71-100.

Goldstein, M. A., Edith S. Hotchkiss, and Erik R. Sirri, 2007. Transparency and liquidity: A Controlled Experiment on Corporate Bonds. *Review of Financial Studies* Vol. 20, Number 2 (March), 235-273.

Goldstein, M. A., and Edith S. Hotchkiss, 2009. Dealer Behavior and the Trading of Newly Issued Corporate Bonds. Working Paper.

Grossman, S. J., and Merton H. Miller, 1988. Liquidity and Market Structure. *Journal of Finance*, Vol. 43, No. 3 (July), 617-633.

Harris, L., 2015. Transactions Costs, Trade Throughs, and Riskless Principal Trading in Corporate Bond Markets. Working Paper, University of Southern California.

Hendershott, T., and A. Madhavan, 2015. Click or call? Auction versus search in the over-the-counter Market. Journal of Finance, 70, 419-446.

Ho, T. and Stoll, 1981, Optimal dealer pricing under transactions and return uncertainty, Journal of Financial Economics 9, pp. 47–73.

Hollifield, B., A. Neklyudov and C. Spatt, 2017. Bid-Ask Spreads, Trading Networks and the Pricing of Securitizations, *Review of Financial Studies*, forthcoming.

Johnson, T., 2008. Volume, liquidity, and liquidity risk. *Journal of Financial Economics* 87, 388–417.

Kyle, A., 1985, Continuous Auctions and Insider Trading. *Econometrica* 53, 1315-1335.

Lesmond, D., J. Ogden, and C. Trzcinka, 1999, A new estimate of transaction costs, *Review of Financial Studies* 12, 1113–1141.

Li, D., and N. Schürhoff, 2015, Dealer Networks, Working paper, Swiss Finance Institute.

Maddala, G. S. 1983. Limited-Dependent and Qualitative Variables in Econometrics. Cambridge: Cambridge University Press.

Madhavan, A., and M. Cheng, 1997. In search of liquidity: Block trades in the upstairs and downstairs markets. *Review of Financial Studies* 10, 175–203.

Nashikkar, Amrut, and M. Subrahmanyam, 2006. Latent Liquidity and Corporate Bond Yield Spreads, Working paper, New York University.

O'Hara, M., Y. Wang, and X. Zhou, 2016, The execution quality of corporate bonds, Working Paper, Fordham University.

Roll, R., 1984. A Simple Implicit Measure of the Effective Bid-Ask Spread in an Efficient Market. *Journal of Finance*, Volume 39, Number 2, 1127–1139.

Schultz, P., 2001. Corporate Bond Trading: A Peek Behind the Curtain. *Journal of Finance* 56, 677-698.

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

Trebbi, F., andK. Xiao, 2016. Regulation and market liquidity, Working paper, University of British Columbia.

Whitcomb, D. K., 1988. Liquidity and Market Structure: Discussion. *Journal of Finance*, Vol. 43, No. 3 (July), 634-637.

Zitzewitz, E., 2010. Paired Corporate Bond Trades. Working paper, Available at SSRN: http://ssrn.com/abstract=1648994.

Appendix Table A1
Variable definitions

Bond characteristics	Rating	Numeric scale for credit rating at the time of trade, where 1=AAA, 2=AA, etc. Unrated bonds are assigned to the lowest rating quality group (11). Ratings are based on S&P, Moody's, and Fitch as available, and are consistent with original FINRA guidelines for bond dissemination under TRACE.
	Bond age	Time since bond issuance (years) at time of dealer roundtrip
	Issue size	Offering amount
	Rule 144A bond	Indicator variable for non-publicly registered Rule 144A bonds
	Time to maturity	Time remaining from the start of the dealer roundtrip to the bond maturity
	Ln(# dealers)	Log of number of dealers in the bond based on all trades reported to TRACE over the full sample period.
	Change in aggregate bond inventory (-30,0)	Change in inventory summed for all dealers in the bond in the 30 day period ending the day prior to the start of the dealer roundtrip
Trading activity variables	Trade count	Number of trades, using all TRACE reported trades in the 30 day period ending the day prior to the start of the dealer roundtrip
	Days traded	Number of days with non-zero trading, using all TRACE reported trades in the 30 day period ending the day prior to the start of the dealer roundtrip
	Decile 1 to 5,6-10	Trading activity (trade count, days traded) in the 30 day period preceeding the dealer roundtrip is in corresponding decile using all dealer roundtrips. Decile 1 is the lowest trading activity group. Deciles 6-10 are reported as one group and include all roundtrips with trading activity above the sample median.
Dealer roundtrips	Paired roundtrips	Paired roundtrips consist of a buy and sell transaction of the same dealer and same bond, day, and quantity. When a dealer has more than two matching trades within the day we match closest in time.
	Other same day roundtrips	Using trades which are not part of a paired roundtrip, within the day we match each dealer buy transaction to sale transactions, using sells up to the volume of the starting buy. Sells can be of any size, and total volume of sells can be less than the starting buy volume.
	Roundtrips completed over more than one day	Using trades which are not part of a paired or other same day roundtrip, we match each dealer buy transaction to subsequent sale transactions, using sells up to the volume of the starting buy. Sells must occur within 60 days of the intial dealer buy. Sells can be of any size, and total volume of sells can be less than the starting buy volume.
	Buy volume >= 5000	Indicator that the dealer buy in the roundtrip is >= 5000 bonds ($5 million)
	1000 <= buy volume < 5000	Indicator that the dealer buy in the roundtrip is < 5,000 bonds and >= 1000 bonds
	500 <= buy volume < 1000	Indicator that the dealer buy in the roundtrip is < 1,000 bonds and >= 500 bonds
	Buy from customer	Indicator that dealer buy in the roundtrip is a purchase from a customer (versus from another dealer)
	% sale volume to customers	Percentage of volme of dealer sells in the roundtrip that are to customers (versus to other dealers)
	Ratio small/total # sells	Ratio of the number sells of less than 100 bonds to the total number of sells included in the dealer roundtrip.
	Weighted ave spread	Difference between buy price and sell prices in the dealer roundtrip. Price differences are weighted by the volume of the sell trade divided by the total volume of sell trades in the roundtrip.
Dealer characteristics	Top ten dealer: trade count	Indicator for the ten dealers with the highest trade count across all TRACE dealers, summing all of the dealer's trades in sample bonds reported over the full sample period
	Top 1% dealer: trade count	Corresponding indicator variable, indicating the highest 1% trade count across all TRACE dealers
	Top ten dealer: volume	Indicator for the ten dealers with the highest total volume across all TRACE dealers, summing all of the dealer's trades in sample bonds reported over the full sample period
	Top 1% dealer: volume	Corresponding indicator variable, indicating the highest 1% volume across all TRACE dealers
	Small trade dealer	Indicator for dealers having more than 50% of trades for less than 100 bonds, based on all of the dealer's trades in TRACE

Appendix Table A2
Stability of trading activity deciles

Table reports the frequency distribution of bonds moving from deciles of trading activity in the prior period (shown in columns) to deciles in the current period (shown in rows). Rows sum to 100 percent. The "no trade" group includes observations with no trading in the current or prior period. Percentages include all sample bond-year or bond-month observations excluding periods within six months of issuance, maturity, or redemption. Deciles are determined by ranking the median trading activity of the bond in a given period.

