Dealer Spreads in the Corporate Bond Market: Agent vs. Market-Making Roles

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Abstract

Utilizing the large subset of trades where dealers act purely as agents, we decompose dealer spreads in U.S. corporate bond OTC markets into components arising from: 1) dealers' market-making role, and 2) their role as agents for their non-dealer customers. We investigate the determinants of both components. We find that agent-related spreads are large and comparable in magnitude to market-making spreads. In their role as agents, dealers face search costs and customer interface costs, while in their role as market makers they face inventory and asymmetric information costs. Consistent with this, we find that while market-making spreads are strongly correlated with risk variables, agent-related spreads depend instead on liquidity driven variables. While market-making spreads are inversely related to trade size, agent-related spreads typically increase with trade size, consistent with agent-dealers devoting lesser search time to smaller trades. Our results also imply that market-making dealers benefit more from direct interaction with traders when risk and information asymmetry is higher, consistent with dealers deriving information-related benefits from their customer interface. Explicit transaction costs of non-dealer customers are typically lower when they trade directly with market-making dealers than through a dealer acting purely as an agent. Finally, we show that existing studies underestimate average overall corporate bond market trading costs by conflating the spreads of dealers acting purely as agents with full dealer spreads that include both agent and market making costs. Our findings on the size and economic determinants of agent-related dealer costs, have significant implications also for other OTC markets.

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Dealer Spreads in the Corporate Bond Market: Agent vs. Market-Making Roles

Financial intermediaries in the U.S. corporate bond market are ‘broker-dealers’ with two functions. As ‘brokers’, they serve as agents for individual or institutional traders (hereafter “customers”), providing market access and counterparty search services. As ‘dealers’, they fulfill a ‘market-making’ function by standing ready to buy (or sell) on their own account as principals when a customer wants to sell (or buy). In a particular trade, a broker-dealer (hereafter just “dealer”) can function purely as an agent, purely as a ‘market-maker’, or both. Hence, dealer spreads reflect not just the costs arising from their market-making role, but also the costs arising from their role as agent. These agent-related spreads impound counterparty search costs (Duffie, 2012) and customer interface costs and benefits. Empirical studies on corporate bond market dealer spreads – Bessembinder, Maxwell and Venkataraman (2006), Goldstein, Hotchkiss and Sirri (2007), and Edwards, Harris, and Piwowar (2007) (hereafter “EHP (2007)”) – have essentially treated dealer spreads as representing market making costs, and not distinguished between dealers’ costs arising from their agent and market making roles. They have thereby underestimated average overall trading costs by conflating the spreads of dealers acting purely as agents with full dealer spreads that include both agent and market making costs. This is also largely true regarding empirical research on dealer spreads in other over-the-counter (“OTC”) markets.[2] In this paper, we build on EHP (2007) to separately investigate dealer spreads arising from dealers’ market-making and agent roles, and analyze their determinants. We also explore the possible advantage market making dealers gain from direct interaction with customers.

[2] See, e.g., Bessembinder (1994) and Lyons (1995) for FX markets; Huang and Stoll (1996), Barclay, Christie, Harris and Schultz (1999), and Huang (2002) for NASDAQ; Hansch, Naik and Viswanathan (1998, 1999) and Naik and Yadav (2003a) for London Stock Exchange; Naik and Yadav (2003b) for London government bond market; and Harris and Piwowar (2006) for the US municipal bond market. There is little empirical evidence on the dealer’s role as agent: The results of Ashcraft and Duffie (2007) for bilateral trades between banks in the Federal Funds market are consistent with theoretical search-based approaches, but do not enable inferences on intermediary transaction costs.

We are able to estimate the component of dealer spreads arising from their agent role by utilizing the sizeable subset of U.S. corporate bond trades in which some dealers act purely as agents – more than one-third of customer buys and customer sells in our two-year sample period. If dealer A receives a customer buy order for a bond that it does not have in inventory, it must obtain the bonds from another dealer B who does. In this situation, dealer A often engages in a "riskless principal trade" in which it arranges to: 1) buy the bonds from dealer B and 2) *simultaneously* resell the bonds to the customer. Likewise, if dealer C receives a sell order for a bond that it does not wish to keep in inventory, C may execute a riskless principal trade in which it buys the bonds from the customer and *simultaneously* resells to dealer B. In these riskless principal trades, dealers A and C do not carry any price or inventory risk, and serve purely as agents of their customers. Hence, their spread represents compensation for their agent-services of searching for the counter-party with the best price and for managing customer orders. On the other hand, Dealer B serves in these cases purely as a market maker, bearing all inventory and asymmetric information costs and risks, but no search or customer interface costs. Thus total customer trading costs on these trades consist of two spreads: 1) that of the customer-interfacing dealer, A or C, who arranges the riskless principal trade and acts purely as an agent, and 2) that of the liquidity providing dealer, B, who holds bonds in inventory and acts purely as a market-maker.

On the other hand, a sizable proportion of trades do not go through a separate dealer that acts purely as an agent. In these trades, a dealer sells directly to a customer from its bond inventory or buys bonds from a customer and retains the bonds in its inventory. In these cases, the dealer acts in dual capacity – as an agent for the customer bearing the customer interface costs/benefits, and as a market maker acting as principal.

We hereafter use the terms "agent-dealer", "principal-dealer", and "dual-capacity-dealer" respectively for a dealer functioning in a specific trade purely as an agent, purely as a market maker, or in a dual capacity as both agent and market maker. The agent and principal roles may differ from bond to bond and from trade to trade, i.e., a dealer may be a principal-dealer for one set of bonds or trades, an agent-dealer for another set of bonds or trades, and a dual-capacity-dealer for a third set of bonds or trades. For instance, a market-making dealer who trades with both agent-dealers and non-dealer customers functions as both a principal dealer and a dual-capacity-dealer. In this paper, we estimate agent-dealer, principal-dealer, and dual-capacity-dealer spreads, and analyze how they vary with: 1) bond market risk factors, 2) bond liquidity measures, 3) bond characteristics related to both risk and liquidity such as rating and maturity, and 4) trade size.

An agent-dealer's spread arguably impounds search costs, i.e., the costs of searching among principal-dealers (or other possible counterparties) for the best price, and customer-interface costs, i.e., order-processing and other costs associated with their customer relationships. A principal-dealer's spread impounds market-making costs, i.e., inventory and asymmetric information costs and risks. A dual-capacity-dealer's spread impounds both market-making costs and the net customer-interface costs that are relevant to them.

Importantly, the customer interface costs of an agent-dealer are likely to be different from those of a dual-capacity-dealer. Clearly, a customer interface results in direct costs of managing customer relationships for both agent-dealers and dual-capacity-dealers. However, a customer interface can also provide significant benefits, particularly to a dealer who is acting in dual-capacity for the specific bond at that time. By interacting directly with the trader, the dual-capacity-dealer may potentially be able to judge whether, and to what extent, the trader is informed or uninformed; and adjust its spread accordingly.[3] On trades routed through an agent-dealer, the principal-dealer does not get access to this information, and the agent-dealer who does not maintain an inventory in this bond at this time does not directly derive any benefits from trying to distinguish between

[3] The potential ability of dealers to infer private information from customer orders and trades is modeled, for example, in Naik, Neuberger, and Vishwanathan (1999).

informed and uninformed traders, and faces no asymmetric information risk. The inventory management of dual-capacity-dealers may also benefit from observing who is trading. Hence, *net* customer interface costs of dual-capacity-dealers are likely to impound customer interface related information benefits and be lower than those of agent-dealers.

The market-making component of dealer costs represents dealer compensation for inventory costs and the asymmetric information risk of trading with more informed traders.[4] Since principal-dealers and dual-capacity-dealers make markets and agent-dealers do not, we expect principal-dealer and dual-capacity-dealer spreads, but not agent-dealer spreads, to be positively correlated with measures of market price risks -- specifically: the VIX index of expected equity market volatility and the MOVE index of expected interest rate volatility. Anticipating that price risks, and therefore inventory and asymmetric information costs, are higher on lower rated bonds and longer duration bonds, we also expect principal-dealer and dual-capacity-dealer spreads to be higher on lower rated and longer maturity bonds. In addition, liquidity is also likely to be lower on these bonds, so we expect principal-dealer and dual-capacity-dealer spreads to be higher on lower rated and longer maturity bonds for this reason as well.

On the other hand, the agent-related component of dealer costs represents compensation for the direct and opportunity costs incurred as an agent – counterparty search costs and customer interface costs – rather than a premium for risk. Consequently we expect little correlation between agent dealer spreads and market price risk variables such as the VIX and MOVE indices. On the basis of the theoretical models of search costs in the literature, we expect search costs to be relatively higher when the returns from search are greater – for example, for assets with lower liquidity – or when the order flow originates from traders who have lesser ability to do their own

[4] See, e.g., Ho and Stoll (1983); Glosten and Milgrom (1985); Glosten and Harris (1988); and Stoll (1989).

search, or from traders with lower bargaining power.[5] Thus agent-dealer spreads, should be higher for assets with lesser liquidity, specifically bonds with low trading volume, low ratings, and longer terms-to-maturity. Search costs will also depend on the agent-dealer's decision on how much effort to devote to the search process, which should depend on the expected payoff of additional search -- and possibly on the importance of the customer. If search and customer interface costs per trade are relatively fixed, then costs per bond and agent-dealer spreads should be an inverse function of trade size, since the smaller the trade the fewer the number of bonds over which search costs can be spread. However, the likely incremental payoff of additional search is lower on small trades possibly leading to less search and lower search costs on small trades. For instance, spending $100 on additional search which is expected to lower the customer's purchase price by an expected $1 per bond is economical if the order is for more than 100 bonds but not if it is for less. Thus, how search costs per bond and agent-dealer spreads vary with trade size is unclear.[6]

Since a principal-dealer faces market making costs and a dual-capacity-dealer both market making and customer-interface costs, holding other factors constant, the difference between a dual-capacity-dealer's spread and a principal-dealer's spread on a similar trade provides a measure of net customer interface costs *applicable to a dual-capacity dealer*. As discussed earlier, the customer interface, while it entails costs, also potentially provides information-related benefits to the dual-capacity-dealer. These benefits should be greater on bonds with high information asymmetry, such as lower rated bonds and bonds that are rarely traded. In addition, since the benefit of possibly

[5] Theoretical models of search costs are relatively recent - pioneered in the finance literature by Duffie, Garleanu, and Pedersen (2005), and include Weill (2007), Vayanos and Weill (2008), Lagos and Rocheteau (2009). Rocheteau and Weill (2011), Afonso (2011), and Lagos, Rocheteau and Weill (2011).

