Dealer Behavior in Highly Illiquid Risky Assets

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Abstract

This study examines dealer behavior in a sample of 14,749 corporate bonds that vary in credit rating and liquidity. Our unique data set allows us to identify purchases and sales by individual dealers, enabling us to determine how long a dealer holds a bond purchase in inventory, how much of that initial purchase is sold to customers, spreads on those sales to customers, and how these vary with the credit rating and liquidity of the bond in the prior 30 days. We find that previous liquidity has little effect on the spreads dealers charge customers; for some rating categories, observed spreads are higher for the most actively traded bonds. Consistent with this finding, dealers' holding periods do not necessarily decline as liquidity increases; in fact, dealer's holding periods are lowest for some of the most illiquid bonds. Dealers are also more likely to sell all of an initial purchase of bonds on the same day for the less liquid bonds. These effects become stronger as credit quality decreases. Overall, our results suggest that dealers endogenously adjust their behavior to mitigate inventory risk from trading in illiquid securities.

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REVISION NOTES: THE PAPER IS CURRENTLY BEING UPDATED USING RECENT DATA FROM FINRA TO EXTEND OUR SAMPLE PERIOD THROUGH 2015. THE VERSION IN PROCESS ALSO INCLUDES ADDITIONAL INVENTORY MEASURES RELATED TO THOSE REPORTED IN THE CURRENT DRAFT.

I. Introduction

Dealers face a variety of challenges when trying to make markets in relatively illiquid risky assets such as corporate bonds. In particular, dealers may assume inventory risk upon purchasing an asset from a customer if they must wait for a counterparty to arrive to offset the original purchase. Such risks are magnified when dealers face price movements on riskier assets and for illiquid assets where fewer buyers for the asset may arrive.

Standard market microstructure models such as Glosten and Milgrom (1985) generally assume that dealers stand by relatively passively and await the arrival of liquidity traders, who arrive via some external Poisson process. These models were generally created to describe US equity markets, which compared to markets such as that for corporate bonds are relatively liquid. Therefore, these theoretical models may be more appropriate as models of equity market dealers or other dealers facing reasonably large natural demand.

Faced with significant inventory risk, dealers may be less willing to commit capital to trading in more illiquid securities. At the same time, dealers may follow other strategies to mitigate this increased liquidity risk. One likely response is to not stand by passively but rather to search actively for counterparty offers. Duffie, Garleanu, and Pedersen (2005) create a model that suggests that as illiquidity increases, agents increasingly engage in costly search mechanisms in order to find the opposite side of a trade. Market makers and agents endogenously increase their search as liquidity decreases. In contrast, as liquidity increases, more orders come to the market makers and they naturally avoid costly search. Therefore, dealer behavior may vary as liquidity changes.

This paper attempts examines the question of how dealers' behavior changes for increasingly illiquid assets by focusing on trading in the over-the-counter dealer market for U.S. Corporate bonds. As demonstrated by Goldstein, Hotchkiss, and Sirri (2007) and others, many corporate bonds are very illiquid, with a substantial portion of bonds in the market trading infrequently or not at all. We examine a

large sample of 14,749 corporate bonds traded on TRACE that vary considerably in credit rating and liquidity.[1] Our unique data set allows us to identify purchases and sales by individual dealers, enabling us to determine how long a dealer holds a bond purchase in inventory, how that initial purchase is sold to customers, the spread on those sales to customers, and how these vary with credit rating and prior measured liquidity of the bond

We first provide a description of the overall liquidity for U.S. corporate bonds. Well over half of the bonds trade less than once a day on average, with many trading only once a month. In order to be able to construct standard market microstructure measures of liquidity, prior research largely excludes more illiquid bonds which are an important part of the market and of our study. We divide our sample into different subgroups based on trading activity observed in a prior 30 day window, often zero for many bonds, and limit ourselves to basic liquidity measures that do not require frequent trading trades to calculate – specifically, trade count and trading volume (our revision finds similar results using the number of days traded in the prior window). Other measures, such as the measure Amihud (2002) measure of price impact or measured based on Roll (1984) implicitly assume and require multiple trades per day for calculation. Using these measures would preclude the analysis from examining a large number of more illiquid bonds. It would also preclude us from understanding the behavior of dealers in periods where market-wide liquidity is abnormally low.

We focus on initial institutional sized trades by examining individual dealer trades involving an initial purchase of 100 bonds or more from a single customer. Since our data set allows us to examine the trading of individual (anonymous) dealers, we then identify subsequent sales of the same bond from this dealer to one or more other customers. We identify such dealer purchases followed by customer sales as a "dealer-round trip." Our empirical tests examine how the spreads, holding period, and other characteristics of such round-trips vary with bond credit risk and trading activity in the 30 day window prior to the purchase of bonds.

[1] See Goldstein, Hotchkiss, and Sirri (2007) and Goldstein and Hotchkiss (2009) for detailed descriptions of TRACE and the U.S. corporate bond market.

Our first key result is that prior illiquidity has little relationship to the spreads dealers charge customers. In fact, the data indicate that average dealer roundtrip spreads are smaller for the least liquid bonds (as measured by trading frequency in the previous 30 days) compared to the most liquid bonds. This result is also generally true when condition on previous volume, although the effect becomes stronger as credit rating becomes weaker. Importantly, this result is not one would expect based on typical market microstructure models which imply dealers should be compensated for potential inventory risk.

Why do dealer roundtrip spreads appear invariant to previous liquidity? One explanation is that dealers endogenously adjust their behavior to mitigate inventory risk, acting more as brokers and less as market makers as liquidity declines. The risk to the dealer upon purchasing a bond is the length of time the dealer must hold onto the bond, exposing the dealer to some inventory risk due to market movements. Illiquid bonds would be of concern if the dealer were unable to offload the bond quickly, as would be implied by a bond that trades once or twice (if at all) over the past 30 days. Lower credit quality bonds also have a larger the risk of market movements during the holding period. Most models would predict that more illiquid bonds and more risky bonds would have a longer holding period, and the longer holding period would result in larger roundtrip spreads. Notably, we find that dealers holding periods do not necessarily decline as liquidity increases, providing a likely the explanation for why the spreads are not clearly increasing as liquidity declines. In fact, dealer's holding periods for some of the most illiquid bonds (with trades less often than once every three days) are shorter than those bonds that trade five times per day or more.

Dealer holding periods also vary by credit rating. Interestingly, the holding period for high-yield bonds is noticeably shorter than that for investment grade bonds. Generally, lower rated bonds have a shorter holding period, and holding periods were interestingly relatively invariant to the liquidity over the previous 30 days. For example, CC rated bonds that trade 1 to 10 times over the previous 30 days (about once every 3 to 10 days) have an average dealer holding period of only 2.10 days; the average dealer holding period for CC rated bonds trading 3 to 5 times per day is a full day longer at 3.17 days. Similar results are found based on other measures of prior trading activity. We confirm these results using

regressions that compare actual holding periods to that expected based on the average trading (or volume) over the past 30 days, and which also control for other bond characteristics shown to be related to trading activity.

Interestingly, dealers accomplish this shorter holding period for illiquid bonds primarily by selling a large percentage of their initial purchase on the *same* day on which the dealer purchased the institutional size order. In fact, despite the lower liquidity of these bonds, the dealers somehow manage to offload to other customers *more* of the illiquid bonds than the liquid bonds on average. For example, for the least liquid AAA bonds that trade one to ten times in the previous 30 days, dealers find customers on the same day as the institutional purchase and sell all of their holdings from that purchase 49% of the time; for AAA bonds that trade much more frequently (at least 150 times in the past 30 days), dealers sell t their entire purchase on the same day only 36% of the time. For high-yield bonds, the effects are even stronger. We also examine the cumulative sell ratio, or what proportion of the initial trade is sold to customers over a fixed window, and find similar results. Using censored regressions to control for the (0,1) nature of the cumulative sell ratio, we find that dealers sell more of their initial purchase for the least liquid than for the most liquid bonds.

Overall, overall our results suggest that dealers manage their holding period risk aggressively for the less liquid and more risky bonds. Dealers thus act more as brokers in such securities, not executing trades until the other side of a transaction has been located. Dealers appear to actively manage their inventory in such a way that their overall holding period risk (considering both time and creditworthiness) is relatively constant, and therefore receive a relatively constant dealer roundtrip spread regardless of the bond's prior liquidity.

Our results also speak to the recent debate regarding the impact of transparency under TRACE on corporate bond liquidity. One criticism of such studies is that comparisons of spreads or other measures in pre- and post-dissemination regimes overlooks the question of whether dealers become more reluctant to commit capital for making markets in illiquid securities in transparent markets. To the extent dealers

largely act as brokers rather than market makers as illiquidity increases, concerns that capital is withdrawn in illiquid markets become less relevant.

Our paper is organized as follows. Section II reviews liquidity measures used for corporate bonds, describes our data, and provides some results related to their relative illiquidity. Section III examines how spreads dealers charge on roundtrip trades vary with increasing degrees of illiquidity and credit risk. Section V examines dealer holding periods, and Section VI considers how dealers offset their inventory. Section VII concludes.

II. Measures of liquidity for corporate bonds

One of the notable difficulties in corporate bond research is the relative lack of data from which to create liquidity measures. As noted by Nashikkar and Subrahmanyam (2006), "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" (p.2).[2] The inherent assumptions underpinning these measures are likely more applicable to the active equity market than in markets where assets often trade by appointment. Further, many of the measures used in market microstructure research require multiple trades per day.