	Median trading activity decile by year							Median trading activity decile by month						
Trade count	Decile in the prior period							Decile in the prior period						
Decile in the current period:	No trading	1	2	3	4	5	6-10	No trading	1	2	3	4	5	6-10
No trades	71.1	25.0	2.4	0.9	0.4	0.2	0.1	82.7	16.6	0.6	0.1	0.0	0.0	0.0
1	7.3	85.4	6.3	0.7	0.2	0.1	0.1	21.8	65.0	11.0	1.8	0.3	0.1	0.1
2	2.1	32.1	46.2	16.2	2.6	0.6	0.2	3.4	38.0	37.7	16.4	3.5	0.7	0.3
3	1.6	9.3	26.6	39.5	17.5	4.0	1.4	1.5	11.8	29.1	35.6	16.6	4.1	1.3
4	1.4	4.2	10.6	23.8	33.3	19.2	7.5	1.1	3.8	10.8	27.7	33.6	17.7	5.4
5	1.2	2.8	4.3	11.7	20.8	31.6	27.7	1.1	1.9	3.5	10.1	24.5	35.6	23.4
6-10	1.4	1.3	2.0	3.7	6.3	12.0	73.5	1.0	0.7	1.1	2.0	4.2	11.4	79.7
Days traded														
Decile in the current period:	No trading	1	2	3	4	5	6-10	No trading	1	2	3	4	5	6-10
No trades	71.1	24.7	2.7	0.8	0.4	0.1	0.1	82.3	16.9	0.4	0.0	0.0	0.0	0.4
1	7.5	85.5	6.3	0.5	0.2	0.0	0.1	22.6	64.6	11.2	1.3	0.3	0.0	0.1
2	1.7	27.8	51.3	14.8	3.4	0.4	0.5	2.5	35.7	41.2	13.9	5.4	0.7	0.7
3	1.3	6.4	29.5	34.4	23.0	2.7	2.7	1.2	9.9	33.9	26.9	19.7	3.7	4.7
4	1.3	2.6	11.5	22.0	36.1	12.6	14.0	1.3	3.1	15.8	23.4	29.7	9.0	17.7
5	1.4	1.8	5.0	9.1	24.3	17.3	41.1	3.9	1.2	6.1	13.0	26.4	11.6	37.8
6-10	1.4	1.0	1.7	3.0	8.9	7.5	76.4	3.6	0.7	1.8	4.0	12.1	8.7	69.1

Appendix Table A3
Comparison of dealer roundtrip volume and trade count to all TRACE reported trades

The volume and number of trades that are part of a dealer roundtrip are compared to all TRACE reported trades in the same set of bonds. The sample consists of 55,988 bonds for which at least one roundtrip is identified. Statistics are also reported for the dataset deleting all dealer buys of less than 100 bonds.

All trades on Trace

Total $ volume of trades that are part of a dealer roundtrip	54,672,244,140
Total # trades that are part of a dealer roundtrip	59,513,429
Total $ volume of trades that are part of a dealer roundtrip completed same day	12,968,980,709
Total # of trades that are part of a dealer roundtrip completed same day	17,942,690
Total $ volume reported on TRACE	57,953,409,971
Total # of trades reported on TRACE	63,864,204
All dealer roundtrip trades as percentage of total TRACE volume	94.3%
All dealer roundtrip trades as percentage of total number of TRACE trades	93.2%
Same day roundtrips as percentage of total TRACE volume	22.4%
Same day roundtrips as percentage of total number of TRACE trades	28.1%

All trades on Trace excluding buys < 100 bonds

Total $ volume of trades that are part of a dealer roundtrip	53,807,340,724
Total # trades that are part of a dealer roundtrip	21,401,029
Total $ volume of trades that are part of a dealer roundtrip completed same day	12,698,666,257
Total # of trades that are part of a dealer roundtrip completed same day	6,998,849
Total $ volume reported on TRACE	57,026,177,683
Total # of trades reported on TRACE	23,002,055
All dealer roundtrip trades as percentage of total TRACE volume	94.4%
All dealer roundtrip trades as percentage of total number of TRACE trades	93.0%
Same day roundtrips as percentage of total TRACE volume	22.3%
Same day roundtrips as percentage of total number of TRACE trades	30.4%

Appendix Table A4
Summary description of dealer roundtrips: small trades

Characteristics of dealer roundtrips starting from a buy trade of less than 100 bonds. Variables are as defined in Appendix Table A1. Paired roundtrips are defined as a pair of trades where a given dealer buys and sells the same quantity of the same bond on the same day. Other roundtrips match each dealer buy of a given bond with one or more subsequent sell trades by that dealer in the same bond up to the face amount of the initial buy trade, using sell trades that occur within 60 days. Panel B reports median spreads based on the type of counterparty (customer, another dealer, or both).

A. Characteristics of dealer roundtrips

	All roundtrips (n=18,973,264)		Paired roundtrips (n=10,450,015)		Other same day roundtrips (n=2,041,739)		Roundtrips completed in more than one day (n=6,481,510)	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Weighted ave holding period	9.0	1.0	1.0	1.0	1.0	1.0	22.7	18.7
Length of holding period	9.8	1.0	1.0	1.0	1.0	1.0	24.9	22.0
Time to last sell (seconds)	763,196	1,695	806	2	6,889	4,560	2,062,287	1,796,156
# sells in the roundtrip	1.22	1.00	1.00	1.00	1.40	1.00	1.46	1.00
Ave buy trade volume	22	15	22	15	23	15	21	15
Ave sell trade volume	337	25	22	15	366	43	768	68
Weighted ave spread	0.909	0.550	0.707	0.427	1.110	0.759	1.128	0.875

Appendix Table A4 - continued

B. Weighted average spreads for dealer roundtrips (less than 100 bonds)

	All roundtrips	Paired roundtrips			Other same day roundtrips				Roundtrips completed in more than one day			
		all	sell to customer	sell to dealer	all	sell to customer	sell to customer & dealer	sell to dealer	all	sell to customer	sell to customer & dealer	sell to dealer
All dealer buys	0.59	0.47	0.80	0.23	0.80	1.45	0.81	0.54	0.92	1.18	0.88	0.79
	(18,973,264)	(10,450,015)	52.8%	47.2%	(2,041,739)	38.7%	2.9%	58.3%	(6,481,510)	33.6%	7.5%	58.7%
Buy from customer	0.75	0.50	1.70	0.42	1.00	2.00	1.17	0.55	1.19	1.50	1.24	0.88
	(7,116,751)	(3,079,407)	21.2%	78.8%	(1,112,376)	38.9%	3.0%	58.1%	(2,924,968)	47.0%	9.6%	62.5%
Buy from dealer	0.50	0.40	0.74	0.04	0.65	0.90	0.50	0.54	0.73	0.68	0.51	0.75
	(11,856,513)	(7,370,608)	66.0%	34.0%	(929,363)	38.5%	2.9%	58.6%	(3,556,542)	22.6%	5.8%	71.4%

Appendix Table A5
Endogenous Switching Regression Model: Comparisons for Decile 1

The table reports the results of the two stage endogenous switching regression model. Panel A provides comparison of decile 1 to all other deciles (2-10, the omitted group). Panel B omits deciles 6-10 and provides comparison of decile 1 to deciles 2-5 (the omitted group). Coefficients for additional included variables from the base specification (Tables 8 and 9) are not reported for brevity. *, **, and *** denote statistical signficance at the 0.10, 0.05, and 0.01 level, respectively. Second stage regressions include quarter fixed effects. Robust standard errors clustered by issuer are shown in parentheses.

	Stage 1: Selection Equation (Probit)				Stage 2: Spread Model							
	A & above	BBB	BB	B & below	A & above		BBB		BB		B & below	
					same day	> 1 day	same day	> 1 day	same day	> 1 day	same day	> 1 day
A. Sample includes all trade count deciles												
Decile 1 (trade count)	0.1895***	0.1856***	0.2875***	0.2157***	0.0613***	0.1472***	0.0264***	0.1345***	0.0183**	0.1176***	0.0416***	0.0361
	(0.018)	(0.017)	(0.017)	(0.014)	(0.009)	(0.016)	(0.008)	(0.017)	(0.008)	(0.030)	(0.007)	(0.025)
Inverse Mills ratio					0.0211	0.0232	-0.0411***	0.0007	0.0107	0.0862**	-0.0127***	0.0361
					(0.034)	(0.021)	(0.010)	(0.024)	(0.012)	(0.036)	(0.004)	(0.028)
Observed minus predicted from > 1 day					-0.071		-0.206		-0.086		-0.125	
Observed minus predicted from same day						-0.018		0.088		0.016		0.099
Observations	3,322,647	2,047,747	892,878	2,212,310	3,322,647		2,047,747		892,878		2,212,310	
B. Sample omits trade count deciles 6-10												
Decile 1 (trade count)	0.1590***	0.1661***	0.2810***	0.2027***	0.0628***	0.1293***	0.0490***	0.1347***	0.0365***	0.1526***	0.0519***	0.0568***
	(0.021)	(0.015)	(0.017)	(0.012)	(0.007)	(0.014)	(0.006)	(0.016)	(0.011)	(0.025)	(0.005)	(0.022)
Inverse Mills ratio					-0.0032	0.0306	-0.0106*	0.0119	0.0323*	0.1010***	-0.0035	0.0464*
					(0.011)	(0.023)	(0.006)	(0.020)	(0.017)	(0.039)	(0.005)	(0.026)
Observed minus predicted from > 1 day					-0.045		-0.184		-0.065		-0.117	
Observed minus predicted from same day						-0.026		0.073		-0.026		0.073
Observations	1,683,063	1,135,643	578,829	1,396,630	1,683,063		1,135,643		578,829		1,396,630	

Table 1
Bond characteristics and trading activity

The table reports summary bond characteristics and monthly bond trading activity. The sample consists of 55,988 non-convertible bonds of 5,796 issuers with trades reported on TRACE between the July 2002 and March 2011 which are matched to Mergent and for which at least one dealer roundtrip is identified. Variables are defined in Appendix Table A1. Trading activity is averaged across months for each bond and excludes trades within 60 days of issuance and within 60 days of maturity or redemption.