[6] The agent-dealer's search effort can also have an indirect effect on principal-dealer spreads. It is possible that agent dealers steer trades by less important customers, or customers with little bargaining power, to preferred (potentially higher cost) principal dealers. Even otherwise, if agent-dealers devote less search (and bargaining) to small trades, then we will tend to observe higher principal-dealer spreads on small trades, not because individual principal-dealers adjust their bid/ask prices, but because of sampling. This reasoning also applies to dual-capacity dealer spreads since it is not economical for customers themselves to spend as much time and expense searching for the best price on a small trade as on large trades.

distinguishing between informed and uninformed traders through direct customer interface should be more valuable when price risk is high, we also expect the net customer interface cost faced by dual-capacity-dealers to vary inversely with price risk measures like the MOVE and VIX indices.

Our analysis is based on corporate bond trades reported on the Trade Reporting And Compliance Engine ("TRACE") over the period November 2008 to December 2010. In November 2008, TRACE began providing additional information which it had always collected but had not made public earlier; i.e., whether the trade represented a sale of bonds by a dealer to a (non-dealer) customer (designated "S" on TRACE), a bond purchase by a dealer from a customer (designated "B"), or a dealer trade with another dealer (designated "D").

TRACE's S trades include both dual-capacity-dealer sales (from the dealer's inventory direct to a customer) and agent-dealer riskless principal sales of bonds (simultaneously bought in a separate trade from a principal-dealer). Likewise TRACE's B trades include both dual-capacity-dealer purchases (direct from customers for the dealer's inventory) and agent-dealer riskless principal purchases (sold simultaneously to a principal-dealer in a separate trade). We are able to distinguish between dual-capacity-dealer trades and agent-dealer trades because a majority of bonds do not trade at all on an average day, and for those that do trade, there are, on average, only 4.1 trades during the day. Hence, if a S and a D trade are within a few seconds of each other and are for exactly the same quantity, it is reasonable to assume that the S trade is an agent-dealer (riskless principal) sale to the customer and that the D trade is the agent-dealer's accompanying purchase of the bonds from a principal-dealer. This also makes it possible to sign the paired D trade as a principal-dealer sale at its ask price. Likewise, if a B and a D trade are for exactly the same quantity and within a few seconds of each other, it is reasonable to assume that the B trade is an agent-dealer (riskless principal) purchase, and the accompanying D trade is a principal-dealer purchase (and agent-dealer sale) at the principal-dealer's bid price. In our sample, though we use a one-minute cutoff for pairing, the average time between paired S and D trades is only 0.4 seconds, and between paired B and D trades only 2.2 seconds. On this basis, 39.3% of S trades are riskless principal sales of agent-dealers and 34.2% of B trades are riskless principal purchases of agent-dealers. The remaining 60.7% of S trades and 65.8% of B trades are dual-capacity-dealer sales and purchases direct with customers. 58.6% of interdealer trades get paired (and therefore signed as being at the bid or ask) on the basis of this procedure.

In the context of the above, the price differences between paired S and D trades are the spreads of agent-dealers on customer buy orders, the price differences between paired D and B trades are the spreads of agent-dealers on customer sell orders, and the price differences between D trades paired with S trades and D trades paired with B trades represent round-trip principal-dealer spreads. The price differences between unpaired S trades and unpaired B trades represent dual-capacity dealer spreads.

In seminal work in this area, EHP (2007) use price differences between S, B, and D trades to estimate transaction costs in the corporate bond market. We extend their study by distinguishing between agent-dealer, principal-dealer, and dual-capacity-dealer spreads; and separately analyzing the determinants of each.[7] We are also able to correct a significant downward bias in the spread estimates of EHP (2007). To illustrate the intuition for this downward bias in EHP (2007) estimates, consider a TRACE S trade. The EHP (2007) spread estimates are based on successive trades. If the S trade is part of a riskless principal trade, the D trade closest to the S trade in time is normally the agent-dealer's purchase of the bonds from the principal-dealer. Thus, the difference between the S trade and a successive D trade tends to pick up only agent-related costs, and not the overall trading costs that also include market-making costs. Likewise if a B trade is part of a riskless principal

[7] While EHP estimate a single spread on dealer purchases or sales, we estimate six: 1) agent-dealer spreads on sales, 2) agent-dealer spreads on purchases, 3) principal-dealer spreads on sales, 4) principal-dealer spreads on purchases, 5) dual-capacity-dealer spreads on purchases, and 6) dual-capacity spreads on sales.

trade, the closest D trade will normally be the agent-dealer's resale of the bonds to the principal-dealer; so, again, only agent-related costs are included in the spread estimate.[8] Similar underestimation of total transaction costs takes place in the extant EHP (2007) procedure potentially for every riskless principal trade, and such trades account for more than a third of customer trades.

Our results include the following. One, agent-dealer spreads are sizable and comparable in magnitude to principal-dealer spreads, implying that the costs arising from a dealer's agent role, i.e., search and customer relation management functions, are roughly comparable to the dealer's market-making costs. Two, as hypothesized, since they bear inventory and asymmetric information risks, principal-dealer and dual-capacity-dealer spreads are significantly positively correlated with measures of market uncertainty – specifically the VIX for equity market volatility and the MOVE index of interest rate volatility. Also as expected, since they hold no inventory, agent-dealer spreads are not significantly correlated with these risk variables. Three, the difference between dual-capacity-dealer spreads and principal-dealer spreads on similar trades (which represents the former's net customer-interface costs/benefits) is negatively correlated with these risk variables implying that the benefit that dual-capacity-dealers derive from direct interaction with the trader identity, and thus possibly being able to judge if the trader is informed or uninformed, increases when risk and information asymmetry are high. Four, while principal-dealer and dual-capacity-dealer spreads decline sharply as trade size increases (consistent with earlier evidence and the presence of fixed costs), agent-dealer spreads tend to increase with trade-size until trade size reaches about 50 bonds implying that agent-dealers devote less search effort to smaller trades (as they rationally should) or that larger traders have greater bargaining power. Five, all three spreads increase as bond specific trading volume decreases implying that both market-making costs and

[8] Each agent-dealer S or B trade is compared with both the trade immediately preceding and that immediately following. Since only one of these is part of the riskless-principal trade, only one of the two spread estimates is biased in this manner.

agent-related costs are negatively related to bond liquidity. Six, all three spreads are higher for lower rated and longer maturity bonds, which is the expected sign for agent-dealer spreads for liquidity reasons and the expected sign for principal-dealer and dual-capacity-dealer spreads for both liquidity and risk reasons. In contrast, the difference between dual-capacity-dealer and principal-dealer spreads is lower on low rated bonds implying that dual-capacity-dealers derive a benefit from observing the identity of the trader and that this benefit is greater on bond issues with more information asymmetry. Seven, except for small trades, customers have significantly lower explicit costs trading directly with dual-capacity dealers rather than trading through agent-dealers. Unsurprisingly therefore, relatively larger trades are often done directly with dual-capacity-dealers, with the customers bearing the associated search costs. Eight, the EHP (2007) procedure tends to underestimate total transaction costs particularly on small trades and trades routed through agent-dealers.

Our results have important implications for the extensive extant empirical research on dealer spreads in other OTC markets that has also not accounted for the costs of dealers arising from their agent role hitherto. The results in this literature need to be interpreted in the context of these large agent-related costs that meaningfully vary with several relevant economic factors in a manner that is in some cases similar and in some cases different from market-making costs. By comparing dual-capacity-dealer and principal-dealer spreads on similar trades, we are also able to explore the determinants of the costs and benefits of the dealer-customer interface -- in particular the possible benefit to dual-capacity-dealers of perhaps judging the likelihood that the trader is informed. This approach to the costs and benefits of the customer interface may also be applicable to other OTC markets.

The rest of this paper is organized as follow. Section 1 describes our data. In section 2, we discuss the possible determinants of agent-dealer, principal-dealer and dual-capacity-dealer spreads in terms of market conditions and bond characteristics. In section 3, we estimate and analyze agent-dealer spreads on riskless principal trades, and principal-dealer spreads on paired agent-dealer trades. In section 4, we estimate and analyze dual-capacity-dealer spreads on trades directly between dual-capacity-dealers and non-dealer customers; and compare transaction costs of customer trades that go through an agent-dealer and those that do not. In section 5, we use all trades in the entire sample at the same time, and an extension of the EHP (2007) model, to estimate and analyze spreads, and to quantify how transaction costs estimates using our decomposition procedure differ from those obtained from EHP (2007). We also explore the costs and benefits to dual-capacity-dealers of the direct customer interface. Section 6 concludes.

1. Data

We obtain bond transaction price from the National Security Dealers Association's (NASD) TRACE database starting November 3, 2008 (when TRACE started attaching S, B, and D codes to reported trades) and ending December 31, 2010. Bond characteristics, such as coupon, maturity, and ratings, were obtained from Mergent's FISD database. For inclusion in our sample, we require that the bond be a non-convertible, non-putable, industrial bond or note denominated in US dollars with fixed (possibly zero) coupon, $1000 par value, semi-annual coupon payments, and at least three years to maturity as of November 1, 2008 which is neither in default nor has a tender offer outstanding. 3859 bonds meet these requirements. Bonds are dropped from the sample when they default, are called or retired, or maturity drops below three years. From the TRACE data, we drop trade observations if: 1) the trade is later corrected or canceled, 2) settlement is over a week in the future, 3) it is a "when issued" or "special price" trade, 4) there is an unreported commission,[9] 5) a

[9] The NASD asks dealers to report if there is a commission that is not included in the price but does not require that they report what the commission is. We drop the few observations that indicate that there is a commission since we cannot observe the amount.

special sale condition is attached, 6) it is an "as of" trade, or 7) the price is less than $25 per $100 par value (which we regard as being in default even if there is no indication of default on FISD). As a final check, we compare the yield-to-maturity (YTM) reported on TRACE with the YTM calculated from the trade price and settlement date reported on TRACE together with the coupon and maturity from the FISD database.[10] For most observations, the two YTMs are virtually identical but for 1.8% of the sample, the two yields differ by more than ten basis points indicating that either: 1) the TRACE price or YTM is incorrect, 2) the bond CUSIP is incorrect, 3) the FISD coupon or maturity date is incorrect, or 4) there was a commission (which is included in the TRACE YTM but not the price) on the trade despite the fact that the TRACE data indicates no commission. It is apparent that in some cases either the TRACE CUSIPs or the FISD dates are incorrect since trades are reported before the bond supposedly was issued or after it was retired.