Because prior studies of corporate bond markets implement liquidity measures similarly 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, Feldhutter, and Lando (2009) and others) requires at least two trades per day. Using a daily Roll (1984) or similar measure (as in Bao, Pan, and Wang ()), or measures of round trip trading costs (as in Feldhutter (2010), Feldhutter, Hotchkiss, and Karakas (2015)) requires two or three trades in a day. 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

[2] Nashikkar and Subrahmanyam (2006) instead use private data on corporate bond holdings to create a measure of "latent" liquidity. However, as they also use CDS data to control for default risk, their study is limited to bonds with CDS data.

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, Feldhutter, and Lando (2009) also note that when used on TRACE data the LOT measure is not reliable, becoming "unrealistically large" (p.3).

As a result, studies of corporate bond trading focus largely on the most liquid bonds. As Goldstein, Hotchkiss, and Sirri (2007) note, the median BBB bond trades only 17% of the days in their sample period.[3] As described below, 27% of the bonds we study trade once or twice a month, if at all. Many of the market microstructure models of dealer behavior, such as the Kyle (1985) model or the 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. As a result, an analysis of dealer behavior where assets may trade infrequently is needed.

II. Data and summary statistics

This study uses data from the Trade Reporting and Compliance Engine (TRACE) system, provided by FINRA. With the July 2002 introduction of TRACE, all NASD members were required for the first time to report prices, quantities, and other information for all secondary market transactions in corporate bonds. Dissemination of trade information based on bond rating and liquidity categories was phased in, allowing regulators to assess the impact of transparency on liquidity at each phase. Our dataset includes all bonds reported to TRACE, regardless of dissemination status. A chronology of the reporting and dissemination rule changes is provided in Goldstein and Hotchkiss (2007).

Our initial sample includes all bonds appearing on TRACE which trade at least once during the time period from July 8, 2002 through July 31, 2008. We exclude convertible bonds, medium term notes, and bonds which cannot be matched with Mergent data for bond characteristics. We further exclude

[3] Almost half of the bonds in their sample would not meet the requirement for calculating the LOT measure.

transactions within 180 calendar days of the offering date, as Goldstein and Hotchkiss (2007) show that this period is not typical of the ongoing bond liquidity and can be affected by the dealer's initial distribution of bonds. In addition to other variables, our TRACE data include anonymous indicators of dealers' identify, an indicator of whether the reporting dealer buys or sells the bonds, and an identifier that allows us to separate customer and interdealer trades.

We identify dealer round-trip transactions by following bonds from a given dealer's initial purchase from a customer to the same dealer's sale of the bonds to another customer (or customers).[4] Some dealer purchases are then followed by a single sale of the same size to another customer, while others are broken into more than one sale. We aggregate all sales that can be associated with the dealer's initial purchase into a single dealer roundtrip transaction (i.e. all dealer roundtrips have a single dealer purchase from a customer but may have more than one dealer-to-customer sales). To focus on the inventory effects faced by the dealer, we limit our analysis of dealer roundtrips to initial purchases of more than 100 bonds, which are likely purchases from institutional customers (Goldstein and Hotchkiss (2007); Goldstein, Hotchkiss, and Pedersen (2009)). Dealer's subsequent sales to customers can be of any size.

The starting point for our analysis is to demonstrate how liquid - or illiquid - are corporate bonds in general. To examine this, for each bond we calculate the median number of trades per month of any type or size, using all bonds that have at least one dealer round-trip during the sample period. We calculate the number of trades per month until the earlier of July 2008 or until the bond is redeemed, called, or matured. Bonds that have no trades are included as zero trades for that month; we then calculate the bond's median number of trades per month.

Figure 1 shows the median number of trades of any type per month for the bonds in our sample. It is clear that many bonds are rarely traded; for 17.5% of the bonds, the median number of trades per month is zero. 27% of the bonds have two or fewer trades per month, or only one trade every ten days;

[4] This measure captures the vast majority of trading in our sample. Expanding the measure to include subsequent interdealer trades has no significant impact on our reported results.

over half (51.6%) have ten or fewer trades per month, or only one trade every two to three days. About 70% of bonds have 23 trades per month, or about one trade per day.

Table 1 describes the sample characteristics in greater detail. We calculate statistics using bond characteristics for each initial institutional sized purchase from a customer as part of a dealer round trip, and the averaged for each bond. For example, the rating for a bond in the table uses each bond's average rating at the beginning of each roundtrip (we denote dealer round-trips as the aggregated customer-dealer-customer trades, or a "CDC" unit in the tables). Panel A shows the distribution of bonds across rating categories (AAA to C), the percentage of Rule 144A bonds, the average number of dealer roundtrips (CDCs) per bond, and the average issue size. We also report the average time to maturity and average age of the bond (time since issuance) for each rating category. The largest proportion of bonds appears near the investment grade/high yield divide. Relatively few bonds are rated above AA or below CCC.

The sample is otherwise relatively similar across ratings. High yield bonds are more often 144A issues, but the average number of dealer roundtrips per bond (around 100) and issue sizes for ratings below AA are relatively similar. Higher rated bonds (AAA to BB) have on average approximately 10 years to maturity, while lower rated bonds are of somewhat shorter duration. Bond age averages approximately five years. Subsequent tests use these measures to co9ntgrol for differences in bond characteristics.

Panels B and C of Table 1 give further breakdowns of liquidity by rating. An important measure of low liquidity levels is trading frequency, as the ability to even observe a price depends on there being a trade.[5] Panel B describes the median number of trades per month, broken into seven different liquidity categories: 0 to 9 trades per month (one trade every three to ten days), 10 to 19 trades per month (one trade every two to three days), 20 to 40 trades per month (approximately one trade per day), 41 to 60

[5] A large literature debates appropriate measures of liquidity, and shows that for several classes of assets (including corporate) bonds that trade count and volume often behave differently from other liquidity measures. For corporate bonds, Dick-Nielsen, Feldhutter and Lando (2012) show that trade count and volume are not significantly priced in bond yields, but their sample is restricted to the most liquid traded bonds. A useful alternative measure to trade count is the number of days traded; the current revision of this study alternatively uses the number of days traded as our primary measure of liquidity, producing similar results to those reported here.

trades per month (one to twos per day), 61 to 90 trades per month (2-3 trades per day), 91 to 150 trades per month (3 to 5 trades per day), and more than 150 trades per month (more than 5 per day). From Panel B, many bonds are in the first three highly illiquid categories, and this is relatively consistent across rating. Overall, based on trading frequency it is clear that many bonds hardly trade.

Bonds that trade infrequently may still trade in large quantities when they do trade, and so could appear more liquid based on trading volume. Panel C examines the sample based on median monthly volume, again broken into seven liquidity categories - the volume cutoffs we report result in a distribution of the number of bonds across groups that is roughly similar to the distribution when using number of trades. In this distribution, there are more bonds in the least liquid and most liquid categories – there are more than twice as many bonds in the most versus the least liquid group. However, the behavior of trading volume across credit ratings is still similar.

We next report summary statistics for dealer roundtrips (CDCs) in Table 2. We use the bond's rating as of the time of the initial dealer purchase. Further, since the most recent liquidity environment is relevant to the dealer's behavior, we calculate the number of trades or the cumulative volume for the 30 day period immediately prior to the day of the initial purchase. Not surprisingly, Panel A reports many more dealer roundtrips for the most frequently traded bonds. However, the number of dealer roundtrips observed for the six other categories is relatively constant and this pattern is relatively constant across credit ratings. The cumulative volume distribution shown in Panel B is similar to that in Panel A, though the two most illiquid categories (500 bonds and under) have half to a quarter of the number of dealer roundtrips as the next three categories. The number of dealer roundtrips increases by 50% for the 3501 to 5500 category before jumping dramatically for the most liquid category (over 5500 bonds in the previous 30 days).

In addition to the number of dealer roundtrips, Table 2 also introduces the first elements of dealer behavior varying by liquidity. Although the dealer roundtrip starts with an initial purchase of more than 100 bonds by the dealer, the dealer can dispose of the bonds in more than one transaction to multiple customers. In theory, if the dealer passively waits for the arrival of counterparties, it is not obvious why

this behavior should vary across liquidity groupings or credit ratings. However, if the dealer actively seeks counterparties to mitigate risk for less liquid bonds, we might expect to see the dealer dispose of his/her inventory in fewer transactions as liquidity and credit rating decreases. The number of sell transactions per dealer roundtrip is in fact consistently smaller for the least liquid categories, measured either by number of trades or cumulative volume. For example, the dealer makes an average of 2.76 sales as part of the dealer roundtrip for BBB bonds that trade over 150 times in the previous 30 days, but sells this inventory in only 1.35 transactions for BBB bonds trading 9 times or fewer in the past 30 days. This effect becomes more pronounced as the credit rating declines; dealer roundtrips for C-rated bonds in the lowest liquidity group are completed using only 1.07 transactions.

III. Pricing and Spreads

As demonstrated in Table 2, the number of transactions a dealer takes to complete a roundtrip seems to vary with both liquidity and credit risk. Since we can follow bonds from an initial dealer purchase to the subsequent disposal, and observe the transaction prices, we can estimate the dealer roundtrip cost. When the initial purchase is followed by multiple customer sales, we calculate a volume weighted average cost using those sales. We weight the price of each subsequent sale to a customer by the number of bonds of that sale divided by the total number of bonds sold to customers from that roundtrip. As such, this measure differs slightly from estimates of roundtrip trading costs reported in several prior studies using the TRACE data (including, among others, Edwards, Harris, and Piwowar (2007), and Goldstein, Hotchkiss and Sirri (2007)). The resulting spreads are quoted as per $100 of face value, and winsorized at the 1% level (weighted average spreads of less than $-2.75 or higher than $6 are removed).