	Mean	Median
A. Bond and issuer characteristics		
Issue size ($000)	220,651	50,000
Time to maturity (years)	5.34	2.60
Age (years)	4.42	3.34
Rule 144A (1/0)	11.2%	0.0%
Rating	3.8	3.0
Stock listing: NYSE/AMEX/Nasdaq	70.3%	
OTC or other exchange	8.5%	
No traded stock	21.2%	
B. Monthly bond trading activity		
Monthly trade count	20.0	3.1
Monthly count of trades >= 100 bonds	6.3	0.6
Monthly volume ($ in thousands)	14,315	717
Monthly number of non-zero trading days	3.4	1.3
Percent of months traded	49.3%	47.8%
C. Trading activity and concentration of dealers		
Number of dealers trading the bond	55.2	30.0
Average percentage interdealer trades	28.0%	27.7%
% of trade count by top ten dealers by trade count	41.1%	43.1%
% of volume by top ten dealers by volume	38.2%	34.0%
% of trade count by top 1% dealers by trade count	67.5%	70.7%
% of volume by top 1% dealers by volume	59.1%	61.9%

Table 2
Measures of bond trading activity by deciles and by credit rating groups

Table reports monthly trading activity by decile of the trading activity variable and by rating group, where decile 1 is the lowest trading activity group. Trading activity variables are defined in Appendix Table A1. For each bond, a monthly average of the trading variable is calculated excluding trades within 60 days of issuance and within 60 days of redemption or maturity. Mean and median of the monthly averages are reported.

		All ratings 55,988 bonds		A and above 31,748 bonds		BBB 10,023 bonds		BB 3,592 bonds		B and lower 10,625 bonds	
Trading activity variable:	Decile	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Trade count	all	20.0	3.1	17.5	2.2	29.3	5.9	28.4	10.7	16.0	3.2
	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	3	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.8
	4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	5	2.5	2.4	2.5	2.4	2.5	2.4	2.5	2.5	2.5	2.5
	6-10	39.0	12.3	39.7	10.5	44.3	13.3	38.5	18.1	30.8	13.0
Days traded	all	3.4	1.3	2.9	0.9	4.6	2.5	5.4	4.0	3.1	1.2
	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	6-10	6.3	4.5	6.2	4.0	6.6	5.0	7.3	6.2	5.9	4.5

Table 3
Summary description of dealer roundtrips

The table provides description of 9,031,796 dealer roundtrips calculated for the dataset of 55,988 bonds, where the initial dealer buy is for at least 100 bonds. Variables are as defined in Appendix Table A1. Paired roundtrips are defined as a pair of trades where a given dealer buys and sells the same quantity of the same bond on the same day. Other roundtrips match each dealer buy of a given bond with one or more sell trades by that dealer in the same bond up to the face amount of the initial buy trade, using sell trades that occur within 60 days. The weighted average spread excludes roundtrips which include any agency trades. Panel B reports median spreads based on the type of counterparty (customer, another dealer, or both).

A. Characteristics of dealer roundtrips

	All roundtrips (n=9,031,796)		Paired roundtrips (n=3,660,482; 40.5%)		Other same day roundtrips (n=1,500,144; 16.6%)		Roundtrips completed in more than one day (n=3,871,170; 42.9%)	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Weighted ave holding period (days)	10.6	1.0	1.0	1.0	1.0	1.0	24.1	21.0
Length of holding period (days)	12.8	1.0	1.0	1.0	1.0	1.0	29.3	28.0
Time to last sell (seconds)	1,021,322	6,540	1,515	99	5,593	2,380	2,440,241	2,340,822
# sells in the roundtrip	2.13	1.00	1.00	1.00	2.08	1.00	3.27	2.00
Ave buy trade volume (# bonds)	2,079	795	1,760	600	2,415	1,000	2,256	820
Ave sell trade volume (# bonds)	2,611	1,000	1,760	600	3,333	1,500	3,155	1,188
Weighted ave spread	0.381	0.150	0.272	0.100	0.432	0.231	0.468	0.292

Table 3 - continued

B. Weighted ave spreads for dealer roundtrips

	All roundtrips	Paired roundtrips			Other same day roundtrips				Roundtrips completed in more than one day			
		all	sell to customer	sell to dealer	all	sell to customer	sell to customer & dealer	sell to dealer	all	sell to customer	sell to customer & dealer	sell to dealer
All dealer buys	0.15	0.10	0.19	0.06	0.23	0.29	0.26	0.08	0.29	0.31	0.31	0.26
	(9,031,796)	(3,660,482)	45.6%	54.4%	(1,500,144)	47.8%	6.8%	45.3%	(3,871,170)	41.1%	25.6%	33.1%
Buy from customer	0.24	0.13	0.13	0.13	0.25	0.25	0.30	0.25	0.25	0.25	0.29	0.21
	(4,191,513)	(1,390,848)	54.8%	45.2%	(614,034)	60.1%	9.5%	30.4%	(2,186,631)	49.1%	26.4%	24.5%
Buy from dealer	0.13	0.08	0.22	0.06	0.13	0.31	0.24	0.06	0.35	0.42	0.33	0.31
	(4,840,283)	(2,269,634)	40.0%	60.0%	(886,110)	39.3%	5.0%	55.6%	(1,684,539)	30.6%	24.5%	44.4%

Table 4
Spreads on dealer roundtrips

The table reports the median weighted average spread for dealer roundtrips. Variable definitions are provided in Appendix Table A1. Reported spreads in this table exclude roundtrips with dealer buy transactions of less than 100 bonds. Spreads are reported for deciles of roundtrips based on trading activity variables in the 30 day period preceding the dealer buy transaction, where decile 1 is the lowest trading activity level group. a,b,c for deciles 1 through 5 denote the median is significantly different from that of deciles 6-10 at the 1 percent, 5 percent, or 10 percent level, respectively.

			All roundtrips (n=8,576,027)	A and above (n=3,375,655)	BBB (n=2,070,371)	BB (n=898,550)	B and lower (n=2,231,451)
	Trading activity decile:	High and low of trading activity variable within decile	Median spread	Median spread	Median spread	Median spread	Median spread
All			0.150	0.106	0.147	0.220	0.250
Trade count							
	1	0 - 16	0.179 [a]	0.100 [a]	0.147 [a]	0.250	0.250 [a]
	2	17 - 38	0.159 [a]	0.102 [a]	0.125 [a]	0.250 [a]	0.250 [a]
	3	39 - 69	0.133 [a]	0.100 [a]	0.110 [a]	0.188 [a]	0.250 [a]
	4	70 - 114	0.125 [a]	0.094 [a]	0.109 [a]	0.188 [a]	0.250 [a]
	5	115 - 179	0.125 [a]	0.087 [a]	0.123 [a]	0.188 [a]	0.250 [a]
	6-10	180 - 16,772	0.162	0.125	0.200	0.240	0.250
Days traded							
	1	0 - 6	0.213 [a]	0.125 [a]	0.181	0.250 [a]	0.250 [a]
	2	7 - 11	0.188 [a]	0.105 [a]	0.132 [a]	0.250	0.250 [a]
	3	12 - 15	0.151	0.100 [a]	0.125 [a]	0.200 [a]	0.250 [a]
	4	16 - 18	0.126 [a]	0.100 [a]	0.125 [a]	0.188 [a]	0.250 [a]
	5	19 - 19	0.125 [a]	0.100 [a]	0.136 [a]	0.188 [a]	0.220 [a]
	6-10	20 - 22	0.137	0.110	0.172	0.200	0.213