To illustrate our trade classification procedure discussed in the introduction, consider the sample of all trades in Alcoa's 5.5% 2017 notes between the 9:24 AM and 12:01 PM on July 29, 2010 reproduced in Table 1. Trade characteristics reported by TRACE are shown in columns 2-6. Consider trades 1 and 2 in Table 1. An interdealer trade, D, at 9:24:55 for 10 bonds is followed one second later by a purchase, B, from a customer for 10 bonds. It seems apparent that in this case a dealer received a sell order from a customer for 10 bonds, not wishing to keep the bonds in inventory and wanting instead to function purely as an agent, the dealer searched for another dealer to provide liquidity, and accordingly arranged a riskless principal trade in which he arranged to resell the bonds to the other dealer and then executed the two orders roughly simultaneously. We designate the agent-dealer's purchase from the customer (trade 2) as an "agent-dealer purchase" and the resale to the principal-dealer (trade 1) as a "principal-dealer purchase." In trade 3, the B trade for 25 bonds is not accompanied by a D trade, so is classified as a "dual-capacity-dealer purchase"

[10] If TRACE does not report a yield, we assume the price is correct.

directly from a non-dealer customer. Trades 4 and 5 are D and S trades respectively for exactly the same number of bonds, 16, at the same time, 10:23:10. Thus it appears that a dealer received a buy order from a customer for bonds it did not have, so searched around and arranged to purchase the bonds from a principal-dealer for $102.042 and to resell to the customer for $103.419. We classify the D trade (trade 4) as a "principal-dealer sale" and the S trade (trade 5) as an "agent-dealer sale."

Trade 6 is a standalone D trade for 3000 bonds. In this case, there is no accompanying B or S trade with an agent-dealer. We designate it as "interdealer-unpaired". In this case, unlike the paired D trades (trades 1 and 4), we cannot determine if trade 6 was at the bid or ask, but signing such trades is not necessary for this study since we are not analyzing individual dealer spreads. Interdealer-unpaired trades represent risk-sharing trades of market-making dealers among themselves and do not directly impact dealer spreads for trades with customers, whether made directly or through an agent-dealer.

In trades 7, 8, and 9 we again have a B trade accompanied by a D trade but note that there are two D trades for the same number of bonds at the same time and price. There appear to be two possibilities. First, although the NASD requires both dealers to an interdealer trade to report, it supposedly only includes the selling dealer's report on TRACE. One possibility is that both reports were included by mistake. Second, the trade may have gone through two agent-dealers. In other words, dealer A bought the bonds and immediately sold to dealer B who immediately sold to dealer C who kept the bonds on its books. There is a similar situation in trades 14, 15, and 16 where an S trade is accompanied by two D trades for the same quantity at the same price. Since our focus is on agent-dealer and principal-dealer spreads, we are not interested in intermediate interdealer trades and do not wish to include duplicates, so remove D trades 9 and 16 from our sample. There are 296,307 such duplicate or intermediate trades leaving us with a final sample of 5,839,480 trades.[11]

Thus our decision rule is: if a S (B) trade is accompanied within one minute by a D trade for exactly the same amount, we designate the S (B) trade as an agent-dealer sale (agent-dealer purchase) and the paired D trade as a principal-dealer sale (principal-dealer purchase).[12] S and B trades not accompanied within one minute by a D trade of the same amount are designated as dual-capacity-dealer sales or dual-capacity-dealer purchases respectively. D trades not accompanied by an S or B trade are interdealer-unpaired trades. 58.6% of D trades can be duly paired and signed. The remaining 41.4% are interdealer-unpaired. 34.2% of B trades and 39.3% of S trades go through agent-dealers. While we pair same size S and D trades, and B and D trades, if within one minute of each other, the vast majority are much closer. The mean time between paired agent-dealer and principal-dealer sales is 0.4 seconds. The mean time between agent-dealer and principal-dealer purchases is 2.2 seconds.

Statistics on the number of trades in each classification are reported in Table 2 along with statistics on trade size (in bonds). Investment grade bond trades of more than $5 million par value (5000 bonds) are reported as 5MM+ on TRACE and trades of speculative grade bonds of more than 1000 bonds are reported as 1MM+.[13] These account for 1.37% and 3.96% of trades in our sample respectively. Since these trade sizes are truncated at 5000 and 1000 bonds respectively, the means and standard deviations in Table 2 for dual-capacity-dealer sales and purchases are understated.

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[11] In the few cases when the two D trades are not at exactly the same price, we drop the trade at the intermediate price.

[12] While rare, we pair multiple B or S trades with one D trade if all occur within one minute of each other and the sum of the B or S trades exactly matches the size of the D trade, e.g., two B trades for 10 bonds each and one D trade for 20 bonds. For this reason the number of agent-dealer purchase trades slightly exceeds the number of interdealer purchases and median and mean trade sizes are slightly smaller – similarly for agent-dealer sales and interdealer sales.

[13] Untruncated trade sizes are now reported on the enhanced version of TRACE albeit with an eighteen month lag.

Means and standard deviations for the other four classifications are unbiased since there are no truncated observations in these classifications and, of course, all medians are unaffected.

As reported in Table 2, trades that go through an agent-dealer tend to be much smaller than dual-capacity-dealer trades directly with a customer. For instance, the mean (median) size of agent-dealer purchases is only 69 (10) bonds compared with 681 (100) bonds for dual-capacity-dealer purchases. For S trades, the means (medians) are 42 (15) bonds for agent-dealer sales and 498 (40) bonds for dual-capacity-dealer sales. In sections 4.2 and 5.2 below, we find that on very small trades, total explicit transaction costs are roughly the same whether the customer deals directly with a dual-capacity-dealer or routes her trade through an agent-dealer. Since the customer's internal search costs are likely lower if she deals with an agent-dealer, it is not surprising that most small trades are through agent-dealers. For larger size trades, we find that total explicit transaction costs are considerably lower if the customer deals directly with a dual-capacity-dealer so again it makes sense that most large trades are direct between the customer and a dual-capacity-dealer.

2. Hypothesized determinants of dealer spreads

In this section, we turn our attention to the hypothesized determinants of agent-dealer, principal-dealer, and dual-capacity-dealer spreads -- as well as the customer interface costs on dual-capacity-trades. The determinants we consider fall into four groups: 1) measures of general bond market risk at the time of the trade, 2) a measure of the traded bond's liquidity, 3) variables likely correlated with both bond risk and liquidity, and 4) trade size. These are described in the next subsection; then hypothesized relations for the different spreads in the following subsections.

2.1. Independent variables

We expect market-making costs to be a function of the market-maker's inventory and asymmetric information risks which comprise both general corporate bond price risk at the time of the trade and the riskiness of the individual bond. To measure general corporate bond market risk at the time of the trade, we employ the MOVE and VIX indices. Merrill Lynch's MOVE index is a weighted average of the implied volatilities on 2, 5, 10, and 30-year Treasury bond options and thus is an index of expected interest rate volatility. Since corporate bonds have default as well as interest rate risk, we also employ the better known VIX index which measures implied volatility on S&P500 index options. The VIX and MOVE indices are fairly highly correlated with $\rho = 0.769$. Since our November 2008 - December 2010 data period includes part of the financial crisis period, we also include as independent variables zero-one dummy variables for: 1) November and December 2008, 2) the first quarter of 2009, 3) second quarter of 2009 and 3) the second half of 2009. 2010 is the left-out period. We anticipate that principal-dealers and dual-capacity-dealers faced higher risks during the financial crisis period of late 2008 and early 2009 than later.

Our bond specific risk variables are the bond's rating and term-to-maturity expecting risk and information asymmetry to be higher on low rated bonds and price risk to be higher on longer maturity bonds. For the rating variable, we use the average of Moody's and S&P ratings from the FISD database, where AAA=1, AA+=2,....CC=21, C=22, and D=25 and include a separate dummy variable to indicate issues where both rating agencies have withdrawn or suspended their rating.[14] Thus a higher number means a lower rating.

As noted above, many bonds are very thinly traded; indeed on the average day, more bonds do not trade than trade. Hence, we expect a bond's liquidity to be an important determinant of spreads. Our main measure of a bond's liquidity is the log of its average daily trade volume (summed over all dealers) over the six-month period from three months before to the trade to three

[14] If only one rating agency rates the bond issue, we use just that rating.

months after.[15] We also anticipate that the bond's liquidity will be correlated with its rating and term-to-maturity.

To the extent some agent-related and market-making-related costs are fixed, costs per bond and spreads should be an inverse function of trade size and numerous studies find that this is the case for dealer spreads in general. EHP (2007) find that the negative relation between trade size and dealer spreads is non-linear and accordingly allow a very flexible form in their estimations by including four different trade size measures. Largely following their example, we regress the spreads on three trade size (measured in bonds) variables: 1) the log of trade size, 2) the reciprocal of trade size, and 3) the square root of trade size.

We next discuss how we expect the different dealer spreads to vary with these variables.

2.2. Agent-dealer spreads

Agent-dealers essentially serve as brokers managing their customer relationships and searching among principal-dealers and other counterparties for the best price for their customers. Since they maintain no inventory, we expect their costs and spreads to be much less sensitive to the risk and asymmetric information variables than the costs and spreads of principal-dealers and dual-capacity-dealers. It is possible that there is a weak relationship since agent-dealers' search costs may increase if principal-dealers become reluctant to trade during high-risk periods.

On the other hand, agent-dealers' spreads should depend heavily on their search costs, which should decline with liquidity. Thus we expect agent-dealer spreads to be inversely related to trade volume and higher on lower rated and longer-maturity issues. Search costs will also depend on the

[15] We include trading volume over the subsequent three months so that we can include trading in recently issued bonds and so that we can explore spread determinants in the late 2008 financial crisis period. For trades in the first and last three months of our November 2008 - December 2010 period, trading volume is measured over the available data period from three to six months. By including trading volume after the trade in our trading volume measure, we are assuming that actual trading volume varies around dealers' expectations.

agent-dealer's decision on how much effort to devote to the search process which in turn likely depends on trade size. If search costs per trade are relatively fixed, then search costs per bond and agent-dealer spreads should be an inverse function of trade size. However, the likely incremental payoff of additional search is lower on small trades. For example, suppose additional search costs $100 and the expected payoff is a reduction in the expected purchase price by $0.15 per bond. This additional search is cost effective if the order is for 1000 bonds but not if it is for 10 bonds. Since partially fixed search and/or customer interface costs imply an inverse relation between trade size and agent-dealer spreads but the economics of search imply less search on small trades, how agent-dealer spreads should vary with trade size is unclear.