In theory, the dealer roundtrip cost should be related to the risk of holding the bonds in inventory. A natural way to think about the dealer's holding period risk is to examine the liquidity of the bond in question over the prior 30 days.[6] It seems reasonable that it will take a while for a dealer to dispose of a

[6] One issue not to overlook regarding these liquidity categories: they are liquidity categories for the bond, not the dealer or the dealer in that bond. For example, when a bond is categorized as trading every three to ten days

bond that has only traded once or twice in the past 30 days. On the other hand, if a bond trades more than five times a day, the dealer should be able to sell that initial purchase to new customers more quickly. The same is expected to hold for volume: if a bond has had relatively higher volume over the past 30 days, it should be easier to offload the initial purchase.

Market microstructure models suggest that these differences in dealer risk should result in higher dealer roundtrip costs for more illiquid or riskier bonds. If, as in many such models, the dealer passively waits for customers to arrive via a Poisson process, it will take longer for a dealer to dispose of a large purchase of less liquid bonds. When dealers are exposed to greater inventory risk for more illiquid and riskier bonds, the dealer should be compensated via a higher dealer roundtrip cost. Alternatively, dealers holding illiquid and riskier bonds may provide larger discounts to attract customers. For example, dealers may provide discounts to customers who search out the dealers, as in Leach and Madhavan (1993). However, the market structure is quite different for corporate bonds than for stocks - without public quoting mechanisms, quoting discounts may not drive volume. Further, Leach and Madhavan (1993) indicate that such behavior is unlikely in a multiple dealer system. Without better theoretical guidance, the question of what dealers charge and how it might vary with illiquidity and risk is an empirical one.

Table 3 shows the mean weighted average spread by rating and liquidity category. These roundtrip spreads are of similar magnitude to those found for institutional sized trades by Edwards, Harris, and Piwowar (2007), Goldstein, Hotchkiss, and Sirri (2007), and others. Panel A reports the dealer roundtrip costs for liquidity groups based on trading frequency, which appear relatively uniform for investment grade bonds, but which increase (holding liquidity constant) as credit rating deteriorates for high yield bonds. More interestingly, the **spreads for roundtrips in bonds with the lowest prior trading frequency are as low or lower than spreads for the most liquid bonds** for all ratings above CCC. For example, for BBB bonds, the spread for bonds that trade only once every 3 to 10 days is about

(zero to ten trades in the past 30 days), this is across *all* dealers and not just for the dealer that just made the purchase. These categories therefore may overstate the liquidity experience for the individual dealer based on prior orderflow. Less actively traded bonds are more likely to involve a small number or even a single dealer, however.

0.43, but the spread on bonds that trade 30 times a day on average is higher (0.76). Holding credit rating constant, we do not observe that lower prior trading frequently is consistently associated with higher spreads.

Panel B of Table 3 shows largely similar results for liquidity based on volume. For investment grade bonds rated AAA, AA, and A, spreads appear to decrease with liquidity based on previous cumulative volume, although there is a slight uptick in spreads at the two most illiquid categories. For BBB bonds, spreads are actually lower for the least liquid category than for the most liquid, although this is not true for the high-yield bonds. However, for the BBB, BB, and B bonds, spreads are at times lower for relatively mid-level liquidity bonds than for the most liquid bonds, demonstrating somewhat of a U-shaped pattern.

To investigate these relationships more rigorously, controlling for other bond characteristics, we run regressions explaining the weighted average dealer roundtrip costs (*spread*). Since it is possible that there are notable differences based on credit rating which might be non-linear, we run a separate regression for each credit rating, as follows:

$$spread = \alpha + \beta_1 d_1 + \beta_2 d_2 + \beta_3 d_3 + \beta_4 d_4 + \beta_5 d_5 + \beta_6 d_6 + \beta_7 lsize + \beta_8 trend + \beta_9 dtc144a + \beta_{10} ttm + \beta_{11} age + \beta_{12} OfferingAmt + \beta_{13} dissem + \varepsilon$$

We include six dummy variables for the prior 30 day trade frequency (Panel A) or volume (Panel B), omitting the most liquid category. We also control for other bond characteristics shown in previous research to be related to trading costs. All specifications include the natural log of the number of bonds in the initial purchase (*lsize*) , as larger initial purchases may be harder to subsequently distribute. We include a trend variable (*trend*) based on the quarter in which the initial purchase occurs, to account for differences across time, including different transparency regimes. We also include a dummy variable (*dtc144a*) that is equal to 1 if the bond is subject to Rule 144a, and zero otherwise, and controls for the bond's time to maturity (*ttm*) and time since issuance (*age*). Since the initial offering size may affect liquidity, we also control for the original offering amount (*OfferingAmt*). Finally, we include a dummy variable (*dissem*) for whether or not the bond's transactions were publicly disseminated by TRACE.

The regression results in Panel A of Table 4 (using prior trading frequency) indicate that spreads are smaller for the less liquid categories than the most liquid group in general, and particularly for the BBB, BB, and B rated bonds. Overall, however, the coefficients across liquidity groups are not monotonic. The results in Panel B for liquidity based on previous trading volume suggests that while spreads for the most liquid group are smaller than those for the six less liquid categories for investment grade bonds rated AAA, AA, and A, this is not true for bonds rated BBB and below. Even for the three A ratings, the coefficients on the liquidity dummies are not uniformly positive and are not monotonically increasing or decreasing with liquidity.

The results in Tables 3 and 4 suggest that dealers are not uniformly either raising or lowering costs based on liquidity. In fact, the results in Tables 3 and 4 suggest that *realized* roundtrip spreads do not vary much with liquidity for highly illiquid bonds, measured either by trading frequency or cumulative volume. This result may therefore explain why previous research relating measures of secondary market liquidity to secondary market yield spreads on corporate bonds find somewhat mixed results depending on the measures used (see, for instance, Bao, Pan, and Wang (2009), Chen, Lesmond, and Wei (2007), Dick-Nielsen, Feldhutter, and Lando (2009)), although many of these papers examine much more liquid bonds than the ones here due to their data requirements of multiple trades per day. To the extent that roundtrip spreads do not vary with liquidity, it is unlikely that roundtrip spreads would be priced into yield spreads. The mitigating techniques of the dealers to reduce their risk by reducing holding period by searching for customers should result in an optimal and relatively constant cost, resulting in a relatively constant roundtrip spread, as we find here.

IV. Holding periods

Our results to this point raise an intriguing question which we further explore - how is it possible that dealer roundtrip spreads do not vary consistently with liquidity? One possibility is that dealers adjust their holding period to mitigate inventory risk. We therefore examine dealers' holding periods and how they vary across liquidity groupings and credit ratings. As before, a dealer holding period begins when

the dealer buys an institutional size of more than 100 bonds from a customer, and we track these sales to multiple customers. The holding period is how long it takes for the dealer to dispose of the purchase to his/her customers.[7]

Table 5 reports the mean weighted average holding period for dealer purchases of over 100 bonds by rating and liquidity category. We first calculate the number of days from initial purchase to the subsequent sale to any. Roundtrips where the buy and sell dates are the same are treated as having a holding period of zero days. Then, the holding period for all sales that are part of the total roundtrip are weighted by the number of bonds that were sold on that day to develop a weighted average holding period for the roundtrip. Holding periods for roundtrips are then averaged within rating and prior liquidity groups. Roundtrip calculated as greater than 60 days are excluded, as it is likely we have not identified the full roundtrip. Any holding period in excess of 30 days is given a holding period value of 31 days.

Panel A of Table 5 shows the holding period across ratings and liquidity categories based on prior trading frequency. Interestingly, holding periods are much longer for investment grade bonds than for high-yield bonds. For investment grade bonds, for all but the most liquid category, the holding periods average 8 to 9 days, while for high-yield bonds, the holding period is averages about five days for BB bonds and drops to two days for CC and C bonds. Overall, the **holding period appears to decrease as credit risk increases**.

Within credit rating groups, holding periods are strikingly similar across liquidity categories, even though liquidity varies tremendously. For example, the least liquid category does not have the longest holding period; the same finding holds for all credit rating groups except for AA bonds. Among bonds rated BBB, the least liquid category has a holding period of 8.89 days, which is less than the holding period length of 9.48 days for BBB bonds that trade every twice as much (trading every 2 to 3 days), or even the holding period of 9.00 days for BBB bonds that trade about once a day. For high yield bonds, the story is even stronger. For BB bonds, the holding period of the least frequently traded category is less

[7] We also examine holdings periods up to the time when a dealer has sold at least 75% of their initial position, and find similar relationships of holding period to prior trading liquidity.

than all other categories except for those that trade over 3 times per day; for all other high yield bonds, the least liquid bond category has a shorter holding period than all bonds except those in the most liquid category.

Further examination of the data suggests that as credit rating deteriorates, holding periods are not monotonically decreasing with liquidity. Importantly, we also observe that holding period does not decline with trading frequency, but appears relatively constant. Using volume instead of trading frequency gives similar, if not stronger, results. Panel B of Table 5 examines liquidity based on cumulative volume over the past 30 days across all dealers. Again, there is a difference between investment grade and high yield bonds; investment grade holding periods are around 7 to 8 days, while high yield bond holding periods drop from about five days for BB bonds to two to three days for CC and C bonds.

Results for the holding period across liquidity groups based on volume are more striking. Panel B indicates that the least liquid group (150 bonds or less over the previous 30 days) has a holding period similar to and often less than almost all other liquidity categories for investment grade bonds. For example, the 7.96 day holding period for A rated bonds that only traded 150 bonds or less over the previous 30 days is about the same as the holding period for A rated bonds that traded over ten times that amount. For high yield bonds, the volume results are most dramatic. High yield bonds whose cumulative volume in the prior 30 days is less than 150 bonds have a lower average holding period than even the most liquid bonds. In fact, once again, holding periods increase with liquidity groups before they again decrease. In addition, holding periods once again do not vary with what one might expect based on cumulative volume.