Table 5
OLS regressions explaining spreads on dealer roundtrips

The dependent variable is the weighted average spread on dealer roundtrips. Deciles are indicator variables for the decile of the trading activity variable at the time of the roundtrip, where the omitted group is the most actively traded bonds (deciles 6-10). Other variables are as defined in Appendix Table A1. All regressions include quarter fixed effects. Robust standard errors clustered by issuer are reported in parentheses.***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Trading activity variable:	Trade count				Days traded			
	A and above	BBB	BB	B & lower	A and above	BBB	BB	B & lower
Decile 1	0.1178***	0.0742***	0.0293	0.0287	0.1376***	0.1133***	0.0801***	0.0995***
	(0.016)	(0.019)	(0.028)	(0.020)	(0.016)	(0.019)	(0.026)	(0.020)
Decile 2	0.0712***	0.0128	-0.0340	-0.0285	0.0953***	0.0477**	0.0376*	0.0391**
	(0.015)	(0.022)	(0.029)	(0.019)	(0.014)	(0.020)	(0.023)	(0.019)
Decile 3	0.0228	-0.0217	-0.0621**	-0.0340*	0.0509***	0.0088	-0.0075	0.0312
	(0.015)	(0.022)	(0.030)	(0.019)	(0.013)	(0.021)	(0.024)	(0.019)
Decile 4	0.0044	-0.0258	-0.0659**	-0.0216	0.0286***	0.0104	-0.0329	0.0252
	(0.012)	(0.022)	(0.028)	(0.019)	(0.010)	(0.021)	(0.022)	(0.016)
Decile 5	-0.0028	-0.0376*	-0.0755**	-0.0191	0.0186***	0.0370*	-0.0241	0.0371***
	(0.009)	(0.021)	(0.031)	(0.016)	(0.005)	(0.022)	(0.015)	(0.013)
Buy volume >= 5000	-0.2604***	-0.3310***	-0.3127***	-0.2903***	-0.2591***	-0.3312***	-0.3103***	-0.2870***
	(0.009)	(0.016)	(0.041)	(0.019)	(0.009)	(0.016)	(0.039)	(0.019)
1000 <= buy volume < 5000	-0.2054***	-0.2552***	-0.2924***	-0.2983***	-0.2042***	-0.2555***	-0.2930***	-0.2975***
	(0.006)	(0.013)	(0.033)	(0.014)	(0.006)	(0.013)	(0.032)	(0.015)
500 <= buy volume < 1000	-0.1253***	-0.1522***	-0.2043***	-0.2149***	-0.1244***	-0.1522***	-0.2046***	-0.2163***
	(0.006)	(0.008)	(0.027)	(0.010)	(0.006)	(0.007)	(0.025)	(0.010)
Ratio small/total # sells	0.5079***	0.7030***	0.7757***	0.8516***	0.5092***	0.7078***	0.7821***	0.8627***
	(0.015)	(0.032)	(0.028)	(0.032)	(0.015)	(0.032)	(0.030)	(0.032)
Rule 144A bond	-0.0111	0.0430*	-0.0057	-0.0144	-0.0160	0.0363	-0.0186	-0.0239
	(0.018)	(0.023)	(0.023)	(0.018)	(0.018)	(0.023)	(0.022)	(0.018)
Time to maturity	0.0145***	0.0117***	0.0091***	0.0024	0.0145***	0.0116***	0.0091***	0.0026*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Buy from customer	0.0366***	0.0333***	0.0278***	0.0088	0.0365***	0.0313***	0.0227**	0.0007
	(0.006)	(0.008)	(0.010)	(0.008)	(0.006)	(0.008)	(0.010)	(0.007)
% sale volume to customers	0.1617***	0.1961***	0.1831***	0.1896***	0.1617***	0.1948***	0.1791***	0.1829***
	(0.007)	(0.016)	(0.012)	(0.008)	(0.007)	(0.016)	(0.012)	(0.008)
Observations	3,375,655	2,070,371	898,550	2,231,451	3,375,655	2,070,371	898,550	2,231,451
Adj. R-squared	0.1254	0.1237	0.1021	0.0688	0.1257	0.1238	0.1020	0.0689

Table 6
Time for completion of roundtrips

The table reports the total number of roundtrips by rating category and by trading activity deciles, and the percentage of roundtrips which are paired roundtrips, other same day roundtrips, and roundtrips completed in more than one day. All variables are as defined in Appendix Table A1. The table includes 8,576,027 roundtrips starting from a dealer buy of at least 100 bonds and excludes roundtrips that include any agency trades.

			Percent of total # roundtrips:			
		Total #	Paired roundtrips	Other same day roundtrips	Roundtrips completed in more than one day	Weighted ave holding period (days) for roundtrips completed in more than one day
All roundtrips		8,576,027	41.1%	17.1%	41.8%	21.0
Rating group						
A and above		3,375,655	41.1%	14.1%	44.7%	20.0
BBB		2,070,371	40.1%	16.6%	43.3%	21.0
BB		898,550	39.4%	18.7%	41.9%	22.2
B and below		2,231,451	42.9%	21.2%	35.9%	22.0
Trade count						
Deciles:	1	905,501	49.9%	12.2%	38.0%	18.0
	2	1,004,219	41.7%	13.9%	44.4%	20.4
	3	1,028,011	40.0%	15.2%	44.8%	21.0
	4	997,979	39.7%	16.2%	44.1%	21.9
	5	958,228	39.8%	16.8%	43.4%	22.0
	6-10	3,682,089	39.9%	19.9%	40.1%	21.0
Days traded						
Deciles:	1	820,287	52.9%	12.6%	34.5%	15.8
	2	931,650	43.4%	14.2%	42.4%	19.0
	3	1,027,692	40.9%	15.7%	43.5%	21.0
	4	1,221,131	40.4%	17.1%	42.5%	22.0
	5	892,266	41.5%	18.9%	39.6%	22.0
	6-10	3,683,001	38.2%	18.7%	43.1%	21.6

Table 7

Roundtrip completion for subsamples of bonds by rating and by dealer characteristics

The table reports the total number of roundtrips by rating category and by trading activity deciles, and the percentage of roundtrips which are paired roundtrips, other same day roundtrips, and roundtrips completed in more than one day. Panel A reports these statistics for subgroups of the highest and lowest rated bonds. Panel B reports roundtrip completions based on whether the dealer is a *top ten: volume* dealer and on whether more than 50% of the dealer's trades on TRACE are for less than 100 bonds (*small trade dealer*). All variables are as defined in Appendix Table A1. The table includes all roundtrips starting from a dealer buy of at least 100 bonds and excludes roundtrips that include any agency trades.

A. Rating category subsamples

		A rated and above					**B rated and below**				
		Total	Percent of total				Total	Percent of total			
		# roundtrips	Paired roundtrips	Other same day roundtrips	Roundtrips completed in more than one day	Weighted ave holding period for roundtrips completed in more than one day (median days)	# roundtrips	Paired roundtrips	Other same day roundtrips	Roundtrips completed in more than one day	Weighted ave holding period for roundtrips completed in more than one day (median days)
Trade count											
Deciles:	1	362,366	48.7%	9.0%	42.3%	14.0	223,906	53.1%	17.3%	29.7%	24.9
	2	327,320	42.0%	10.4%	47.6%	16.0	293,565	43.4%	18.2%	38.4%	24.0
	3	325,033	40.8%	11.4%	47.8%	18.2	319,477	41.2%	19.4%	39.4%	23.2
	4	344,220	39.8%	12.6%	47.5%	18.2	306,629	41.3%	20.3%	38.4%	22.9
	5	376,917	39.6%	13.4%	46.9%	22.0	271,969	41.4%	21.5%	37.1%	22.0
	6-10	1,639,799	40.0%	17.0%	43.0%	21.9	815,905	41.6%	24.4%	34.0%	20.0
Days traded											
Deciles:	1	327,817	51.1%	9.3%	39.6%	12.0	212,763	56.9%	17.9%	25.2%	22.5
	2	296,399	43.2%	10.4%	46.4%	15.0	289,422	45.4%	18.7%	35.9%	23.0
	3	292,868	41.5%	11.4%	47.0%	17.0	353,184	42.1%	19.7%	38.2%	23.0
	4	380,457	41.6%	13.2%	45.2%	20.2	407,356	40.9%	21.2%	37.9%	22.5
	5	366,015	43.1%	15.9%	41.0%	22.0	227,208	40.8%	23.1%	36.1%	22.0
	6-10	1,712,099	38.3%	16.0%	45.7%	22.0	741,518	39.9%	23.4%	36.7%	21.0