2.3. Principal-dealer spreads

Since they make markets, we expect principal-dealer spreads to vary directly with their inventory risk. Thus, we anticipate higher principal-dealer spreads when corporate bond prices are relatively more uncertain and volatile. Principal-dealers are also likely to face higher asymmetric information risk in periods of higher volatility and for more risky bonds, i.e., greater likelihood that they are trading with more informed traders. Thus, we hypothesize that principal-dealer spreads will vary directly with the MOVE and VIX indices, will be higher during the financial crisis period, and will be higher on lower-rated and longer-maturity bonds. Since inventory costs are higher when there is low turnover, we also anticipate that spreads will vary inversely with liquidity. Finally, to the extent that trading and order processing costs have a fixed component, we anticipate that principal-dealer spreads will vary inversely with trade size. Note that this expected trade-size-spread relationship is reinforced by the economics of search discussed in section 2.2. If agent-dealers devote less search (and bargaining) to small trades (as is rational), then we will tend to observe higher principal-dealer spreads on small trades, not because individual dealers adjust their bid/ask prices (though they may), but because of sampling. If agent-dealers do little search, the observed principal-dealer sale price may not be at the lowest principal-dealer ask price and the observed principal-dealer buy may not be at the highest principal-dealer bid. Furthermore, it is also possible that agent dealers steer trades by less important customers, or customers with little bargaining power, to preferred (potentially higher cost) principal dealers.

2.4. Dual-capacity-dealer and their customer-interface spreads

Dual-capacity-dealers face the same market-making costs as principal-dealers. Hence, we expect the hypothesized relationships discussed in section 2.3 to apply to dual-capacity-dealers as well. In other words, we expect dual-capacity-dealer spreads to vary directly with the MOVE and VIX indices, and bond term-to-maturity; we expect them to be inversely related to trading volume and to be higher on lower rated bonds.

In addition, however, since dual-capacity-dealers buy and sell directly to customers, they bear the costs of managing these relationships, which we term customer interface costs. Hence, the customer-interface costs of dual capacity dealers can be estimated as the difference between dual-capacity-dealer spreads and corresponding principal-dealer spreads. Although we expect dual-capacity-dealer spreads to be greater than principal-dealer spreads due to customer interface costs, dealing directly with customers provides benefits as well as costs. Since the identity of the trader is known, the dual-capacity dealer may be able to judge whether the trader is informed or uninformed and adjust its spread accordingly. On trades routed through an agent-dealer, the principal-dealer does not have access to this information. Consequently, informed traders may choose to route their trades through agent-dealers but, anticipating this behavior, dealers functioning as both dual-capacity-dealers and principal-dealers may increase their spreads on the latter. This implies that net customer-interface-costs should be lower on bonds with high information asymmetry. Thus while we expect both principal-dealer and dual-capacity-dealer spreads to be higher on lower rated bonds, we expect net customer-interface spreads to be lower on low rated bonds. Similarly, the information asymmetry and thus the benefit from direct customer interface are likely higher on bonds which are rarely traded. Heavily traded bonds likely have more analysts following them and private information is more likely to have already been revealed through a previous trade. Thus, while we expect both principal-dealer and dual-capacity-dealer spreads to be negatively correlated with a bond's trading volume, we expect net customer interface costs to be positively correlated. Dual-capacity-dealers also have the opportunity of using any information arising from interfacing with customers to potentially manage their inventory in that particular corporate bond more profitably.

Both the asymmetric information and inventory management benefits of direct customer interface are arguably greater in periods of high volatility, when risk and potentially the degree of information asymmetry are high. Thus, while we expect both principal-dealer and dual-capacity-dealer spreads to be positively correlated with the VIX and MOVE indices, the net customer interface costs of dual-capacity-dealers should be negatively correlated with these indices.

3. Agent-dealer and principal-dealer spreads

3.1 Descriptive statistics

We use prices on agent-dealer and principal-dealer trades to separate, quantify, and analyze bond dealer compensation for agent and market-making services. The difference between the agent-dealer sale price to the non-dealer customer and the price at which the agent-dealer simultaneously buys the bonds from a principal-dealer (in a riskless principal trade) represents the agent-dealer's compensation for searching for counterparties, for order processing, and for managing customer relationships. Likewise, the price at which an agent-dealer resells bonds to a principal-dealer minus the price paid to the customer represents the agent-dealer's compensation for agent services on customer sale orders. Since they do not keep the bonds on their books, and have simultaneously arranged an offsetting trade with a principal-dealer, agent-dealers do not face inventory or asymmetric information risks. The difference between the principal-dealer sale and purchase prices represents the principal-dealer's compensation for bearing inventory and asymmetric information risks. This makes it possible to separate compensation for market-making and agent services. To prevent outliers possibly caused by TRACE data errors dominating the results, estimated spreads are winsorized at the 0.5% and the 99.5% level.[16]

Average agent-dealer spreads on riskless principal sales and purchases, presented in the second and third columns respectively of Table 3, are \$0.743 and \$0.299 respectively. Zero spreads are observed on about one-fourth of agent-dealer sales and about one-half of agent-dealer purchases. This could be because the trade is one leg of a round-trip portfolio rebalancing trade, and the spread is charged on just one of the legs of the round-trip. If this is the case, then while the sum of the sale and purchase spreads accurately reflects roundtrip transaction costs, the separate sale and purchase spreads in Table 3 do not. Another possibility is that the agent-dealer is providing this service as part of a bundle of other services to its client in which case the spreads in Table 3 understate true transaction costs.[17]

In the final column of Table 3, we present round-trip spread statistics for principal-dealer trades with agent-dealers. For this, we pair (when possible) each principal-dealer sale trade with a principal-dealer purchase trade on the same day, and each principal-dealer purchase trade with a

[16] There are several suspicious trade reports on TRACE, such as supposed trades well after the bond matured according to FISD or well before the bonds were issued.

[17] Alternatively, this could potentially be because of commissions being charged separately. However, dealers are asked to indicate on their TRACE trade reports if they charge a separate commission, though they are not required to report the amount. Very few report levying any commissions and, as mentioned earlier, we exclude from our sample those that do since we cannot observe the amount. Hence, assuming TRACE reporting is accurate in this regard, there are no additional commissions on the zero spread trades in Table 3.

same-day principal-dealer sale trade; and measure the spread as the principal-dealer sale price minus the principal-dealer purchase price. When there is more than one possible purchase (sale) trade with which a sale (purchase) trade can be paired, we choose the trade closest in size and, if more than one same size trade, we choose the trade closest in time. Note that since the final column is estimated only from (paired) principal-dealer sales and purchases on the same day, many principal-dealer sale and purchase trades cannot be part of the sample, particularly for relatively more illiquid bonds. Hence, this sub-sample tends to consist of the more actively traded bonds and the spreads in the final column should not be viewed as representative of all principal-dealer spreads. With this caveat in mind, we observe that the mean principal-dealer spread on same day trades is $1.20, and that is comparable in magnitude with average round trip agent-dealer spreads of $1.04. Full sample principal-dealer spread estimates are presented later in section 3.3.

3.2. Regression results

In Table 4, regressions are estimated for agent-dealer and principal-dealer spreads, with and without time dummies for the financial-crisis period. Rather than force the regression coefficients to be the same for both agent-dealer sales and agent-dealer purchases, separate regressions were estimated for sales and purchases in a two equation system. However, as discussed in section 3.1, it appears that total roundtrip transaction costs are sometimes levied in the sale and other times in the purchase rather than being charged separately, meaning that the separate sale and purchase coefficients are likely biased but that their sum should represent an unbiased measure of the impact on the roundtrip spread.[18] Consequently the implied impact on roundtrip spreads is reported in

[18] We also estimated separate Tobit regressions for sales and purchases. The results were qualitatively unchanged from the OLS estimations reported in Table 4.

Table 4. This also facilitates comparison with the principal-dealer spreads, which are necessarily roundtrip.

Principal-dealer spreads are measured as the difference in the prices on principal-dealer sales to and purchases from agent-dealers which requires pairing principal-dealer sales and purchases. For each principal-dealer sale to (purchase from) an agent-dealer, we first seek a purchase (sale) on the same day. If there is no same day trade, we match the sale (purchase) with the purchase (sale) that is closest in time in either direction out to a maximum of eight weeks. For spreads across different days, it is necessary to control for interest rate changes between the two days. For this, we construct a predicted price change variable based on the average percentage price change between the two trade dates for corporate bonds of the same rating and approximate maturity.[19] 48.4% of our matches are on the same day, 78.0% within two days and 89.3% within one week.

Regression results with White standard errors are reported in Table 4. We estimate regressions both with and without the time period dummies since they are correlated with the VIX and MOVE indices that tended to be highest during then 2008 financial crisis and gradually declined over 2009.

3.2.1. Bond market risk

We hypothesized above that due to inventory and/or asymmetric information risks, principal-dealer spreads should vary directly with bond market risk. This is clearly confirmed. As shown in the third and fifth columns in Table 4, the coefficients of both the VIX and MOVE indices

[19] For this we calculate percentage price changes as reported on TRACE for all bonds on TRACE divided into eighteen rating/maturity bond groupings: six rating classifications: AAA & AA, A, BBB, BB, B, and below B; and three maturity groupings: 1) three to five years, 2) five to ten years, and 3) over ten years. The predicted price change for the bond is then calculated as the price on the sale date times the average percentage price change between the sale and purchase dates for bonds in the same rating/maturity group.

are large, positive, and significant at the .001 level. According to the coefficients in the third column, a one point rise in the VIX leads to an increase of 2.97 cents in principal-dealer spreads and a one point rise in the MOVE index leads to a rise of 0.7 cents. A one standard deviation rise in the VIX raises the spread $0.342 and a one standard deviation rise in the MOVE raises the spread $0.244. Spreads were also higher in the financial crisis period than later. The results in the last column of Table 4 indicate that, even after controlling for the VIX and MOVE indices, for the average bond trade, principal-dealer spreads were about $1.10 higher in late 2008 than in 2010, and declined monotonically throughout 2009. In an unreported regression without VIX and MOVE, the 2008-2010 difference is $1.76.