These findings are consistent with our conjecture that dealers actively mitigate their risk by managing their holding periods. Rather than passively waiting for customers to arrive, dealers may actively search out counterparties as suggested in Duffie, Garleanu, and Pedersen (2005). Although such search is costly, it may be more beneficial as liquidity decreases or default probability increases.

To further investigate this possibility, Table 5a examines the percentage of dealer roundtrips completed on the *same* day. As before, Panel A examines prior liquidity based on trading frequency, while Panel B categorizes roundtrips based on prior trading volume. Again, for both panels, there are far greater differences between investment grade and high yield than there are across liquidity groups. For investment grade bonds, about 33% of round trips are completed within the same day, while for high-yield bonds, the rate rises to about 50% for BB bonds and to about 75% for the CC and C bonds. Still, within a rating category, there is little variation, regardless of whether the bond trades once every 10 days or thirty times per day. For the high yield categories, and even for credit ratings A and BBB, the least liquid bonds have *more* roundtrips completed in a day that even the most active bonds.[8]

Since the number of roundtrips completed in the same day does not seem to vary across liquidity groups, it seems clear that the dealers must be engaging in some sort of optimal search behavior to find the opposing side of a trade. The relationship of holding period and credit rating is also consistent with dealers engaging in search for customers to serve as counterparties. Our interpretation to this point is, however, based on univariate statistics, and it is possible that there are some uncontrolled differences across these categories.

To examine this issue, we create an "expected" holding period based on either the number of trades or the volume in the bond over the past 30 days. For the number of trades, to get an expected holding period, we divide the number of trades in the past 30 days into 30 - the expected holding period is therefore how many days we expect to wait for another trade. This calculation implicitly assumes that the entire transaction can be completed in the next trade. While this is a strong assumption, the data in Table 2 and Table 5a indicate that this is frequently the case. More importantly, it is a conservative estimate of expected holding period; if we used the data from Table 2, we would generate longer expected holding periods, as it should take more than one transaction to complete the roundtrip. To get an expected holding

[8] The one exception is in Panel A for BBB bonds, where 42% of the least liquid bonds (0-10 trades in the past 30 days) complete their roundtrips on the same day, while it is 44% for the most liquid bonds (more than 5 trades per day). However, Panel B indicates that in terms of volume, the least liquid BBB bonds have a slightly higher same-day roundtrip percentage (43%) than the most liquid (42%).

period for volume, we divide 30 by the cumulative volume over the past 30 days. We then take the difference between the actual holding period (truncated at 31 days) and the expected holding period, which becomes our dependent variable *dexhp2*.

We also control for other bond characteristics and include the six dummy variables for liquidity, corresponding to the appropriate liquidity categories, omitting the most liquid category as before. Since Table 5 also indicates notable differences based on credit rating which appear to be non-linear, we run a separate regression for each credit rating:

$$dexhp2 = \alpha + \beta_1 d_1 + \beta_2 d_2 + \beta_3 d_3 + \beta_4 d_4 + \beta_5 d_5 + \beta_6 d_6 + \beta_7 lsize + \beta_8 trend + \beta_9 dtc144a + \beta_{10} ttm + \beta_{11} age + \beta_{12} OfferingAmt + \beta_{13} dissem + \varepsilon$$

Table 6 shows the difference between the expected and actual weighted average holding periods. Interestingly, the results in Table 6 both for trading frequency (Panel A) and volume (Panel B) indicate that, after including the controls, the difference between the expected holding period and the actual holding periods for the least liquid bonds is less than that for the most liquid bonds. As credit rating deteriorates in the high-yield group, this becomes true also for the next least liquid bonds. In addition, the effects are non-monotonic across liquidity groups for investment grade bonds. While there is little monotonicity for high yield bonds in Panel A based on trading frequency, there is some evidence for the high yield bonds in Panel B that as a bond gets more liquid as measured by volume, the difference between expected and actual increases slightly.

Beyond this, the control variables have signs as expected. Across both panels and all credit ratings, the difference is statistically significantly negatively related to size. Besides the AAA bonds, there is some evidence of a trend over time. Being a 144a bond matters but the sign varies for Panel A; for Panel B, it is generally negatively related except for AAA and CC bonds, both of which have fewer observations. Time to maturity and age also generally seem to matter and have the opposite signs. Generally speaking, dissemination appears to increase the difference, but less so for lower credit ratings.

Overall, Tables 5, 5a, and 6 indicate that holding period does not vary with liquidity in a way that suggests that the dealers passively waiting for customers to arrive. Instead, the holding period results imply that dealers engage in search to find clients to manage and reduce their risk, as suggested by Duffie, Garleanu, and Pedersen (2005). It appears that dealers actively engage in search more when liquidity is lower, and that this search results in relatively uniform holding periods across liquidity regimes. Even so, holding periods are not monotonic or uniform across liquidity; instead, holding periods appear somewhat U shaped. Dealers are more likely to engage in search and reduce holding periods for high yield bonds than for investment grade bonds, and within high yield, they are more likely to reduce their holding period the worse the credit quality of the bond.

V. Sell Ratios

Another final measure of dealer activity we examine is how much of the initial purchase is ultimately sold to another customer within a fixed time window. We therefore examine the percentage of the initial purchase of bonds by the dealer that is ultimately sold to a customer by examining the sell-ratio for each round trip. The sell ratio is the ratio of the volume of all subsequent customer sells by the dealer related to this roundtrip divided by the volume of the initial purchase from a customer by the dealer that started the roundtrip. *Ex ante*, there is no reason why this sell ratio should vary either by liquidity group or by credit rating.

Table 7 examines sell ratios for these roundtrips by credit rating and liquidity groups. As in Table 5, Panel A again uses the same trading frequency liquidity groups; Panel B uses the same cumulative volume groupings as in Table 5. These two panels show similar results. For investment grade bonds, the sell ratio is highest for the least liquid groups at around 84%, and sell ratios monotonically decrease as liquidity increases to around 50% based on the number of transactions (Panel A) and 60% based on volume (Panel B). These results are similar for high-yield bonds, but as credit deteriorates, the sell ratio increases. In fact, for CC bonds, the sell ratio is 94% for the least liquid bonds in both panels and 76% (Panel A) to 78% (Panel B) for the most liquid bonds. Based on the results from Table 7, it

again appears that dealers seem to be searching out customers more for less liquid and lower rated bonds, further confirming the inferences from Tables 5, 5a, and 6.

As with our other measures of dealer behavior, we also run multivariate regressions explaining the sell ratio. As the dependent variable (*sellratio*) is a variable that only can go from 0 to 1, and many observations have a sell ratio of 1, we run a censored regression.

Table 8 contains the results for the censored regressions for the sell ratio, with a lower bound of 0 and an upper bound of 1. Panel A provides liquidity categories by trading frequency; Panel B provides liquidity categories by cumulative volume. As in Table 6, the most liquid category in either Panel A or B has not been dummied out, so all results are relative to the most liquid bonds. The results of both panels suggest that even after controlling for the variety of factors (initial transaction size, time trend, 144a, maturity, age of the bond, offering amount, and whether the bond's prices are disseminated) sell ratios for the least liquid groups are higher than for the most liquid category. In both panels, across investment grade and high yield bonds, the coefficients on the liquidity dummies are positive and monotonically decreasing as liquidity increases. While not as pronounced as in Table 5, the magnitude of the coefficients for the high yield bonds are generally larger than those for investment grade bonds. Overall, the results in this regression support those in Table 5.

Overall, Tables 7 and 8 indicate that dealers more frequently offload their inventory to customers for less liquid and lower credit quality bonds. Combined with the results in Tables 2, 5, 5a, and 6, these results suggest that dealers actively search for customers and reduce their holding period risk. Such behavior can explain the relative stability of the dealer roundtrip costs across liquidity categories shown in Tables 3 and 4.

VI. 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 a given dealer, trading is even less frequent.

Little is known about dealer behavior in assets that trade rarely. Standard market microstructure models, which model dealers as passive order takers waiting for customers to arrive, suggest that for very infrequently traded assets dealers would have to hold the asset in inventory for a long time; this would subject the dealer to price risk associated with long holdings, and likely require a large bid-ask spread to compensate for this risk.

Using a unique dataset, we analyze dealer behavior in these highly illiquid risky assets. We match an initial dealer institutional size purchase of 100 bonds or more from a customer with the dealer's subsequent sales to other customers. In contrast to the expectations of the standard models, we find that dealer roundtrip spreads for initial purchases of institutional size illiquid bonds are less than those of much more frequently traded bonds, despite vast differences in liquidity.

Further examination indicates that for a given credit rating, the average dealer holding period does not vary substantially. However, average dealer holding periods are notably shorter (almost half) for lower rated, more risky bonds. Despite the decreased liquidity, dealers appear to sell more of their initial purchase of illiquid bonds to other customers on the same day that the dealers purchased the bonds than they do for more liquid bonds, and overall they are more able to sell their purchase of illiquid bonds to other customers than their purchases of liquid bonds. Collectively, these results suggest that dealers actively manage their inventory risk in illiquid assets in such a way so as to keep their overall inventory risk relatively constant regardless of the natural liquidity of the bond.