Table 7 - continued

B. Subsamples by dealer characteristics

		Top ten dealer: volume					Other dealers				
		Total	Percent of total			Weighted ave holding period for roundtrips completed in more than one day (median days)	Total	Percent of total			Weighted ave holding period for roundtrips completed in more than one day (median days)
		# roundtrips	Paired roundtrips	Other same day roundtrips	Roundtrips completed in more than one day		# roundtrips	Paired roundtrips	Other same day roundtrips	Roundtrips completed in more than one day	
Trade count deciles:	1	542,802	37.8%	12.6%	49.6%	21.3	362,699	68.0%	11.4%	20.6%	8.0
	2	655,357	31.7%	14.6%	53.8%	22.7	348,862	60.5%	12.8%	26.7%	11.0
	3	681,395	30.9%	15.9%	53.2%	23.0	346,616	57.8%	13.8%	28.3%	13.6
	4	657,734	31.2%	16.8%	52.0%	23.0	340,245	56.2%	15.0%	28.8%	15.0
	5	617,223	31.5%	17.3%	51.2%	23.1	341,005	54.8%	15.8%	29.4%	16.7
	6-10	2,164,047	32.9%	20.1%	46.9%	22.1	1,518,042	49.9%	19.6%	30.5%	17.9
Days traded deciles:	1	459,373	41.3%	13.0%	45.6%	20.2	360,914	67.6%	12.2%	20.3%	7.0
	2	593,473	33.1%	14.7%	52.2%	22.0	338,177	61.5%	13.4%	25.1%	10.0
	3	681,637	31.9%	16.2%	51.9%	22.8	346,055	58.6%	14.5%	26.9%	13.0
	4	806,910	32.1%	17.5%	50.3%	23.0	414,221	56.4%	16.2%	27.4%	15.0
	5	552,126	33.1%	19.2%	47.7%	23.9	340,140	55.2%	18.3%	26.5%	18.0
	6-10	2,225,039	31.0%	18.9%	50.1%	22.9	1,457,962	49.2%	18.4%	32.4%	18.0
		Small trade dealer					Other dealers				
Trade count deciles:	1	433,164	49.5%	11.4%	39.1%	15.0	472,337	50.2%	12.8%	36.9%	21.0
	2	448,581	39.0%	12.0%	48.9%	18.0	555,638	43.8%	15.5%	40.7%	22.0
	3	448,856	36.6%	13.0%	50.4%	20.0	579,155	42.6%	16.9%	40.5%	22.3
	4	440,027	36.0%	14.2%	49.8%	21.0	557,952	42.7%	17.8%	39.5%	22.1
	5	437,163	35.9%	15.0%	49.1%	21.5	521,065	43.0%	18.3%	38.7%	22.2
	6-10	1,943,556	36.4%	19.6%	44.0%	21.0	1,738,533	43.9%	20.3%	35.8%	21.5
Days traded deciles:	1	409,708	52.2%	12.1%	35.7%	12.4	410,579	53.5%	13.2%	33.3%	20.0
	2	421,464	41.1%	12.8%	46.1%	16.3	510,186	45.3%	15.4%	39.3%	21.0
	3	440,571	37.5%	13.7%	48.8%	19.0	587,121	43.4%	17.1%	39.4%	22.0
	4	530,031	36.9%	15.5%	47.6%	21.0	691,100	43.0%	18.3%	38.7%	22.2
	5	432,205	38.8%	18.3%	42.9%	22.0	460,061	44.1%	19.4%	36.6%	23.0
	6-10	1,917,368	34.4%	18.1%	47.5%	21.2	1,765,633	42.3%	19.4%	38.3%	22.0

Table 8
First Stage Probit Model

The table provides probit models for the selection of roundtrips completed within the same day versus longer roundtrips where bonds are taken into overnight dealer inventory. The dependent variable equals one for paired roundtrips and other same day roundtrips, and zero otherwise. Other variables are as defined in Appendix Table A1. *, **, and *** denote statistical significance at the 0.10, 0.05, and 0.01 level, respectively. Standard errors clustered by issuer are shown in parentheses.

Trading activity variable:	Trade count				Days traded			
	A & above	BBB	BB	B & below	A & above	BBB	BB	B & below
VARIABLES								
Decile 1	0.1518***	0.0583*	0.2662***	0.1156***	0.4389***	0.3714***	0.4942***	0.4336***
	(0.030)	(0.035)	(0.028)	(0.026)	(0.019)	(0.033)	(0.024)	(0.023)
Decile 2	-0.0158	-0.1171***	0.0271	-0.0838***	0.1895***	0.1216***	0.1840***	0.1353***
	(0.019)	(0.028)	(0.023)	(0.022)	(0.012)	(0.026)	(0.018)	(0.018)
Decile 3	-0.0425***	-0.1353***	-0.0530***	-0.1175***	0.1278***	0.0669***	0.0775***	0.0537***
	(0.014)	(0.024)	(0.020)	(0.020)	(0.010)	(0.022)	(0.016)	(0.017)
Decile 4	-0.0454***	-0.1203***	-0.0494***	-0.1014***	0.1184***	0.0600***	0.0513***	0.0316**
	(0.012)	(0.019)	(0.018)	(0.018)	(0.008)	(0.015)	(0.013)	(0.014)
Decile 5	-0.0444***	-0.0999***	-0.0343**	-0.0764***	0.1604***	0.1178***	0.0768***	0.0455***
	(0.009)	(0.014)	(0.016)	(0.015)	(0.007)	(0.011)	(0.012)	(0.011)
Buy volume >= 5000	0.0565***	0.1744***	0.3246***	0.3784***	0.0635***	0.1699***	0.3251***	0.3799***
	(0.011)	(0.016)	(0.025)	(0.018)	(0.011)	(0.016)	(0.023)	(0.018)
1000 <= buy volume < 5000	-0.0312***	0.0786***	0.1754***	0.2461***	-0.0270**	0.0768***	0.1797***	0.2552***
	(0.011)	(0.010)	(0.016)	(0.014)	(0.011)	(0.010)	(0.015)	(0.013)
500 <= buy volume < 1000	-0.0924***	-0.0743***	0.0079	0.0806***	-0.0892***	-0.0749***	0.0117	0.0834***
	(0.009)	(0.008)	(0.011)	(0.012)	(0.009)	(0.009)	(0.011)	(0.012)
Rule 144A bond	0.1148***	0.0698**	0.0597**	0.0105	0.1179***	0.1080***	0.0914***	0.0516**
	(0.037)	(0.032)	(0.026)	(0.021)	(0.037)	(0.034)	(0.027)	(0.021)
Time to maturity	-0.0010*	-0.0014**	0.0003	-0.0020*	-0.0016***	-0.0012	0.0002	-0.0022*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bond age	0.0019	0.0043**	0.0085***	0.0111***	-0.0028**	-0.0008	0.0053***	0.0061**
	(0.001)	(0.002)	(0.002)	(0.003)	(0.001)	(0.002)	(0.002)	(0.003)
Issue size	-0.0070	-0.0168	0.0518***	-0.0151	0.0064	-0.0050	0.0635***	0.0016
	(0.006)	(0.013)	(0.010)	(0.011)	(0.005)	(0.010)	(0.011)	(0.011)
Buy from customer	-0.4160***	-0.2888***	-0.1561***	-0.0844***	-0.4192***	-0.2963***	-0.1608***	-0.0949***
	(0.014)	(0.023)	(0.034)	(0.013)	(0.014)	(0.023)	(0.036)	(0.013)
% sale volume to customers	-0.0299**	-0.0102	-0.0285**	-0.0455***	-0.0288**	-0.0104	-0.0296**	-0.0544***
	(0.012)	(0.014)	(0.015)	(0.013)	(0.012)	(0.014)	(0.015)	(0.014)
Top ten dealer: volume	-0.6503***	-0.7433***	-0.8986***	-0.8522***	-0.6512***	-0.7437***	-0.8979***	-0.8465***
	(0.019)	(0.012)	(0.017)	(0.012)	(0.018)	(0.012)	(0.017)	(0.013)
Top ten dealer: trade count	-0.1934***	-0.2848***	-0.3765***	-0.3416***	-0.1882***	-0.2816***	-0.3729***	-0.3389***
	(0.018)	(0.015)	(0.022)	(0.013)	(0.017)	(0.015)	(0.022)	(0.013)
Ln(# dealers)	0.0294	-0.0067	-0.0368**	-0.0384***	0.1093***	0.0881***	0.0147	0.0375**
	(0.019)	(0.017)	(0.015)	(0.014)	(0.015)	(0.018)	(0.014)	(0.015)
Change in aggregate bond inventory (-30,0)	0.0020*	0.0004	0.0004	0.0002	0.0018	-0.0001	0.0003	0.0004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Stock listing	-0.0314	-0.0619**	-0.0342	-0.0623***	-0.0368	-0.0565*	-0.0288	-0.0618***
	(0.024)	(0.029)	(0.023)	(0.020)	(0.022)	(0.031)	(0.022)	(0.021)
Crisis	0.3044***	0.3177***	0.1943***	0.1552***	0.3108***	0.3191***	0.1895***	0.1389***
	(0.009)	(0.018)	(0.019)	(0.014)	(0.009)	(0.020)	(0.019)	(0.015)
Post-crisis	0.1680***	0.1683***	0.0789***	0.0804***	0.1986***	0.2100***	0.0993***	0.0802***
	(0.012)	(0.019)	(0.017)	(0.022)	(0.012)	(0.020)	(0.017)	(0.023)
Constant	0.3105***	0.6165***	0.7226***	0.8970***	-0.2236**	-0.0239	0.3676***	0.4159***
	(0.117)	(0.103)	(0.093)	(0.075)	(0.087)	(0.099)	(0.086)	(0.072)
Observations	3,322,647	2,047,747	892,878	2,212,310	3,322,647	2,047,747	892,878	2,212,310
p-value	0.53	0.00	0.38	0.00	0.58	0.00	0.32	0.03