We also hypothesized above that since they face no inventory or information risk, agent dealer spreads should be much less sensitive to the risk variables. The results in Table 4 are consistent with this. In the regressions without time dummies, the coefficients of the VIX and MOVE variables are miniscule and insignificant. In the regressions with time dummies, several are significant but coefficients are smaller than in the principal-dealer regression and signs are mixed. The coefficients in the fourth column imply that a one standard deviation change in the VIX is associated with only a $0.027 change in the agent-dealer spread. Agent-dealer spreads are actually negatively related to the MOVE index though again the economic significance is tiny: a point change in MOVE changes the spread by only 0.01 cents. Turning to the coefficients of the time dummies, the implication is that agent-dealer spreads were actually slightly lower in 2008 financial crisis period than in 2010.

In summary, as hypothesized, the results in Table 4 indicate that principal-dealer spread are strongly positively correlated with our measures of bond market risk but that agent-dealer spread coefficients are either insignificant or small and of inconsistent sign.

3.2.2. Liquidity

Our hypothesis that, due to inventory costs, principal-dealer spreads vary inversely with how actively a bond is traded is also clearly confirmed in that principal-dealer spreads are a strong negative function of the log of average daily trade volume. Similarly, our hypothesis that agent-dealer spreads vary inversely with liquidity as measured by trading volume (since search costs are higher for less liquid bonds) is also confirmed. However, our results indicate that agent-dealer spreads are much less sensitive to trading volume than principal-dealer spreads.

3.2.3. Rating and maturity

Our results indicate that both principal-dealer and agent-dealer spreads are significantly higher on longer time-to-maturity and lower-rated issues. Consistent with our hypothesis that inventory risk is higher on longer term bonds since their prices are more volatile, the coefficient in the final column implies that principal-dealer spreads are about $0.54 higher on 20-year bonds than on 5-year notes. Similarly, consistent with being less liquid, the results in column 4 imply that agent-dealer sale spreads tend to be about $0.74 higher on 20-year bonds than on 5-year notes.

Both agent-dealer spreads and principal-dealer spreads are higher on lower rated issues. The principal-dealer results are consistent with our expectations given that lower rated bonds are more volatile and probably have greater information asymmetry. The agent-dealer results are consistent with higher search costs on lower rated bonds. Our rating variable is in terms of modified ratings. In other words, the difference between A and A- rated issues is one rating unit and that between A and Baa rated issues is three. Thus, our results indicate each full (unmodified) rating drop is associated with an increase in the principal-dealer spread by about $0.13 and in the agent-dealer spread by about $0.10.

3.2.4. Trade size

The presence of three different trade size variables in the regressions makes it difficult to immediately determine from the coefficients in Table 4 how spreads vary with trade size. Hence, similar to EHP (2007), we use the coefficient estimates in Table 4 to estimate spreads on trade sizes ranging from 5 to 1000 bonds. The results are shown in Table 5 assuming all non-size variables are at their sample means.[20] Consistent with findings by EHP(2007) and others for dealer spreads in general, estimated principal-dealer spreads decline monotonically as trade size increases falling from \$1.63 for a trade of 5 bonds to \$0.53 for a trade of 1000 bonds.

In contrast, estimated agent-dealer spreads actually increase slightly until trade size exceeds 50 bonds, then decline. As explained in section 2.2, our interpretation of this finding (especially since order processing and customer interface costs likely have a fixed element) is that it indicates that agent-dealers devote less search effort to small trades. Notably, agent-dealer spreads are comparable in magnitude to principal-dealer spreads for all except very small trade sizes.

4. Dual-capacity-dealer spreads

Next we examine round-trip spreads on direct trades between dual-capacity-dealers and non-dealer customers, i.e., customer trades that do not go through an agent-dealer. For this we measure spreads as the difference between the prices of dual-capacity-dealer sales and dual-capacity-dealer purchases. Each dual-capacity-dealer sale is matched with the dual-capacity-dealer purchase that is closest in time, and vice-versa, where the maximum time between trades is eight weeks. We have a total of 1,786,271 dual-capacity-dealer sale-purchase pairs of which 69.2% are same day pairs.

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[20] For later comparison with the results for other samples, we calculate spreads at mean values for the non-size variables from the full sample of all trades, not just trades that go through agent dealers. Terms-to-maturity are slightly longer in that sample. Otherwise the means are very close.

4.1. Spread regressions

In Table 6, we estimate basically the same spread regressions for direct customer trades of dual-capacity-dealers as were estimated in Table 4 for principal-dealer-spreads on trades with agent-dealers. As noted above, TRACE truncates the reported trade sizes at 1000 bonds for speculative grade bonds and 5000 for investment grade. While very few trades involving agent-dealers were truncated, a number of dual-capacity-dealer trades are. Having observed in Tables 4 and 5 that principal-dealer spreads decline with trade size, it is possible that spreads are even lower on truncated trades. Hence, we add zero-one dummy variables to denote truncated trade sizes on dual-capacity-dealer trades expecting negative coefficients. We present results without and with time dummies for the financial crisis period.

As expected, qualitatively, most of the results for dual-capacity-dealer trades are very similar to those for principal-dealer trades. Again spreads are positively related to the VIX and MOVE indices (though not for the MOVE when the time dummies are included) and negatively related to trading volume although the relations are somewhat weaker than observed for principal-dealer spreads in Table 4. Similarly, spreads are higher in 2008 and early 2009 than later but the differences are not as great as in Table 4. As with principal-dealer spreads, dual-capacity-dealer spreads are higher on lower rated and longer maturity bonds. The weaker results are not surprising given that dual-capacity-dealer spreads represent not only market-making costs but also agent-role related customer relationship costs, and the dependence of the latter on risk-related variables should arguably be lower.

In column 2 of Table 7, we use the coefficients from Table 6 to estimate spreads on different size trades following the same procedure as in Table 5. All non-size variables are assumed to be at their sample means. As observed in Table 5 for trades of principal-dealers, spreads decline monotonically and sharply with trade size from $2.82 for trades of 5 bonds to $0.45 for trades of 1000 bonds.

4.2. Comparing transaction costs on trades with and without agent-dealers

One issue we wish to explore is how trading costs differ if a customer deals with a dual-capacity-dealer versus employing an agent-dealer. Since we observe both, it seems obvious that in some cases, customers find agent-dealers advantageous and in others not. Testing is complicated by the fact that we can never observe what trading costs would have been if bond buyers and sellers had made the other choice. With this caveat in mind, we explore how estimated costs differ. Since the data in Table 2 indicate that trades involving agent-dealers are much smaller, we examine how costs compare on same size trades. For this comparison, estimates of principal-dealer spreads and the total of principal-dealer plus agent-dealer spreads from Table 5 are repeated in the last two columns of Table 7. Again the non-size variables are assumed to be at their sample means in the overall sample of all trades.

For very small transactions of 10 bonds or less, total transaction costs are approximately the same whether the trade goes through an agent dealer or not. For medium to large trades, total transaction costs are considerably lower on trades directly between dual-capacity-dealers and non-dealer customers. This pattern explains what we observe in Table 2: that trades involving agent-dealers tend to be much smaller than direct trades with dual-capacity-dealers. However, since a large number of trades in the 50 to 100 bonds range go through agent-dealers, it appears that cost is not the sole criterion. One obvious possible reason is that agent-dealers provide search services. In other words, if the non-dealer customer does not employ an agent-dealer, it has to conduct its own search for the dual-capacity-dealer with the best price. While search-related cash costs may be higher if an agent-dealer is employed, total search costs including the non-dealer customer's own time may not be. In addition as discussed in section 2.4, informed traders may prefer to route trades through an agent-dealer to hide their identity from the market-maker.

5. All Trades: Combined Sample Evidence

In section 2 we examined the subset of trades that involve agent-dealers and in section 3 the subset of trades directly between dual-capacity-dealers and non-dealer customers. We now present evidence based on successive trades over the entire sample, which consists of these two sub-samples plus the unpaired-interdealer trades, employing an extension of the EHP (2007) procedure. This has several advantages. First, we are able to reduce the noise by comparing trade prices closer in time. For example, when estimating spreads on dual-capacity-dealer trades directly with non-dealer customers, we compared each dual-capacity-dealer sale to the closest dual-capacity-dealer purchase. The two trades could be several days apart with numerous trades of other types in-between; so, although we attempted to control for this, the price differences could reflect time-related changes in underlying prices that have not been fully controlled for - not just bid-ask spreads. In this section, we use price differences between successive trades regardless of type so time differences and price noise are smaller. Second, we are able to compare our spread estimates with those obtained applying the EHP (2007) procedure. EHP (2007) estimate spreads from prices differences between successive trades without distinguishing between agent-dealer, principal-dealer, and dual-capacity-dealer trades. For sales or purchases by agent-dealers, the trade closest in time is generally the accompanying trade between the agent-dealer and a principal-dealer. Thus we suspect that on these trades, the EHP (2007) procedure picks up only the agent-dealer spread and hence will tend to underestimate the full spread. In other words, if on a trade that goes through an agent-dealer the agent dealer's spread is x and the principal-dealer's spread is y, their procedure treats as two trades with transaction costs of *x* and *y* rather than two parts of a single trade with total transaction cost of *x+y*.

5.1. Estimation procedure

For this we employ a variant of the procedure developed by Harris and Piwowar (2006) and Edwards, Harris, and Piwowar (2007) (EHP). For each bond in their sample, EHP estimate:

$$r_{i,n-1,n} = \beta_{0,i}(Q_{i,n} - Q_{i,n-1}) + \sum_{j=1}^{4} \beta_{j,i}(Q_{i,n}S_{j,i,n} - Q_{i,n-1}S_{j,i,n-1}) + \sum_{k=1}^{3} \Upsilon_{k,i}\, \Delta Y_{k,i,n-1,n} + \varepsilon_{i,n-1,n} \tag{1}$$

In equation 1 (their equation 6), $r_{i,n-1,n}$ is the return on bond issue *i* between trades *n-1* and *n* adjusted for drift between the two trades. $Q_{i,n}$ is a dummy variable which is equal to 1 if trade *n* for bond *i* is a S trade (whether by an agent-dealer or a dual-capacity-dealer), equal to -1 if trade *n* is a B trade and equal to zero if a D trade (whether a sale to an agent-dealer, a purchase from an agent-dealer, or an unpaired interdealer trade). $S_{j,i,n}$ represents size measure *j* for trade *n* of bond *i*.[21] $\Delta Y_{k,n-1,n}$ measures the change in yield index *k* from *n-1* to *n*.[22] EHP (2007) estimate equation (1) separately for each bond *i,* then calculate representative spreads using a weighted average of the coefficients.