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Figure 1:
Median Number of Trades per Month

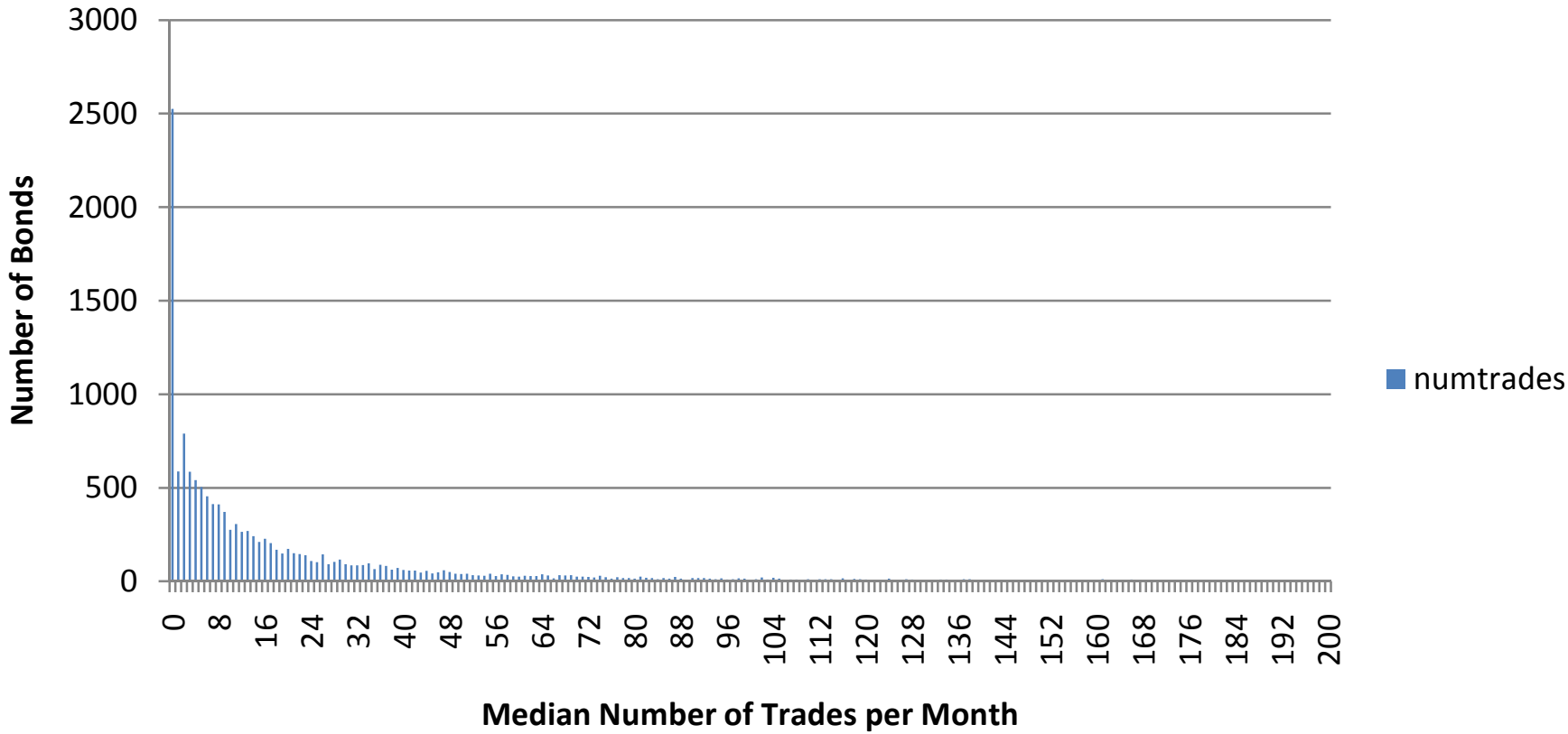

Table 1
Summary Statistics

This table presents summary statistics on the bonds in this sample by rating. Rating for each bond is the rating of the bond at the time a customer-dealer-customer (CDC) chain was created by the dealer purchasing an institutional size amount (100+) bonds from a customer; the rating then averaged across all CDCs for that bond. Panel A shows the number of bonds, the percent of bonds that are 144a, and the mean number of CDCs per bond for that rating. Issue size, Time to Maturity, and Age of the bond are first averaged across CDCs for a bond, then averaged across all cusips with that rating. Panels B and C show the number of bonds whose median number of trades (or volume) falls in the respective liquidity categories

	Investment Grade				High-Yield				
	AAA	AA	A	BBB	BB	B	CCC	CC	C
A. Average Summary Statistics by bond									
Number of Bonds	446	892	3318	4174	1588	2539	1386	331	75
144a	12%	12%	9%	11%	18%	29%	25%	4%	11%
# of CDCs per bond	109	141	109	95	113	84	94	57	25
Issue size	288,207	794,391	424,443	391,216	356,916	311,048	270,017	323,678	319,445
Time to Maturity	13.0	7.5	9.9	10.2	9.0	6.8	6.3	6.0	5.7
Age of bond	6.7	4.7	5.5	4.5	4.2	3.0	3.8	5.6	5.6
B. Number of bonds by rating based on median number of trades per month									
3 to 10 days	251	345	1,443	2,324	703	1,219	680	222	54
2-3 days	66	113	492	708	250	433	201	27	12
about 1 day	47	127	552	496	264	412	177	31	4
1 -2 per day	29	60	211	167	114	145	85	13	3
2-3 per day	24	48	186	136	97	94	78	8	1
3-5 per day	18	58	161	130	70	77	55	14	1
30 per day	10	134	244	157	52	55	52	16	0
C. Number of bonds by rating based on median volume per month									
150 or less	208	144	719	1,037	317	508	317	140	33
150 - 500	71	38	192	291	63	62	34	14	1
501 - 1500	47	67	289	357	61	108	53	20	2
1501 - 2500	11	29	175	201	81	104	46	14	3
2501 - 3500	10	21	157	140	54	82	48	6	3
3501 - 5500	19	55	227	215	94	173	77	22	4
more than 5500	79	531	1,530	1,877	880	1,398	753	115	29

Table 2
Summary Statistics for Dealer Purchases from a customer and then sold to (multiple) customer(s) -- CDCs
Number of Dealer Purchase Groups and Average Number of Customer Sales per Dealer Purchase Group by Rating

This table presents summary statistics on customer-dealer-customer (CDC) round trip groupings for a single initial purchase of more than 100 bonds from a customer by an individual dealer that is later sold to one or more other customers. Although the individual dealer bought the bonds in a single transaction with a single customer, the dealer may then turn around and sell the bonds over multiple trades to multiple customers, so that each purchase may or may not have multiple sales. Each purchase is then catagorized by the size of the intial purchase, the credit rating of the bond at the time of purchase and a liquidity bucket for that bond over the previous 30 days. Num is the number of observations of a customer-dealer-customer purchase/sale combination per retail/institutional, credit rating, and liqudity category. Avg is the average number of sales to a customer that was matched to a dealer purchase per observation in that size, liqudity, and rating group. Panel A shows the data for liquidity buckets based on the trading frequency (number of trades in the past 30 days, so one trade every 3 to 10 days, etc.); Panel B shows liquidity buckets based on volume in the past 30 days.

Liquidity	Investment Grade								High-Yield									
Group	AAA		AA		A		BBB		BB		B		CCC		CC		C	
	Num	avg	Num	avg	Num	avg	Num	avg	Num	avg	Num	avg	Num	avg	Num	avg	Num	avg
A. Trading Frequency (number of trades over the previous 30 days)																		
3 to 10 days	1,736	1.40	4,648	1.37	16,909	1.41	27,761	1.35	11,747	1.24	22,114	1.16	10,598	1.15	1,528	1.14	493	1.11
2-3 days	974	1.44	3,679	1.46	14,119	1.55	21,508	1.44	12,084	1.28	22,630	1.20	9,387	1.18	920	1.15	419	1.15
about 1 day	1,122	1.75	5,304	1.59	22,319	1.64	28,488	1.51	19,663	1.30	33,751	1.25	14,834	1.20	1,580	1.17	604	1.19
1 -2 per day	814	2.10	3,909	1.81	14,310	1.79	15,951	1.62	12,875	1.37	21,203	1.30	9,773	1.23	1,400	1.23	507	1.17
2-3 per day	952	2.08	4,462	1.92	15,714	1.84	15,502	1.69	12,192	1.46	18,905	1.34	10,564	1.27	1,836	1.27	573	1.38
3-5 per day	1,164	2.69	7,592	2.01	21,857	1.87	18,319	1.82	12,174	1.63	18,711	1.40	13,452	1.36	2,979	1.27	875	1.28
30 per day	2,264	2.51	30,345	2.06	57,305	2.15	69,706	2.76	25,008	2.03	36,983	1.73	29,486	1.52	9,081	1.31	3,286	1.27
B. Cumulative Volume (previous 30 days)																		
150 or less	1,039	1.95	2,170	1.59	9,913	1.71	10,538	1.52	3,189	1.37	4,253	1.25	2,473	1.21	529	1.14	136	1.07
150 - 500	925	1.99	3,521	1.75	13,157	1.85	8,534	1.81	3,339	1.57	4,722	1.33	1,389	1.35	247	1.19	97	1.23
501 - 1500	1,550	2.13	7,974	1.91	26,252	1.81	19,783	1.79	12,470	1.51	21,969	1.29	6,244	1.30	857	1.22	286	1.22
1501 - 2500	1,077	1.96	6,553	1.90	19,153	1.86	17,084	1.74	13,683	1.49	24,822	1.32	9,427	1.33	1,170	1.26	324	1.60
2501 - 3500	774	2.05	5,938	1.90	14,721	1.81	14,685	1.82	12,040	1.45	21,782	1.35	10,029	1.33	1,175	1.29	309	1.18
3501 - 5500	1,009	1.99	9,196	1.93	21,676	1.87	23,647	1.77	17,330	1.48	30,699	1.38	18,161	1.31	2,443	1.27	741	1.22
more than 5500	2,652	2.06	24,587	1.93	57,661	1.90	102,964	2.18	43,692	1.60	66,050	1.42	50,371	1.33	12,903	1.27	4,864	1.24

Table 3
Weighted Average Spread for Dealer Purchases from a customer and then sold to (multiple) customer(s)

This table presents the weighted average spread between the transaction price on an initial purchase of more than 100 bonds by a dealer from a customer and the price paid when the dealer later sells that same bond to other customers. Although the dealer bought the bonds in a single transaction with a single customer, the dealer may then turn around and sell the bonds over multiple trades to multiple customers, so that each purchase may or may not have multiple sales. Each purchase has a weighted average spread, where the weights are the spread (difference between the purchase price and the sale price) for that specific sale weighted by the number of bonds sold divided by the total number of bonds sold to customers across all sales associated with that purchase. Observations were winsorized at the 1% level so that weighted average spreads of less than -2.75 or more than 6 were removed. Each purchase is then catagorized by the credit rating of the bond at the time of purchase and a liquidity bucket for that bond based on the trading frequency (Panel A) or cumulative volume (Panel B) for that bond over the previous 30 days prior to the initial purchase. Then a simple average is taken of the cumulative sell ratios per credit rating and liqudity category.