Table 9
Second Stage Endogenous Switching Regression Models

The dependent variable is the weighted average spread for dealer roundtrips completed the same day or completed over longer holding periods. Regressions include quarter fixed effects. Robust standard errors (in parentheses) cluster by issuer. Inverse Mills ratio is calculated from Stage 1 models reported in Table 8. Variables are as defined in Appendix Table A1.

A. Using indicators for deciles by trade count

	A & above		BBB		BB		B & below	
Roundtrip is:	same day	> 1 day	same day	> 1 day	same day	> 1 day	same day	> 1 day
Decile 1	0.0603***	0.1760***	0.0051	0.1250***	0.0039	0.0363	0.0353***	-0.0016
	(0.012)	(0.021)	(0.013)	(0.041)	(0.015)	(0.065)	(0.011)	(0.047)
Decile 2	0.0202*	0.1204***	-0.0270**	0.0340	-0.0151	-0.0850	-0.0034	-0.0656
	(0.011)	(0.021)	(0.013)	(0.046)	(0.017)	(0.064)	(0.009)	(0.047)
Decile 3	0.0004	0.0416**	-0.0406***	-0.0232	-0.0245	-0.1157*	-0.0168*	-0.0523
	(0.011)	(0.021)	(0.013)	(0.047)	(0.019)	(0.065)	(0.009)	(0.047)
Decile 4	-0.0138*	0.0125	-0.0440***	-0.0343	-0.0224	-0.1138*	-0.0106	-0.0380
	(0.008)	(0.017)	(0.012)	(0.047)	(0.020)	(0.061)	(0.008)	(0.047)
Decile 5	-0.0192***	0.0027	-0.0402***	-0.0534	-0.0224	-0.1399**	-0.0063	-0.0447
	(0.006)	(0.013)	(0.010)	(0.048)	(0.020)	(0.061)	(0.007)	(0.039)
Buy volume >= 5000	-0.2467***	-0.2996***	-0.3171***	-0.4093***	-0.3045***	-0.3779***	-0.2782***	-0.3627***
	(0.007)	(0.013)	(0.017)	(0.019)	(0.035)	(0.056)	(0.013)	(0.033)
1000 <= buy volume < 5000	-0.2016***	-0.2339***	-0.2776***	-0.2890***	-0.2771***	-0.3554***	-0.2637***	-0.4154***
	(0.006)	(0.009)	(0.012)	(0.019)	(0.027)	(0.043)	(0.010)	(0.025)
500 <= buy volume < 1000	-0.1313***	-0.1404***	-0.1769***	-0.1775***	-0.2056***	-0.2284***	-0.1973***	-0.2806***
	(0.005)	(0.008)	(0.007)	(0.012)	(0.020)	(0.034)	(0.007)	(0.019)
Ratio small/total # sells	0.5843***	0.4297***	0.8002***	0.4856***	0.8859***	0.6326***	0.9730***	0.6254***
	(0.019)	(0.015)	(0.046)	(0.035)	(0.043)	(0.038)	(0.028)	(0.045)
Rule 144A bond	-0.0350**	0.0020	0.0230	0.0447	-0.0170	-0.0045	0.0134**	-0.0858*
	(0.017)	(0.028)	(0.014)	(0.041)	(0.012)	(0.050)	(0.006)	(0.044)
Time to maturity	0.0108***	0.0180***	0.0069***	0.0158***	0.0048***	0.0151***	0.0008	0.0047
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.003)	(0.001)	(0.004)
Buy from customer	0.0203*	0.0327***	0.0273***	-0.0040	0.0403***	0.0255	0.0598***	-0.0675***
	(0.012)	(0.010)	(0.006)	(0.016)	(0.007)	(0.018)	(0.005)	(0.017)
% sale volume to customers	0.1669***	0.1792***	0.2026***	0.2192***	0.1625***	0.2423***	0.1487***	0.2271***
	(0.009)	(0.009)	(0.016)	(0.022)	(0.010)	(0.021)	(0.006)	(0.015)
Constant	0.2378***	0.9070***	0.4872***	0.3326	0.5776***	-0.0734	0.5596***	-0.1271
	(0.028)	(0.074)	(0.053)	(0.262)	(0.036)	(0.270)	(0.042)	(0.215)
Inverse Mills ratio	0.0203	0.0226	-0.0407***	0.0125	0.0101	0.0789**	-0.0143***	0.0393
	0.0322	0.0202	0.00941	0.0233	0.0113	0.037	0.00456	0.0279
Observations	3,322,647		2,047,747		892,878		2,212,310	
p_chi^2	0.529	0.265	0.000	0.594	0.376	0.031	0.002	0.159
Observed minus predicted from > 1 day	-0.070		-0.209		-0.086		-0.126	
Observed minus predicted from same day		-0.0176		0.0909		0.0172		0.100