Our approach is similar in principle but differs in several ways. First, while EHP (2007) estimate a single dealer spread, we distinguish agent-dealer, principal-dealer and dual-capacity-dealer spreads. Second, while equation (1) assumes that all interdealer trades are equally likely to be sales and purchases, we sign those interdealer trades that are between principal-dealers and agent-dealers (i.e., those that are part of a riskless-principal trade.) Thus while EHP (2007) recognize

[21] EHP use four trade size measures: 1) the log of the trade size, 2) the reciprocal, 3) size, and 4) size squared. We use the first two and add the square root of trade size.

[22] EHP use three indices: a general bond index, the yield difference between long and short bonds, and the difference between high and low credit risk bonds. So $\beta_0 + \sum_{j=1}^{4} \beta_j S_{j,x}$ provides an estimate of the spread on trades of size x for both sales or purchases controlling for changes in market rates. As explained above we use a single variable based on the return on bonds of the same rating and similar maturity.

three trade types: dealer sales, dealer purchases, and interdealer trades and assume equal spreads on sales and purchases, we recognize seven: 1) agent-dealer sales, 2) dual-capacity-dealer sales, 3) principal-dealer sales, 4) agent-dealer purchases, 5) dual-capacity-dealer purchases, 6) principal-dealer purchases, and, 7) unpaired interdealer trades. For this, we accordingly estimate:

$$\left(P_{i,n} - P_{i,n-1}\right) = \alpha_0 + \sum_{m=1}^{6} \alpha_m\left(Q_{m,i,n} - Q_{m,i,n-1}\right) + \sum_{m=1}^{6} \sum_{j=1}^{8} \beta_{j,m}\left(Q_{m,n}X_{j,i,n} - Q_{m,n-1}X_{j,i,n-1}\right) + \Upsilon \Delta Y_{i,n-1,n} + \varepsilon_{i,n-1,n} \quad (2)$$

In equation 2, $P_{i,n}$ is the trade n price of bond i and $P_{i,n-1}$ is the price of the previous trade of the same bond.[23] The m subscript represents the trade type, i.e., 1) agent-dealer sales, 2) dual-capacity-dealer sales, 3) principal-dealer sales, 4) agent-dealer purchases, 5) dual-capacity-dealer purchases from non-dealers, or 6) principal-dealer purchases. $X_{j,i,n}$ represents variable j (e.g., VIX, bond rating, trade size, etc.) for bond i at the time of trade n. $Q_{m,i,n}$ is equal to 1 if trade n of bond i is of type m and 0 otherwise. Note that we define a dummy for each trade type except unpaired interdealer trades. Thus, $\beta_{j,m}$ estimates how variable j impacts the price difference between trades of type m and unpaired interdealer trades and $\beta_{j,m}$-$\beta_{j,p}$ estimates how variable j impacts the price difference between trades of type m and those of type p.

EHP (2007) estimate equation (1) separately for each bond and then average the $\beta_{j,i}$ coefficients over all bonds I, which they are able to do since their independent variables are time series. Since we wish to also estimate how spreads vary with cross-sectional bond characteristics, such as rating, maturity, and liquidity, we estimate equation (2) over all bonds.[24] Again we require

[23] EHP's dependent variable is in return form; ours in dollars. For bonds trading near par, the two measures are basically the same but differ somewhat for bonds trading at a discount or premium.

[24] Moreover, separate estimations for each bond would require a many observations and at least one trade of each type. Note that equation (1) has seven variables so requires at least nine observations to estimate. EHP (2007) report that this nine observation requirement eliminates approximately 20% of the bonds in their sample. For each variable j, we estimate separate coefficients for each trade type m so estimation of our type model would require J+2

that trades *n-1* and *n* be no more than eight weeks apart yielding a sample of 5,754,632 *n-1* and *n* trade pairs of the same bonds. The mean time between any two trades is 0.34 days, but of course this is highly skewed, with 87.0% of the successive trade pairs on the same day. When not on the same day, the average is 2.59 days.

5.2 Results

Results of the estimation of equation (2) are reported in Table 8. To make the economic meaning of these results clearer, we report the implied impact of variable *j* on our three spreads of interest: agent-dealer spreads, principal-dealer spreads, and dual-capacity dealer spreads, rather than the individual coefficients, $\beta_{j,m}$. Thus in Table 8 we report the following coefficient combinations:

1) For principal-dealer spreads: $\beta_{j,\text{principal-dealer sales}} - \beta_{j,\text{ principal-dealer purchases}}$

2) For dual-capacity-dealer spreads: $\beta_{j,\text{ dual-capacity-dealer sales}} - \beta_{j,\text{ dual-capacity-dealer purchases}}$.

3) For agent-dealer-spreads: $(\beta_{j,\text{ agent-dealer sales}} - \beta_{j,\text{ principal-dealer sales}}) +$

$(\beta_{j,\text{ principal-dealer purchases}} - \beta_{j,\text{ agent-dealer purchases}})$

So the estimates in columns 2-4 of Table 8 show the estimated impact of variable *j* on the three spreads. Standard errors for the three coefficient combinations corrected for heteroskedasticity using the NeweyWest procedure are reported in parentheses. '*' and '**' denote coefficient combinations significantly different from zero at the 5% and 1% levels respectively. In the final column of Table 8 we also report estimates of how net customer interface costs of dual-capacity-dealers vary with each variable *j*; these will be discussed separately in section 5.3 below.

5.2.1. Market risk variables

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observations of each trade type m where J is the number of independent variables.

As hypothesized, since market-making risks should increase in periods of greater price uncertainty and paralleling our results in sections 3 and 4, principal-dealer spreads and dual-capacity-dealer spreads are both significantly and positively correlated with the VIX and MOVE indices. A one-point increase in the VIX is associated with an increase in principal-dealer spreads of 2.07 cents, and dual-capacity-dealer spreads of 1.35 cents. A one-point increase in the MOVE index is associated with an increase in principal-dealer spreads of 0.73 cents, and dual-capacity-dealer spreads of 0.12 cents. We argued above that since they do not hold inventories, agent-dealer spreads should depend only on the costs arising from the dealer's role as agent and vary little, if at all with price risk. Consistent with this, as reported in column 3 of Table 8, agent-dealer spreads are not significantly related to either the VIX or MOVE indices.

5.2.2. Liquidity

Consistent with our previous results, and our hypothesis that both market-making and search costs are higher for illiquid bonds, Table 8 shows that principal-dealers, agent-dealers, and dual-capacity-dealers all demand more compensation for bonds with lower trading volume: all these spreads are significant negative functions of the bond's trading activity. As with the MOVE and VIX, the impact is greatest for dealers acting purely in market-making capacity, i.e., principal-dealers, and relatively weaker for dealers acting purely as an agent, or in a dual capacity.

5.2.3. Rating and maturity

Paralleling our results in sections 2 and 3, principal-dealer, agent-dealer, and dual-capacity-dealer spreads are all higher for lower rated and longer maturity bonds. As discussed above, for principal-dealers and dual-capacity-dealers this is probably due to the higher price risk on low rated and longer maturity bonds and probably also due to liquidity. The higher agent-dealer spreads are possibly due to lower liquidity and higher search costs. The impacts are of comparable orders of magnitude.

5.2.4. Trade Size

In Table 9, we report estimated spreads by trade size based on the regression coefficients in Table 8. For these calculations, we assume that the non-size variables, such as bond maturity and rating, are at their sample means. Principal-dealer spread estimates in Table 9 tend to be smaller than the subsample estimates in Table 5, and agent-dealer spreads tend to be larger. However, total round trip transaction cost estimates combining agent-dealer and principal-dealer spreads are approximately the same except for very small trades. The patterns as trade size rises are identical to those estimated earlier. Principal-dealer spreads decline monotonically and sharply with trade size. Agent-dealer spreads rise until trade size exceeds about 50 bonds, then decline. This pattern is consistent with reduced agent-dealer search on smaller trades. Dual-capacity-dealer spreads are somewhat smaller than the subsample estimates in Table 7 but again the pattern is identical in that spreads decline sharply with trade size.

Similar to Table 7, in Panel B of Table 9, we compare total explicit transaction costs if a trade is routed through an agent dealer (i.e., agent-dealer spread plus principal-dealer spread) with the transaction cost if the customer trades directly with a market maker (i.e., dual-capacity-dealer spreads). In section 4 and Table 7 we found that (based on the two subsamples) for very small trades of 5 or 10 bonds, estimated total explicit transaction costs were roughly the same whether or not the trades went through an agent-dealer, but that for larger trades, monetary cash transaction costs were decidedly lower for trades directly between dual-capacity-dealers and non-dealer customers. Comparing the two columns in Panel B of Table 9, the conclusions remain the same. Except for the smallest sized trades – i.e., trades of only five bonds where estimated round-trip transaction costs are \$2.46 for trades that go through an agent-dealer and \$2.49 for trades that do not – spreads for trades executed by customers directly with dual-capacity-dealers are much lower than for trades executed by customers through agent-dealers. Transaction costs decrease rapidly for direct trades with dual-capacity-dealers, and much more slowly for trades executed through agent-dealers. For trades of 100 bonds, the estimates are \$2.22 for trades that go through an agent-dealer and \$1.16 for trades that do not; and for trades of 1000 bonds: \$1.10 and \$0.29. It bears repeating that these are just the explicit costs. For trades through an agent-dealer, the agent-dealer bears the search cost; for trades with market-maker, the customer. Also, informed traders may prefer the anonymity the agent-dealer provides.

5.3. Customer interface benefits of dual-capacity-dealers

Since dual-capacity-dealers bear both the cost of making a market in the bonds and of managing the customer relationship while principal-dealers costs are solely market-making costs, implied net customer interface costs of dual-capacity-dealers may be calculated as the difference between dual-capacity-dealer spreads and principal-dealer spreads. As discussed in section 2.4 above, these costs are net because the direct customer interface may benefit the dual-capacity-dealer since, from her knowledge of the trader, she may be able to infer how informed the trader is and also may be able to use knowledge from the customer interface to manage her inventory.