Liquidity	Investment Grade				High-Yield				
Group	AAA	AA	A	BBB	BB	B	CCC	CC	C
A. Trading Frequency (number of trades over the previous 30 days)									
3 to 10 days	0.35	0.26	0.39	0.43	0.47	0.46	0.59	0.67	0.62
2-3 days	0.31	0.23	0.34	0.38	0.42	0.40	0.50	0.62	0.53
about 1 day	0.42	0.25	0.34	0.36	0.39	0.40	0.48	0.63	0.65
1 -2 per day	0.41	0.27	0.37	0.37	0.42	0.40	0.46	0.68	0.59
2-3 per day	0.41	0.30	0.35	0.38	0.44	0.43	0.48	0.63	0.65
3-5 per day	0.44	0.29	0.34	0.42	0.49	0.48	0.53	0.57	0.63
30 per day	0.58	0.33	0.41	0.76	0.65	0.61	0.57	0.63	0.48
B. Cumulative Volume (previous 30 days)									
150 or less	0.64	0.38	0.50	0.54	0.59	0.55	0.73	0.77	0.65
150 - 500	0.53	0.29	0.43	0.48	0.58	0.49	0.68	0.76	0.66
501 - 1500	0.37	0.34	0.36	0.46	0.50	0.44	0.57	0.69	0.59
1501 - 2500	0.36	0.33	0.34	0.44	0.47	0.46	0.55	0.73	0.74
2501 - 3500	0.40	0.30	0.35	0.45	0.46	0.46	0.56	0.66	0.61
3501 - 5500	0.44	0.28	0.34	0.45	0.47	0.46	0.54	0.63	0.63
more than 5500	0.40	0.28	0.37	0.57	0.48	0.47	0.49	0.60	0.51

Table 4
Weighted Average Spread Regressions -- CDCs

This table presents regressions on the weighted average spread of an initial purchase of more than 100 bonds by a dealer from a customer that is later sold to other customers. The weighted average spread is defined and classified as in Table 7. In Panel A, dummy variables for liquidity groups based on the number of trades in the previous 30 days are as follows: d1 (0-9), d2 (10-19), d3 (20-40); d4 (41-60), d5 (61-90), d6 (91-150). (Bond with 150+ trades are not dummied and are captured by the intercept.) In Panel B, dummy variables for cumulative volume is as shown (observations with cumulative volume in excess of 5500 bonds are not dummied and are captured by the intercept.) Lsize is the natural log of the dealer's initial purchase of bonds. Trend is a time variable by quarter. Dtc144a is a dummy variable that is 1 if the bond is subject to Rule 144a and 0 otherwise. Ttm is time to maturity in days. Age is time since maturity in days. Offering Amount is the face value of the original issue of the bonds. Dissem is a dummy variable that is 1 if the bond is disseminated through TRACE, and 0 otherwise.

	Investment Grade				High-Yield				
	AAA	AA	A	BBB	BB	B	CCC	CC	C
Panel A:	Trading Frequency (number of trades over the previous 30 days)								
Intercept	1.42 ***	1.01 ***	1.33 ***	1.85 ***	1.81 ***	1.70 ***	2.10 ***	2.09 ***	1.75 ***
3 to 10 days	-0.24 ***	0.01	-0.09 ***	-0.22 ***	-0.26 ***	-0.22 ***	0.00	0.08 **	-0.01
2-3 days	-0.26 ***	-0.03 **	-0.13 ***	-0.30 ***	-0.31 ***	-0.25 ***	-0.07 ***	0.01	-0.10
about 1 day	-0.25 ***	-0.07 ***	-0.14 ***	-0.33 ***	-0.32 ***	-0.24 ***	-0.09 ***	0.00	0.01
1 -2 per day	-0.24 ***	-0.07 ***	-0.11 ***	-0.34 ***	-0.29 ***	-0.23 ***	-0.09 ***	0.06 *	-0.04
2-3 per day	-0.22 ***	-0.04 ***	-0.11 ***	-0.32 ***	-0.26 ***	-0.19 ***	-0.06 ***	0.00	0.05
3-5 per day	-0.18 ***	-0.03 ***	-0.09 ***	-0.28 ***	-0.21 ***	-0.13 ***	-0.02 **	-0.05 **	0.08 *
lsize	-0.10 ***	-0.09 ***	-0.11 ***	-0.16 ***	-0.14 ***	-0.13 ***	-0.18 ***	-0.18 ***	-0.13 ***
trend	-0.03 ***	0.02 ***	0.00	-0.05 ***	-0.03 ***	-0.04 ***	-0.04 ***	-0.05 ***	0.01
dtc144a	-0.28 ***	-0.36 ***	-0.36 ***	-0.12 ***	-0.12 ***	-0.07 ***	-0.12 ***	-0.03	-0.19 **
ttm	0.06 ***	0.07 ***	0.06 ***	0.05 ***	0.03 ***	0.03 ***	0.01 ***	0.01 *	-0.01 *
age	0.04 ***	-0.01 **	0.01 ***	0.03 ***	0.04 ***	0.06 ***	0.04 ***	0.01	0.00
Offering Amt	-3.04 ***	-0.35	-5.70 ***	-3.41 ***	-9.83 ***	-10.11 ***	-6.93 ***	-3.94 **	-8.71 *
dissem	-0.29 ***	-0.35 ***	-0.34 ***	-0.21 ***	-0.18 ***	-0.16 ***	-0.21 ***	-0.08 ***	-0.29 ***
Adj R^2	13.8%	11.8%	10.2%	12.9%	9.5%	8.0%	8.7%	5.3%	3.3%
N	8,940	58,770	158,543	192,332	103,463	170,650	95,276	18,601	6,370
Panel B:	Cumulative Volume (over the past 30 days)								
Intercept	1.23 ***	0.93 ***	1.26 ***	1.69 ***	1.68 ***	1.61 ***	2.07 ***	2.07 ***	1.75 ***
150 or less	0.15 ***	0.12 ***	0.10 ***	0.09 ***	0.01	-0.04 ***	0.13 ***	0.17 ***	0.01
150 - 500	0.07 *	0.05 ***	0.06 ***	-0.02 *	-0.09 ***	-0.12 ***	0.02	0.03	-0.03
501 - 1500	-0.04	0.08 ***	0.00	-0.05 ***	-0.12 ***	-0.13 ***	-0.04 ***	-0.02	-0.08
1501 - 2500	-0.06 *	0.05 ***	-0.02 **	-0.06 ***	-0.12 ***	-0.10 ***	-0.03 ***	0.06 *	0.04
2501 - 3500	0.03	0.03 **	-0.01	-0.06 ***	-0.10 ***	-0.08 ***	-0.01	0.01	-0.04
3501 - 5500	0.05	0.01	-0.02 ***	-0.07 ***	-0.07 ***	-0.05 ***	0.00	0.01	0.01
lsize	-0.11 ***	-0.09 ***	-0.11 ***	-0.16 ***	-0.15 ***	-0.14 ***	-0.18 ***	-0.18 ***	-0.13 ***
trend	-0.03 ***	0.02 ***	0.00 **	-0.07 ***	-0.04 ***	-0.05 ***	-0.05 ***	-0.06 ***	0.01
dtc144a	-0.33 ***	-0.33 ***	-0.38 ***	-0.13 ***	-0.17 ***	-0.09 ***	-0.12 ***	-0.02	-0.21 **
ttm	0.05 ***	0.07 ***	0.06 ***	0.05 ***	0.03 ***	0.02 ***	0.00 ***	0.01 **	-0.01 **
age	0.03 ***	-0.02 ***	-0.01 ***	0.03 ***	0.04 ***	0.07 ***	0.05 ***	0.01	0.00
Offering Amt	1.95 **	2.85 ***	-1.46 ***	3.42 ***	-3.44 ***	-5.23 ***	-4.88 ***	-3.88 **	-8.62 *
dissem	-0.30 ***	-0.34 ***	-0.33 ***	-0.17 ***	-0.15 ***	-0.14 ***	-0.20 ***	-0.07 ***	-0.29 ***
Adj R^2	13.8%	11.8%	10.1%	11.9%	8.6%	7.5%	8.7%	5.3%	3.2%
N	8,940	58,770	158,543	192,332	103,463	170,650	95,276	18,601	6,370

Table 5

Mean Weighted Average Holding Period for Dealer Purchases from a customer and then sold to (multiple) customer(s) -- CDCs

This table presents the weighted average number of days that a dealer holds in inventory an initial purchase of more than 100 bonds from a customer that is later sold to other customers (CDCs). Although the dealer bought the bonds in a single transaction with a single customer, the dealer may then turn around and sell the bonds over multiple trades to multiple customers, so that each purchase may or may not have multiple sales. Each purchase has a weighted average holding period, where the weights are the holding period for that specific sale weighted by the number of bonds sold divided by the total number of bonds sold to customers across all sales associated with that purchase. Each purchase is then catagorized by the size of the intial purchase, the credit rating of the bond at the time of purchase and a liquidity bucket for that bond based on the number of trades (Panel A) or volume (Panel B) in that bond over the previous 30 days. Then a simple average is taken of the weighted average holding periods per retail/institutional, credit rating, and liqudity category.