Table 9 - continued

B. Using indicators for deciles by days traded

	A & above		BBB		BB		B & below	
Roundtrip is:	same day	> 1 day	same day	> 1 day	same day	> 1 day	same day	> 1 day
Decile 1	0.0819***	0.2023***	0.0295**	0.1929***	0.0325***	0.1160**	0.0664***	0.1448***
	(0.012)	(0.024)	(0.012)	(0.034)	(0.012)	(0.058)	(0.011)	(0.042)
Decile 2	0.0451***	0.1502***	-0.0032	0.0885**	0.0088	0.0437	0.0177*	0.0655
	(0.011)	(0.020)	(0.011)	(0.039)	(0.011)	(0.052)	(0.010)	(0.041)
Decile 3	0.0157*	0.0763***	-0.0202*	0.0154	-0.0066	-0.0404	-0.0034	0.0661
	(0.009)	(0.019)	(0.011)	(0.041)	(0.013)	(0.052)	(0.008)	(0.042)
Decile 4	0.0033	0.0333**	-0.0233**	0.0146	-0.0076	-0.0706	-0.0075	0.0443
	(0.006)	(0.014)	(0.009)	(0.042)	(0.013)	(0.046)	(0.007)	(0.037)
Decile 5	0.0002	0.0131	-0.0050	0.0349	0.0024	-0.0620*	-0.0016	0.0700**
	(0.003)	(0.009)	(0.004)	(0.034)	(0.008)	(0.032)	(0.004)	(0.031)
Buy volume >= 5000	-0.2462***	-0.2984***	-0.3185***	-0.4088***	-0.3035***	-0.3730***	-0.2771***	-0.3479***
	(0.007)	(0.013)	(0.017)	(0.019)	(0.034)	(0.054)	(0.013)	(0.034)
1000 <= buy volume < 5000	-0.2012***	-0.2324***	-0.2788***	-0.2891***	-0.2773***	-0.3550***	-0.2626***	-0.4095***
	(0.006)	(0.009)	(0.012)	(0.019)	(0.026)	(0.042)	(0.010)	(0.026)
500 <= buy volume < 1000	-0.1306***	-0.1390***	-0.1777***	-0.1778***	-0.2058***	-0.2274***	-0.1977***	-0.2797***
	(0.005)	(0.008)	(0.007)	(0.012)	(0.019)	(0.033)	(0.007)	(0.019)
Ratio small/total # sells	0.5873***	0.4287***	0.8062***	0.4916***	0.8897***	0.6395***	0.9768***	0.6451***
	(0.019)	(0.015)	(0.047)	(0.034)	(0.045)	(0.037)	(0.029)	(0.044)
Rule 144A bond	-0.0429***	-0.0057	0.0158	0.0348	-0.0227**	-0.0235	0.0109*	-0.1040**
	(0.016)	(0.029)	(0.014)	(0.041)	(0.011)	(0.049)	(0.006)	(0.044)
Time to maturity	0.0107***	0.0179***	0.0069***	0.0157***	0.0048***	0.0152***	0.0009	0.0050
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.003)	(0.001)	(0.004)
Buy from customer	0.0224***	0.0360***	0.0263***	-0.0108	0.0381***	0.0173	0.0557***	-0.0861***
	(0.007)	(0.010)	(0.006)	(0.017)	(0.007)	(0.018)	(0.005)	(0.018)
% sale volume to customers	0.1670***	0.1805***	0.2021***	0.2157***	0.1609***	0.2343***	0.1456***	0.2081***
	(0.009)	(0.009)	(0.017)	(0.023)	(0.010)	(0.020)	(0.006)	(0.015)
Constant	0.2067***	0.8640***	0.4662***	0.3023	0.5526***	-0.1415	0.5261***	-0.1917
	(0.024)	(0.074)	(0.052)	(0.264)	(0.037)	(0.271)	(0.045)	(0.217)
Inverse Mills ratio	0.00872	0.0294	-0.0433***	-0.000972	0.0112	0.0877**	-0.0098**	0.0322
	0.0156	0.0208	0.00958	0.024	0.0112	0.0378	0.00458	0.0286
Observations	3,322,647		2,047,747		892,878		2,212,310	
p_chi^2	0.575	0.160	0.000	0.968	0.320	0.019	0.031	0.260
Observed minus predicted from > 1 day	-0.074		-0.208		-0.089		-0.129	
Observed minus predicted from same day		-0.0160		0.0897		0.0171		0.101

Table 10

Second Stage Endogenous Switching Regression Models: Effect of Market Stress

The dependent variable is the weighted average spread for dealer roundtrips completed the same day or completed over longer holding periods. Panel A includes interactions of trading activity deciles with indicator for the financial crisis period, defined as the second quarter of 2007 through the second quarter of 2009. Panel B includes interactions with an indicator for days of increases in the VIX in the 95th percentile of VIX changes over our sample period. Regressions include quarter fixed effects. Robust standard errors (in parentheses) cluster by issuer. Inverse Mills ratio is calculated from Stage 1 models not reported. Additional control variables not reported are as specified in Table 9. Variables are as defined in Appendix Table A1.

A. Interactions of crisis with deciles by trade count

	A & above		BBB		BB		B & below	
Roundtrip is:	same day	> 1 day	same day	> 1 day	same day	> 1 day	same day	> 1 day
Decile 1	0.0617***	0.1329***	-0.0017	0.0962**	0.0093	-0.0443	0.0420***	-0.0911
	(0.013)	(0.021)	(0.014)	(0.046)	(0.015)	(0.071)	(0.013)	(0.057)
Decile 2	0.0239**	0.0775***	-0.0325**	0.0197	-0.0184	-0.1349**	-0.0003	-0.1372**
	(0.011)	(0.022)	(0.015)	(0.051)	(0.018)	(0.066)	(0.011)	(0.057)
Decile 3	0.0051	0.0139	-0.0453***	-0.0295	-0.0262	-0.1396**	-0.0159	-0.1222**
	(0.011)	(0.022)	(0.015)	(0.053)	(0.019)	(0.064)	(0.010)	(0.057)
Decile 4	-0.0111	-0.0197	-0.0473***	-0.0323	-0.0224	-0.1231*	-0.0103	-0.0664
	(0.009)	(0.019)	(0.014)	(0.051)	(0.021)	(0.063)	(0.010)	(0.056)
Decile 5	-0.0188***	-0.0258*	-0.0429***	-0.0489	-0.0260	-0.1330**	-0.0056	-0.0661
	(0.007)	(0.014)	(0.011)	(0.050)	(0.019)	(0.060)	(0.008)	(0.048)
Decile 1 * crisis	-0.0054	0.2135***	0.0387*	0.1989***	-0.0188	0.4546*	-0.0299*	0.4815***
	(0.012)	(0.043)	(0.021)	(0.075)	(0.019)	(0.259)	(0.018)	(0.147)
Decile 2 * crisis	-0.0155	0.2381***	0.0359*	0.1260	0.0161	0.3216	-0.0146	0.3918***
	(0.011)	(0.044)	(0.022)	(0.079)	(0.019)	(0.262)	(0.017)	(0.147)
Decile 3 * crisis	-0.0207*	0.1536***	0.0331	0.0752	0.0100	0.1891	-0.0051	0.3803**
	(0.011)	(0.041)	(0.022)	(0.082)	(0.018)	(0.263)	(0.015)	(0.152)
Decile 4 * crisis	-0.0117	0.1773***	0.0255	0.0160	0.0012	0.1010	-0.0030	0.1744
	(0.012)	(0.040)	(0.021)	(0.079)	(0.018)	(0.248)	(0.015)	(0.153)
Decile 5 * crisis	-0.0009	0.1512***	0.0224	-0.0071	0.0216	-0.0088	-0.0042	0.1376
	(0.010)	(0.035)	(0.019)	(0.083)	(0.018)	(0.252)	(0.014)	(0.137)
Inverse Mills ratio	0.0205	0.0254	-0.0407***	0.0121	0.0101	0.0783**	-0.0143***	0.0339
	(0.033)	(0.020)	(0.009)	(0.023)	(0.011)	(0.036)	(0.005)	(0.028)
Observed minus predicted from > 1 day	-0.070		-0.209		-0.086		-0.126	
Observed minus predicted from same day		-0.018		0.091		0.017		0.100
Observations	3,322,647		2,047,747		892,878		2,212,310	