We next explore how these implied customer interface costs vary with relevant factors, such as trade size, bond rating and maturity, liquidity, and market conditions. Specifically, referring to equation 2, we estimate the impact of factor j on the net customer interface costs of dual-capacity-dealers as:

$$(\beta_{j,\text{ dual-capacity-dealer sales}} - \beta_{j,\text{ principal-dealer sales}}) + (\beta_{j,\text{ principal-dealer purchases}} - \beta_{j,\text{ dual-capacity-dealer purchases}})$$

As discussed in Section 2.4, since information asymmetry is likely higher on low rated and rarely traded bonds, we hypothesized that net customer interface costs of dual-capacity-dealers increase with trading volume and decline as the credit rating worsens. Since, the benefits of knowing the customer and how informed he is are greater when risk and information asymmetry are high, we also expect net customer benefits to be negatively correlated with the VIX and MOVE indices.

Our results on the variation of customer-interface costs with VIX, MOVE, trading volume, bond maturity, and credit rating are presented in the final column of Table 8. This table also presents the variation with trade size variables, but because of the concomitant presence of three different trade size variables, it is difficult to easily visualize the impact of trade size. Hence, the variation of implied customer interface costs with trade size corresponding to the scenario in which all other variables are at their sample means, is presented in the final column of Panel A of Table 9.

As expected, net customer interface costs are higher for more liquid bonds. Similarly, as expected, net customer interface costs decrease very significantly with an increase in risk as measured by VIX or MOVE – an increase of one point in VIX (or MOVE) decreases customer interface costs (and hence arguably increases information benefits for dual-capacity-dealers from customer interface) by 0.72 cents (or 0.61cents). Customer interface costs are also significantly lower for bonds with greater credit risk. Finally, customer interface costs are relatively large in magnitude for small trades, and decrease sharply on a per-bond basis as trade size increases. This is consistent both with customer interface costs having a fixed per trade component and/or with larger trades potentially providing greater information benefits to dual-capacity dealers. Overall, our results are consistent with dual-capacity-dealers obtaining significant informational benefits from interfacing with customers and directly executing their trades.

5.4. Comparing our transaction cost estimates with previous studies.

The main earlier paper estimating corporate bond transaction costs is the seminal paper by EHP (2007) from which we have borrowed heavily. EHP (2007) recognize three trade types: 1) dealer sales or "S" trades (which combine our agent-dealer sales and dual-capacity-dealer sales to non-dealer customers), 2) dealer purchases or "B" trades (which combine our agent-dealer purchases and dual-capacity-dealer purchases from non-dealer customers), and 3) interdealer or "D" trades (our principal-dealer sale and purchase transactions with agent-dealers, and unpaired interdealer trades). On the other hand, we recognize seven trade types (as discussed earlier), and estimate agent-dealer, principal-dealer, and dual-capacity-dealer spreads separately.

We suspect that their procedure tends to underestimate average overall bond transaction costs including both trades that go through an agent and those that do not. In their procedure each trade is compared with the immediately preceding and following trade and any D trade is considered as being equally likely to be at the bid or ask and thus represents the expected bid-ask midpoint. Consider an S trade. For sales by a dual-capacity-dealer, there is no problem but if the S trade is a sale by an agent dealer, then either the immediately following or prior trade will normally be the agent-dealer's purchase from a principal-dealer -- in other words a D trade which is treated as equally likely to be at the bid or ask but is clearly at the principal-dealer's ask. Hence, in their estimation procedure, the difference between the S and D trades will be treated as representing the total spread on the transaction when in fact it only measures the agent-dealer's spread and excludes the principal-dealer's. Since the trades that go through an agent-dealer tend to be considerably smaller than those directly with a dual-capacity-dealer, we expect this underestimation of total transaction cost to be greatest on smaller trades.

To explore how much difference this makes, we estimate equations (1) and (2) over the same sample with the same variables and report the resulting transaction cost estimates in column 2 of Table 10. Note that this does not duplicate exactly the procedure in EHP (2007). First, whereas they include only trade size as a spread determinant, we include measures of bond rating and maturity, market uncertainty, and bond liquidity in both estimations. Second, they estimate equation (1) separately for each bond and average the coefficients while we estimate a single equation. Thus, comparing transaction cost estimates from our estimation of equation (1) with those resulting from our estimation of equation (2), which are reproduced in columns 3 and 4 of Table 10, reveals how treating all S and B trades alike (whether by agent-dealers or dual capacity-dealers) and all interdealer D trades as equally likely to be at the bid or ask (whether a principal-dealer sale or purchase) impacts the transaction cost estimates but does not exactly mimic EHP's estimates.

As shown in Table 10, for trades of less than 100 bonds, transaction cost estimates based on equation (1) are clearly lower than those based on estimates of equation (2) and this holds both for trades that go through an agent-dealer and those that do not. As seen in Panel B of Table 9, for all but the smallest trades, transaction cost estimates from equation (2) are much lower on direct trades between a dual-capacity-dealer and a customer, than on trades that go through an agent-dealer. Equation (1) estimates a single transaction cost for both, which for trades of more than 100 bonds, lies between the two equation (2) estimates - though closer to the lower. Clearly, the equation (1) procedure, which does not recognize that total transaction costs on trades that go through an agent-dealer consist of two spreads, tends to under-estimate total transaction costs on these trades.

6. Conclusions

The trading costs of customers impound not just the costs of dealers arising from their market-making role, but also the counterparty search costs and the customer-interface related costs and benefits arising from dealer's role as agent. We significantly extend extant empirical research on corporate bond market dealer spreads by separately estimating dealers' costs arising from their agent and market making roles, and examining their determinants in the context of the theory underpinning market-making, search costs and the informational benefits to dealers from direct customer access. This also enables us to correct for the underestimation of overall trading costs in earlier research for trades involving an agent-dealer.

Our empirical investigation is based on the large subset of riskless principal trades reported in the TRACE corporate bond database. Using these trades, we are able to isolate, 1) the trades of agent-dealers whose trading capacity in that trade is purely that of an agent for a non-dealer customer; 2) the trades of principal-dealers whose trading capacity in that trade is purely that of a market-maker with no customer interface; and 3) the trades of dual-capacity-dealers whose trading capacity in that trade includes a customer interface as well as functioning as a market maker providing liquidity from their own inventory. We estimate the dealer spreads for each of these categories and analyze how they vary with bond characteristics and market conditions.

We document several interesting results. First, dealer costs arising from their role as agent are large and comparable in magnitude to the costs arising from their market-making role. Second, consistent with search-based models, agent-related dealer costs do not vary (or vary very little) with measures of market uncertainty – measures like the VIX for equity market volatility and the MOVE index of interest rate volatility – while, market-making costs increase significantly (as expected) with these risk measures. Third, while market-making costs decline sharply as trade size increases (consistent with earlier evidence), agent-related costs tend to increase with trade-size, but level off and then decrease beyond a level, consistent with agent-dealers (probably rationally) conducting less price search on smaller trades. Fourth, both market-making costs and agent-related costs increase as trading volume decreases, and for lower rated and longer maturity bonds, consistent with market-making costs being affected by risk and liquidity factors, and agent-related costs by liquidity factors. Fifth, except for very small trades, explicit transaction costs (i.e., not including the trader's own search costs) are significantly lower if the trader trades directly with a dual-capacity dealers rather than trading through an agent-dealer. Unsurprisingly therefore, relatively large trades are usually done directly with dual-capacity-dealers, with the customers involved potentially bearing the associated search costs themselves. Sixth, net customer interface costs faced by dual-capacity-dealers are also reasonably large in magnitude, albeit significantly smaller than market making costs, but decrease sharply on a per-bond basis as trade size increases. Seventh, consistent with dual-capacity-dealers benefitting from knowing whom they are trading with and thus possibly being able to separate informed from uninformed traders, net customer interface costs are lower on lower rated and sparsely traded issues. Also, consistent with the customer interface being more valuable when price uncertainty is high, net customer interface costs are negatively correlated with the VIX and MOVE indices. Finally, as expected, the EHP (2007) procedure tends to underestimate total transaction costs of trades that involve both an agent-dealer and a principal-dealer. Thus spreads on small trades are considerably larger than those estimated heretofore.

Our results have important implications not just for corporate bond markets, but also for the extensive extant empirical research on dealer spreads in other OTC markets that has also not hitherto accounted for the costs of dealers arising from their agent role. The exploration of these implications will undoubtedly be a subject for future research.

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Table 1 - TRACE Data Example

Trades of Alcoa's 5.5% notes maturing Feb 1, 2017 on July 29, 2010 between 9:24 and 12:01 as reported on TRACE are shown. Columns 2-6 repeat data from TRACE. Our trade classifications are shown in column 7. We classify paired B & D trades (or S & D) trades when the trades are within one minute of each other and the quantities are identical [or the sum of the B (S) trades equals the D quantity] as "agent-dealer purchase" and "principal-dealer purchase" (or "agent-dealer sale" and "principal-dealer sale) respectively. Unpaired B and S trades are classified as "dual-capacity-dealer purchases" and "dual-capacity-dealer sales" respectively. Unpaired D trades are classified as "interdealer unpaired". The two unclassified trades in column 7 are intermediate trades or duplicates.