Liquidity	Investment Grade				High-Yield				
Group	AAA	AA	A	BBB	BB	B	CCC	CC	C
A. Trading Frequency (number of trades over the previous 30 days)									
3 to 10 days	6.57	8.94	8.58	8.89	4.87	3.62	2.99	2.10	2.46
2-3 days	7.59	8.48	9.11	9.48	5.68	4.42	3.74	2.29	2.71
about 1 day	7.82	8.05	8.84	9.00	6.02	4.94	4.18	2.79	3.24
1 -2 per day	7.00	8.45	8.50	8.13	5.97	4.84	3.84	2.98	2.62
2-3 per day	6.23	7.60	7.59	7.35	5.46	4.47	3.68	3.27	2.68
3-5 per day	7.09	7.49	7.07	6.58	4.73	3.89	3.35	3.17	2.94
30 per day	4.01	5.10	5.38	3.40	3.07	2.66	2.46	2.35	2.26
B. Cumulative Volume (previous 30 days)									
150 or less	5.64	7.96	7.96	8.11	4.10	3.02	2.48	2.12	2.31
150 - 500	7.12	7.50	8.50	8.57	5.19	3.97	3.26	2.49	3.20
501 - 1500	7.22	7.62	8.19	8.38	5.30	4.53	3.84	2.74	3.41
1501 - 2500	6.08	7.17	7.95	8.42	5.69	4.66	4.02	2.49	2.65
2501 - 3500	7.62	6.91	7.83	8.19	5.60	4.75	4.09	2.68	3.84
3501 - 5500	7.19	6.41	7.24	8.01	5.71	4.48	3.84	3.07	2.71
more than 5500	4.98	5.79	5.97	5.15	4.15	3.29	2.78	2.56	2.37

Table 5a - zero day Holding periods
Percentage of Dealer Purchases from a customer and then sold to (multiple) customer(s) completed on the SAME day -- CDCs

This table presents the percentage of observations where the dealer bought more than 100 bonds from a customer and then sold it off to multiple customers on the same day. Specifically, this table shows the percentage of observations where the weighted average number of days that a dealer holds in inventory an initial purchase of bonds from a customer that is later sold to other customers (CDCs) was zero. Although the dealer bought the bonds in a single transaction with a single customer, the dealer may then turn around and sell the bonds over multiple trades to multiple customers, so that each purchase may or may not have multiple sales. Each purchase has a weighted average holding period, where the weights are the holding period for that specific sale weighted by the number of bonds sold divided by the total number of bonds sold to customers across all sales associated with that purchase. Each purchase is then catagorized by the size of the intial purchase, the credit rating of the bond at the time of purchase and a liquidity bucket for that bond based on the number of trades in that bond over the previous 30 days.

Liquidity	Investment Grade				High-Yield				
Group	AAA	AA	A	BBB	BB	B	CCC	CC	C
A. Trading Frequency (number of trades over the previous 30 days)									
3 to 10 days	49%	37%	40%	42%	63%	69%	74%	84%	81%
2-3 days	40%	33%	34%	37%	56%	62%	67%	81%	76%
about 1 day	39%	32%	31%	36%	50%	56%	61%	75%	73%
1 -2 per day	35%	28%	30%	35%	47%	53%	59%	68%	76%
2-3 per day	34%	29%	30%	36%	46%	53%	60%	65%	70%
3-5 per day	27%	28%	31%	37%	48%	52%	59%	61%	63%
30 per day	36%	32%	33%	44%	52%	57%	62%	64%	63%
B. Cumulative Volume (previous 30 days)									
150 or less	51%	36%	37%	43%	67%	74%	80%	86%	82%
150 - 500	36%	31%	29%	37%	59%	66%	72%	81%	74%
501 - 1500	32%	29%	30%	36%	54%	60%	64%	78%	73%
1501 - 2500	38%	29%	30%	36%	51%	57%	62%	74%	75%
2501 - 3500	33%	29%	31%	36%	50%	55%	61%	73%	70%
3501 - 5500	36%	31%	32%	37%	48%	55%	61%	69%	72%
more than 5500	39%	34%	36%	42%	51%	57%	62%	64%	65%

Table 6
Difference between Expected and Actual Weighted Average Holding Periods -- CDCs

This table presents regressions on the difference between the weighted average holding period of a dealer's initial purchase of bonds from a customer that is later sold to other customers (CDCs) and the expected holding period. Holding period is defined and classified as in Table 3. The expected holding period is calculated based on the number of trades (volume) for that particular bond in the 30 days prior to the day of the intial purchase by the customer that starts the CDC chain. In Panel A, dummy variables for liquidity groups based on the number of trades in the previous 30 days are as follows: d1 (0-9), d2 (10-19), d3 (20-40); d4 (41-60), d5 (61-90), d6 (91-150). (Observations with 150+ trades are not dummied and are captured by the intercept.) In Panel B, dummy variables for cumulative volume is as shown (observations with cumulative volume in excess of 5500 bonds are not dummied and are captured by the intercept.) Lsize is the natural log of the dealer's initial purchase of bonds. Trend is a time variable by quarter. Dtc144a is a dummy variable that is 1 if the bond is subject to Rule 144a and 0 otherwise. Ttm is time to maturity in days. Age is time since maturity in days. Offering Amount is the face value of the original issue of the bonds. Dissem is a dummy variable that is 1 if the bond is disseminated through TRACE, and 0 otherwise.

	Investment Grade				High-Yield				
	AAA	AA	A	BBB	BB	B	CCC	CC	C
Panel A:	Trading Frequency (number of trades over the previous 30 days)								
Intercept	6.82 ***	5.77 ***	6.68 ***	7.64 ***	8.29 ***	7.56 ***	8.55 ***	7.65 ***	6.79 ***
3 to 10 days	-13.08 ***	-9.02 ***	-9.23 ***	-7.90 ***	-9.58 ***	-9.58 ***	-11.16 ***	-13.72 ***	-12.95 ***
2-3 days	-0.31	1.41 ***	1.28 ***	2.99 ***	-0.02	-0.41 ***	-0.64 ***	-1.81 ***	-1.62 ***
about 1 day	1.62 ***	2.05 ***	2.09 ***	3.69 ***	1.40 ***	1.15 ***	0.83 ***	-0.34 *	-0.15
1 -2 per day	1.51 ***	2.60 ***	2.26 ***	3.48 ***	1.81 ***	1.55 ***	1.05 ***	0.32	-0.30
2-3 per day	1.07 **	1.75 ***	1.73 ***	3.02 ***	1.60 ***	1.50 ***	1.07 ***	0.76 ***	-0.01
3-5 per day	1.75 ***	1.72 ***	1.35 ***	2.47 ***	1.21 ***	1.16 ***	0.86 ***	0.74 ***	0.37
lsize	-0.42 ***	-0.33 ***	-0.49 ***	-0.65 ***	-0.82 ***	-0.92 ***	-0.97 ***	-0.82 ***	-0.64 ***
trend	-0.24 ***	0.26 ***	0.11 ***	0.07 ***	0.15 ***	0.16 ***	0.06 ***	0.03	-0.03
dtc144a	4.28 ***	0.71 **	-1.65 ***	-2.45 ***	-1.35 ***	-0.63 ***	-0.97 ***	-0.54 **	0.27
ttm	-0.22 ***	0.19 ***	0.13 ***	0.02 ***	0.06 ***	0.09 ***	0.16 ***	0.11 ***	-0.06 **
age	-0.30 ***	-0.90 ***	-0.62 ***	-0.37 ***	-0.35 ***	-0.06 ***	-0.36 ***	-0.24 ***	-0.09
Offering Amt	-37.26 ***	-62.33 ***	-85.27 ***	-71.75 ***	-54.27 ***	5.99	13.39 **	28.70 **	-6.65
dissem	2.51 ***	1.61 ***	2.50 ***	1.08 ***	0.62 ***	0.41 ***	0.20 ***	0.00	0.52
Adj R^2	24.1%	11.5%	13.5%	15.4%	16.1%	18.2%	22.0%	27.5%	22.9%
N	9,007	59,091	160,524	196,289	105,470	174,183	98,052	19,314	6,743
Panel B:	Cumulative Volume (over the past 30 days)								
Intercept	630.72 ***	421.58	1045.83 ***	419.59 ***	242.33 ***	189.29 ***	551.49 ***	279.86 ***	97.64 ***
150 or less	-858.20 ***	-2115.87 ***	-2124.17 ***	-2012.55 ***	-1185.62 ***	-1127.18 ***	-1408.00 ***	-931.78 ***	-290.50 ***
150 - 500	-312.17 ***	-231.95	-267.79 **	-305.04 ***	-207.56 ***	-182.76 ***	-216.95	-237.75 ***	-168.15 ***
501 - 1500	-130.61 ***	-103.28	-106.31	-99.63 ***	-64.91 ***	-56.93 ***	-61.26	-80.89 ***	-58.32 ***
1501 - 2500	-77.86	-73.79	-60.62	-46.24 **	-32.35 ***	-27.99 *	-30.43	-41.33 **	-31.76 ***
2501 - 3500	-48.48	-54.06	-37.56	-28.81	-19.82 **	-16.75	-17.95	-28.80	-18.40 **
3501 - 5500	-43.05	-34.87	-27.03	-18.84	-13.48 *	-8.67	-8.64	-18.26	-11.73 **
lsize	-90.26 ***	-28.20	-133.07 ***	-61.93 ***	-34.47 ***	-28.86 ***	-68.91 ***	-37.41 ***	-13.42 ***
trend	4.57	45.41 *	-28.46	4.15	1.25	3.94	8.78	-8.48 **	2.57
dtc144a	92.08 *	-94.57	415.69 **	254.41 ***	75.06 ***	30.69	13.11	43.73 *	5.39
ttm	1.89	6.46	-21.35 **	0.86	-0.74	0.71	-18.07 *	-2.25	0.14
age	-12.75	-68.27	-21.79	-22.28 ***	-12.34 ***	2.99	-28.16	2.14	-6.20 ***
Offering Amt	-2611.33 **	-5314.18	-2837.50	-1812.23 ***	260.71	277.04	1426.07	-1891.75 *	5.65
dissem	-33.75	-288.18	-24.69	4.06	-6.91	-32.51 **	-59.49	34.56 ***	-3.27
Adj R^2	6.1%	0.1%	0.2%	4.9%	7.7%	0.7%	0.2%	7.1%	12.8%
N	9,007	59,091	160,524	196,289	105,470	174,183	98,052	19,314	6,743