Table 10 - continued

B. Interactions of high delta vix with deciles by trade count

	A & above		BBB		BB		B & below	
Roundtrip is:	same day	> 1 day	same day	> 1 day	same day	> 1 day	same day	> 1 day
High delta VIX	0.0084*	-0.2136***	-0.0043	-0.4241***	0.0018	-0.1381**	-0.0021	-0.0954
	(0.004)	(0.023)	(0.010)	(0.075)	(0.012)	(0.057)	(0.011)	(0.084)
Decile 1	0.0618***	0.1754***	0.0022	0.1113***	0.0043	0.0271	0.0350***	-0.0103
	(0.011)	(0.021)	(0.013)	(0.040)	(0.015)	(0.065)	(0.011)	(0.047)
Decile 2	0.0218**	0.1161***	-0.0280**	0.0223	-0.0146	-0.0860	-0.0043	-0.0671
	(0.011)	(0.021)	(0.013)	(0.046)	(0.018)	(0.064)	(0.009)	(0.048)
Decile 3	0.0013	0.0377*	-0.0412***	-0.0365	-0.0243	-0.1226*	-0.0167*	-0.0541
	(0.011)	(0.021)	(0.013)	(0.047)	(0.020)	(0.065)	(0.009)	(0.048)
Decile 4	-0.0128	0.0065	-0.0445***	-0.0450	-0.0222	-0.1143*	-0.0115	-0.0372
	(0.008)	(0.018)	(0.012)	(0.047)	(0.020)	(0.061)	(0.009)	(0.047)
Decile 5	-0.0184***	-0.0038	-0.0410***	-0.0639	-0.0223	-0.1338**	-0.0060	-0.0469
	(0.006)	(0.014)	(0.010)	(0.047)	(0.021)	(0.061)	(0.007)	(0.040)
Decile 1 * high delta VIX	-0.0232**	-0.0053	0.0544***	0.2922***	-0.0071	0.2176**	0.0058	0.1860
	(0.011)	(0.040)	(0.017)	(0.107)	(0.029)	(0.107)	(0.018)	(0.120)
Decile 2 * high delta VIX	-0.0257***	0.0711*	0.0190	0.2394**	-0.0098	0.0209	0.0158	0.0255
	(0.010)	(0.040)	(0.015)	(0.100)	(0.035)	(0.086)	(0.018)	(0.120)
Decile 3 * high delta VIX	-0.0147	0.0631	0.0127	0.2746***	-0.0036	0.1567*	-0.0014	0.0328
	(0.010)	(0.041)	(0.017)	(0.102)	(0.025)	(0.089)	(0.015)	(0.119)
Decile 4 * high delta VIX	-0.0157*	0.1011**	0.0108	0.2166**	-0.0049	0.0164	0.0147	-0.0211
	(0.008)	(0.043)	(0.014)	(0.096)	(0.022)	(0.095)	(0.015)	(0.114)
Decile 5 * high delta VIX	-0.0106	0.1108***	0.0151	0.2237**	-0.0026	-0.1132	-0.0052	0.0411
	(0.008)	(0.035)	(0.014)	(0.106)	(0.018)	(0.101)	(0.015)	(0.118)
Inverse Mills ratio	0.0203	0.0226	-0.0408***	0.0134	0.0102	0.0789**	-0.0144***	0.0398
	(0.033)	(0.020)	(0.009)	(0.023)	(0.011)	(0.037)	(0.005)	(0.028)
Observed minus predicted from > 1 day	-0.071		-0.210		-0.086		-0.126	
Observed minus predicted from same day		-0.018		0.091		0.017		0.100
Observations	3,322,647		2,047,747		892,878		2,212,310	

Table 11
Endogenous Switching Regression Model Excluding Roundtrips of *Top Ten: Volume* Dealers

The table reports the results of the two stage endogenous switching regresison model. Coefficients are reported for trading activity deciles; coefficients for additional included variables from the base specification (Tables 8 and 9) are not reported for brevity. Variables are as defined in Appendix Table A1. *, **, and *** denote statistical signficance at the 0.10, 0.05, and 0.01 level, respectively. Regressions include quarter fixed effects. Robust standard errors clustered by issuer are shown in parentheses.

	Stage 1: Selection Equation (Probit)				Stage 2: Spread Model							
	A & above	BBB	BB	B & below	A & above		BBB		BB		B & below	
Observations	2,438,837	1,386,454	533,329	1,330,823	2,438,837		1,386,454		533,329		1,330,823	
					same day	> 1 day	same day	> 1 day	same day	> 1 day	same day	> 1 day
A. Deciles based on trade count												
Decile 1	0.1044***	0.1815***	0.3929***	0.2449***	0.0872***	0.3289***	-0.0052	0.3232***	0.0821***	0.2966***	0.0775***	0.0417
	(0.015)	(0.034)	(0.028)	(0.032)	(0.011)	(0.029)	(0.014)	(0.052)	(0.017)	(0.094)	(0.013)	(0.058)
Decile 2	-0.0437***	-0.0075	0.1420***	0.0313	0.0019	0.1046***	-0.0412***	-0.0248	0.0125	0.0295	0.0051	-0.1000*
	(0.011)	(0.027)	(0.022)	(0.027)	(0.009)	(0.025)	(0.014)	(0.050)	(0.017)	(0.070)	(0.011)	(0.052)
Decile 3	-0.0639***	-0.0394*	0.0460**	-0.0241	-0.0199**	0.0027	-0.0523***	-0.1265***	-0.0161	-0.0615	-0.0145	-0.1124**
	(0.010)	(0.023)	(0.020)	(0.024)	(0.008)	(0.024)	(0.014)	(0.048)	(0.019)	(0.067)	(0.011)	(0.053)
Decile 4	-0.0590***	-0.0415**	0.0108	-0.0234	-0.0293***	-0.0287	-0.0501***	-0.1470***	-0.0220	-0.0637	-0.0065	-0.0503
	(0.009)	(0.018)	(0.018)	(0.020)	(0.006)	(0.021)	(0.013)	(0.047)	(0.020)	(0.065)	(0.010)	(0.053)
Decile 5	-0.0548***	-0.0405***	0.0177	-0.0225	-0.0314***	-0.0310*	-0.0451***	-0.1378***	-0.0163	-0.0404	-0.0008	-0.0695
	(0.008)	(0.013)	(0.018)	(0.017)	(0.005)	(0.016)	(0.011)	(0.046)	(0.020)	(0.065)	(0.008)	(0.045)
Inverse Mills ratio					0.5440***	-1.4230***	0.0036	-1.7290***	0.4840***	-0.6040***	0.4300***	-0.3700***
					(0.011)	(0.042)	(0.014)	(0.092)	(0.025)	(0.221)	(0.022)	(0.121)
Observed minus predicted from > 1 day					-0.079		-0.196		-0.067		-0.134	
Observed minus predicted from same day						0.008		0.097		0.049		0.141
B. Deciles based on days traded												
Decile 1	0.2823***	0.4045***	0.5190***	0.4989***	0.1467***	0.4757***	0.0254**	0.5502***	0.1346***	0.4351***	0.1430***	0.3113***
	(0.014)	(0.033)	(0.035)	(0.028)	(0.012)	(0.034)	(0.013)	(0.046)	(0.013)	(0.087)	(0.014)	(0.062)
Decile 2	0.0867***	0.1733***	0.2275***	0.1964***	0.0519***	0.2174***	-0.0122	0.1801***	0.0481***	0.1386**	0.0462***	0.0741
	(0.012)	(0.027)	(0.022)	(0.022)	(0.009)	(0.025)	(0.012)	(0.044)	(0.011)	(0.062)	(0.012)	(0.049)
Decile 3	0.0493***	0.1162***	0.1279***	0.1062***	0.0194***	0.1032***	-0.0273**	0.0487	0.0156	0.0425	0.0146	0.0495
	(0.010)	(0.022)	(0.016)	(0.020)	(0.007)	(0.022)	(0.012)	(0.041)	(0.013)	(0.054)	(0.010)	(0.049)
Decile 4	0.0640***	0.1023***	0.0807***	0.0692***	0.0197***	0.0955***	-0.0269***	0.0530	0.0073	0.0061	0.0079	0.0283
	(0.008)	(0.015)	(0.013)	(0.015)	(0.005)	(0.018)	(0.010)	(0.045)	(0.013)	(0.056)	(0.008)	(0.044)
Decile 5	0.1261***	0.1470***	0.0969***	0.0626***	0.0439***	0.1701***	-0.0022	0.1937***	0.0214**	0.0174	0.0163***	0.0623
	(0.007)	(0.010)	(0.013)	(0.011)	(0.004)	(0.016)	(0.004)	(0.051)	(0.009)	(0.039)	(0.005)	(0.038)
Inverse Mills ratio					0.5430***	-1.4070***	-0.0044	-1.7080***	0.4840***	-0.5700***	0.4280***	-0.4230***
					(0.011)	(0.044)	(0.012)	(0.094)	(0.025)	(0.181)	(0.022)	(0.127)
Observed minus predicted from > 1 day					-0.080		-0.193		-0.073		-0.141	
Observed minus predicted from same day						0.008		0.095		0.050		0.143