Table 7
Mean Cumulative Sell Ratio for Dealer Purchases from a customer and then sold to (multiple) customer(s)

This table presents the average percentage of an initial purchase of more than 100 bonds by a dealer from a customer that is later sold to other customers. Although the dealer bought the bonds in a single transaction with a single customer, the dealer may then turn around and sell the bonds over multiple trades to multiple customers, so that each purchase may or may not have multiple sales. Each purchase has a cumulative sell ratio, which is the sum of all of the bonds subsequently sold to customers divided by the total size of the intitial purchase of bonds associated with those sales. Each purchase is then catagorized by the size of the intial purchase, the credit rating of the bond at the time of purchase and a liquidity bucket for that bond based on the trading frequency (Panel A) or cumulative volume (Panel B) for that bond over the previous 30 days prior to the initial purchase. Then a simple average is taken of the cumulative sell ratios per retail/institutional, credit rating, and liqudity category.

Liquidity	Investment Grade				High-Yield				
Group	AAA	AA	A	BBB	BB	B	CCC	CC	C
A. Trading Frequency (number of trades over the previous 30 days)									
3 to 10 days	88%	84%	83%	82%	86%	86%	88%	94%	91%
2-3 days	82%	79%	75%	74%	80%	82%	84%	91%	89%
about 1 day	77%	73%	72%	69%	75%	77%	81%	87%	88%
1 -2 per day	73%	66%	67%	65%	70%	75%	79%	84%	89%
2-3 per day	66%	63%	64%	63%	69%	74%	79%	82%	85%
3-5 per day	58%	58%	60%	60%	68%	72%	76%	79%	82%
30 per day	48%	52%	54%	54%	63%	68%	73%	76%	76%
B. Cumulative Volume (previous 30 days)									
150 or less	86%	81%	81%	84%	89%	89%	92%	94%	91%
150 - 500	72%	72%	72%	76%	79%	83%	85%	91%	88%
501 - 1500	69%	65%	68%	71%	76%	80%	82%	88%	86%
1501 - 2500	69%	60%	65%	68%	74%	77%	80%	86%	89%
2501 - 3500	69%	58%	63%	67%	73%	76%	79%	84%	86%
3501 - 5500	69%	57%	62%	65%	71%	76%	79%	83%	87%
more than 5500	59%	57%	59%	59%	68%	72%	77%	78%	80%

Table 8

Sell Ratio CENSORED Regressions -- CDCs

This table presents regressions on the cumulative sell ratio of an initial purchase of more than 100 bonds by a dealer from a customer that is later sold to other customers (CDCs). Cumulative sell ratio is defined and classified as in Table 5. In Panel A, dummy variables for liquidity groups based on the number of trades in the previous 30 days are as follows: d1 (0-9), d2 (10-19), d3 (20-40); d4 (41-60), d5 (61-90), d6 (91-150). (Bond with 150+ trades are not dummied and are captured by the intercept.) In Panel B, dummy variables for cumulative volume is as shown (observations with cumulative volume in excess of 5500 bonds are not dummied and are captured by the intercept.) Lsize is the natural log of the dealer's initial purchase of bonds. Trend is a time variable by quarter. Dtc144a is a dummy variable that is 1 if the bond is subject to Rule 144a and 0 otherwise. Ttm is time to maturity in days. Age is time since maturity in days. Offering Amount is the face value of the original issue of the bonds. Dissem is a dummy variable that is 1 if the bond is disseminated through TRACE, and 0 otherwise. As the sell ratio cannot be less than zero or larger than 1, censored regresssions were run with a lower bound of zero and an upper bound of 1.

	Investment Grade				High-Yield				
	AAA	AA	A	BBB	BB	B	CCC	CC	C
Panel A:	Trading Frequency (number of trades over the previous 30 days)								
Intercept	-0.19 ***	-0.15 ***	-0.16 ***	-0.21 ***	-0.28 ***	-0.25 ***	-0.38 ***	-0.30 ***	-0.10 *
3 to 10 days	0.41 ***	0.20 ***	0.24 ***	0.23 ***	0.27 ***	0.24 ***	0.20 ***	0.33 ***	0.25 ***
2-3 days	0.25 ***	0.12 ***	0.14 ***	0.12 ***	0.16 ***	0.15 ***	0.08 ***	0.27 ***	0.16 ***
about 1 day	0.17 ***	0.11 ***	0.10 ***	0.06 ***	0.08 ***	0.06 ***	0.03 ***	0.15 ***	0.19 ***
1 -2 per day	0.11 ***	0.07 ***	0.06 ***	0.02 ***	0.03 ***	0.02 ***	0.00	0.06 ***	0.23 ***
2-3 per day	0.09 ***	0.06 ***	0.04 ***	0.00	0.01	0.01 **	0.00	0.04 **	0.16 ***
3-5 per day	0.03	0.03 ***	0.02 ***	-0.01	0.00	0.00	-0.01	-0.01	0.07 ***
lsize	0.16 ***	0.16 ***	0.16 ***	0.16 ***	0.18 ***	0.19 ***	0.21 ***	0.20 ***	0.19 ***
trend	-0.03 ***	-0.04 ***	-0.03 ***	0.00 **	-0.01 ***	-0.01 ***	-0.02 ***	0.00	-0.03 ***
dtc144a	-0.19 ***	0.02	0.05 ***	-0.01	0.04 ***	-0.01 **	0.05 ***	0.02	-0.01
ttm	-0.01 ***	-0.02 ***	-0.02 ***	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 ***	0.00
age	0.06 ***	0.09 ***	0.08 ***	0.05 ***	0.05 ***	0.03 ***	0.04 ***	0.06 ***	0.03 ***
Offering Amt	-2.09 ***	-2.74 ***	-4.00 ***	-2.97 ***	-5.45 ***	-10.64 ***	-14.95 ##	-15.70 ***	-23.89 ***
dissem	-0.04 **	-0.06 ***	-0.09 ***	-0.09 ***	-0.03 ***	0.00	0.02 ***	0.01	0.00
Sigma	0.464 ***	0.43 ***	0.45 ***	0.46 ***	0.49 ***	0.50 ***	0.49 ***	0.51 ***	0.54 ***
Panel B:	Cumulative Volume (over the past 30 days)								
Intercept	-0.16 ***	-0.13 ***	-0.16 ***	-0.22 ***	-0.33 ##	-0.26 ***	-0.39 ***	-0.39 ***	-0.07
150 or less	0.29 ***	0.10 ***	0.17 ***	0.30 ***	0.37 ***	0.32 ***	0.33 ***	0.38 ***	0.23 ***
150 - 500	0.07 ***	0.07 ***	0.08 ***	0.20 ***	0.24 ***	0.23 ***	0.21 ***	0.38 ***	0.20 ***
501 - 1500	0.03 *	0.03 ***	0.06 ***	0.12 ***	0.16 ***	0.14 ***	0.10 ***	0.30 ***	0.14 ***
1501 - 2500	0.05 **	0.02 ***	0.03 ***	0.08 ***	0.12 ***	0.08 ***	0.05 ***	0.21 ***	0.29 ***
2501 - 3500	0.01	0.01	0.03 ***	0.05 ***	0.08 ***	0.05 ***	0.03 ***	0.14 ***	0.12 ***
3501 - 5500	0.01	0.01	0.02 ***	0.03 ***	0.04 ***	0.02 ***	0.01	0.10 ***	0.12 ***
lsize	0.18 ***	0.17 ***	0.17 ***	0.16 ***	0.18 ***	0.19 ***	0.22 ***	0.21 ***	0.19 ***
trend	-0.03 ***	-0.04 ***	-0.02 ***	0.00	-0.01 ***	0.00 ***	-0.01 ***	0.00	-0.02 **
dtc144a	-0.01	0.11 ***	0.13 ***	0.05 ***	0.08 ***	0.00	0.05 ***	0.07 ***	-0.02
ttm	0.00 ***	-0.02 ***	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 ***	0.00	9.93
age	0.06 ***	0.09 ***	0.08 ***	0.04 ***	0.04 ***	0.02 ***	0.03 ***	0.05 ***	0.02 *
Offering Amt	-3.83 ***	-4.22 ***	-5.79 ***	-3.42 ***	-5.72 ***	-11.94 ***	-16.02 ***	-15.87 ***	-28.11 ***
dissem	-0.04 **	-0.07 ***	-0.10 ***	-0.09 ***	-0.04 ***	-0.01 ***	0.01 **	0.01	-0.07 **
Sigma	0.468 ***	0.43 ***	0.46 ***	0.46 ***	0.49 ***	0.50 ***	0.49 ***	0.51 ***	0.54 ***