Trade	Time	Message sequence #	Price	Trace code	# of bonds	Classification
1	9:24:55	2798	102.309	D	10	Principal-dealer purchase
2	9:24:56	2799	101.797	B	10	Agent-dealer purchase
3	10:09:00	6027	101.028	B	25	Dual-capacity-dealer purchase
4	10:23:10	7321	102.042	D	16	Principal-dealer sale
5	10:23:10	7328	103.419	S	16	Agent-dealer sale
6	10:48:30	10062	102.5	D	3000	Interdealer unpaired
7	10:49:27	10134	102.222	D	20	Principal-dealer purchase
8	10:49:27	10137	100.722	B	20	Agent-dealer purchase
9	10:49:27	10138	102.222	D	20	
10	10:50:20	10213	102.112	D	20	Principal-dealer sale
11	10:50:20	10217	103.49	S	20	Agent-dealer sale
12	11:13:12	12935	102.749	S	25	Agent-dealer sale
13	11:13:12	12937	102.749	D	25	Principal-dealer sale
14	11:16:49	13374	103.516	S	25	Agent-dealer sale
15	11:16:52	13337	102.745	D	25	Principal-dealer sale
16	11:16:52	13340	102.745	D	25	
17	11:39:48	16259	103.901	S	10	Agent-dealer sale
18	11:39:55	16232	102.745	D	10	Principal-dealer sale
19	11:42:00	16511	101.25	B	100	Dual-capacity-dealer purchase
20	11:51:00	17524	101.75	B	5	Dual-capacity-dealer purchase
21	11:54:00	17854	103.017	S	10	Dual-capacity-dealer sale
22	12:01:00	18636	103.745	S	2	Dual-capacity-dealer sale

Table 2 - Descriptive Statistics for Paired and Unpaired Trades					
Numbers of trades and statistics on trade size are reported for 5,839,480 trades of industrial bonds on TRACE between November 3, 2008 and December 31, 2010. TRACE classifies trades as purchase (B), sale (S), and interdealer (D). We classify S & D (or B & D) trades that are within one minute of each other and of identical quantity [or the sum of the S (or B) trades equals the D quantity] as "agent-dealer sales" (or "agent-dealer purchases") and "principal-dealer sales" (or "principal-dealer purchases") respectively. The remaining unpaired S, B, and D trades are termed as "dual-capacity-dealer sales", "dual-capacity-dealer purchases", and "interdealer unpaired" respectively. TRACE truncates trade sizes at 5000 bonds (par value $5,000,000) for investment grade bonds and 1000 bonds for speculative grade bonds which affects the reported means and standard deviations, but not the medians.					
			Trade size in bonds		
Trade type	# trades	% of trades	Median	Mean	Std. dev.
Dual-capacity-dealer sale	1,344,597	23.03%	40	498.1	1085.2
Agent-dealer sale	871,349	14.92%	15	42.2	179.2
Principal-dealer sale	855,873	14.66%	16	42.9	181.4
Interdealer unpaired	926,404	15.86%	90	538.0	1048.7
Principal-dealer purchase	458,737	7.86%	11	71.4	329.6
Agent-dealer purchase	472,229	8.09%	10	69.4	324.3
Dual-capacity-dealer purchase	910,291	15.59%	100	681.3	1261.0
All	5,839,480	100.00%	25	330.0	887.7

Table 3 - Agent-dealer and Principal-dealer Spread Statistics			
Statistics are presented for agent-dealer and principal-dealer spreads on trades involving both dealer types from November 3, 2008 through December 31, 2010. Agent-dealer spreads on sales are measured as the price at which the agent-dealer sells bonds to the customer minus the price at which the agent-dealer simultaneously buys the bonds from a principal-dealer who makes a market in the bonds. Agent-dealer spreads on purchases are measured as the price at which the agent-dealer resells the bonds to a principal-dealer minus the price at which the agent-dealer buys the bonds from the customer. Principal-dealer spreads are measured as the difference between principal-dealer's sale and purchase prices on trades with agent-dealers. The principal-dealer spread sample is restricted to same day sales and purchases so excludes less actively traded bonds.			
	Agent-dealer spreads		Roundtrip principal-dealer spreads (same-day trades)
	Sales	Purchases	
Mean spread	\$0.743	\$0.299	\$1.195
Median	\$0.600	\$0.000	\$0.895
Standard deviation	\$0.743	\$0.517	\$1.302
% Zero	22.86%	51.47%	
Observations	871,349	472,229	530,214

Table 4 - Agent-dealer and Principal-dealer Spread Regressions				
Spreads on corporate bond transactions involving both an agent-dealer that organizes a riskless principal trade and a market-making principal-dealer are regressed on: 1) the VIX, 2) the MOVE index of interest rate uncertainty, 3) bond's liquidity measured by the log of the average daily trade volume, 4) the log of the bond's maturity, 5) the bond's rating, and 6) measures of trade size. For principal-dealer spreads based on trades on different days, a variable measuring the average price change on bonds of the same rating and similar maturity is included. Equations for agent-dealer sales and purchases are estimated separately and the combined impact on round trip spreads is reported below. In Panel B, time period dummies are added. White standard errors are reported in parentheses. * and ** designate coefficients significantly different from zero at the .05 and .01 levels respectively.				
	Panel A - No time dummies		Panel B - With time dummies	
	Agent-dealer spreads	Principal-dealer spreads	Agent-dealer spreads	Principal-dealer Round trip
Intercept	-0.3113** (.0109)	1.1193** (.0195)	-0.3941** (.0124)	1.8608** (.0217)
VIX index (x100)	0.0222 (.0128)	2.9692** (.0223)	0.2305** (.0208)	1.4374** (.0356)
MOVE index (x100)	0.0077 (.0042)	0.6964** (.0068)	-0.0146* (.0057)	0.1443** (.0088)
log of avg. daily bonds traded - 6 months	-0.0224** (.0008)	-0.2776** (.0015)	-0.0244** (.0008)	-0.2846** (.0015)
log of years to maturity	0.5310** (.0020)	0.3802** (.0032)	0.5341** (.0020)	0.3929** (.0031)
rating	0.0346** (.0003)	0.0422** (.0005)	0.0355** (.0003)	0.0449** (.0005)
dummy for withdrawn rating	0.0659** (.0126)	0.3430** (.0191)	0.0877** (.0126)	0.4301** (.0190)
log of trade size (in bonds)	0.1888** (.0024)	-0.1639** (.0042)	0.1870** (.0024)	-0.1609** (.0042)
reciprocal of trade size -	-0.3380** (.0101)	0.4215** (.0229)	-0.3298** (.0101)	0.4338** (.0228)
square root of trade size	-0.0524** (.0005)	-0.0049** (.0006)	-0.0522** (.0005)	-0.0062 (.0006)
2008 November - December			-0.1267** (.0103)	1.1007** (0.0186)
2009 first quarter			-0.0021 (.0064)	0.8883** (.0107)
2009 second quarter			0.0216** (.0046)	0.7793** (.0074)
2009 second half			0.0658** (.0031)	0.3464** (.0039)
Average price change on same rating/maturity bonds		0.5889** (.0034)		0.5933** (.0034)
Observations	1,343,578	1,087,358	1,343,578	1,087,358

Table 5 - Estimated Round-trip Agent-dealer and Principal-dealer Spreads by Trade Size

Based on the coefficient estimates in Table 4 (for the regressions without time dummies), round trip agent-dealer and principal-dealer spreads are estimated by trade size for trades involving both dealer types. Estimates are at the overall sample means for all non-trade-size variables.

Trade size (# bonds)	Agent-dealer	Principal-dealer	Total
5	$0.984	$1.628	$2.612
10	$1.100	$1.468	$2.568
25	$1.197	$1.283	$2.481
50	$1.227	$1.151	$2.377
100	$1.207	$1.019	$2.226
250	$1.078	$0.838	$1.916
500	$0.867	$0.691	$1.558
1000	$0.513	$0.532	$1.044

Table 6 - Spread Regressions for Dual Capacity Dealer Trades

Roundtrip spreads on direct trades between a dual-capacity-dealer and non-dealer customer are regressed on: 1) the VIX, 2) the MOVE index of interest rate uncertainty, 3) bond's liquidity as measured by the log of the average daily trade volume, 4) the log of the bond's maturity, 5) the bond's rating, and 6) measures of trade size. For dual-capacity-dealer spreads based on trades on different days, a variable measuring the price change on bonds of the same rating and similar maturity is included. In the second regression time period dummy variables are included. White standard errors are reported in parentheses. * and ** designate coefficients significantly different from zero at the .05 and .01 levels respectively.

	Without time dummies			With time dummies	
	Coefficient	Std. error		Coefficient	Std. error
Intercept	2.8313**	(.0122)		3.1260**	(.0142)
VIX index (x100)	1.7206**	(.0151)		1.1880**	(.0243)
MOVE index (x100)	0.1670**	(.0048)		-0.0243**	(.0062)
Log of avg. daily bonds traded - 6 months	-0.1125**	(.0011)		-0.1243**	(.0011)
Log of years to maturity	0.5109**	(.0018)		0.5137**	(.0018)
Average rating	0.0705**	(.0003)		0.0718**	(.0003)
Dummy for withdrawn rating	0.7010**	(.0109)		0.7499**	(.0108)
2008 November - December				0.2843**	(.0125)
2009 first quarter				0.3946**	(.0075)
2009 second quarter				0.3588**	(.0051)
2009 second half				0.1136**	(.0031)
Log of trade size (in bonds)	-0.7148**	(.0019)		-0.7165**	(.0019)
Reciprocal of trade size	-2.0491**	(.0174)		-2.1299**	(.0173)
Square root of trade size	0.0343**	(.0002)		0.0344**	(.0002)
Trade size truncated	-.3841**	(.0039)		-.3914**	(.0039)
Average ΔP on same rating/maturity bonds	0.5607**	(.0053)		0.5609**	(.0053)
Adjusted r-square	.302			.306	
Observations	1,783,076			1,783,076	

Table 7 - Comparing Spreads on Trades with and without Agent-dealers			
Based on the coefficient estimates in tables 4 and 6, dealer spreads are estimated for round-trip trades directly between a dual-capacity-dealer and a non-dealer customer, and for trades that go through an agent-dealer. For the latter we estimate both the principal-dealer's spreads and the total transaction cost including the estimated agent-dealer spread. Spreads are estimated setting the non-trade size variables at their overall sample means.			
Trade size	Dual-capacity-dealer spreads	Trades involving agent-dealers	
		Principal-dealer spreads	Total including agent-dealer spreads
5	\$2.820	\$1.628	\$2.612
10	\$2.561	\$1.468	\$2.568
25	\$2.092	\$1.283	\$2.481
50	\$1.708	\$1.151	\$2.377
100	\$1.334	\$1.019	\$2.226
250	\$0.891	\$0.838	\$1.916
500	\$0.624	\$0.691	\$1.558
1000	\$0.448	\$0.532	\$1.044

Table 8 - Transaction Cost Relations based on Successive Trades over the Complete Sample

We estimate the equation

$$(P_{i,n} - P_{i,n-1}) = \alpha_0 + \sum_{m=1}^{6} \alpha_m (Q_{m,i,n} - Q_{m,i,n-1}) + \sum_{m=1}^{6} \sum_{j=1}^{8} \beta_{j,m} (Q_{m,n} X_{j,i,n} - Q_{m,n-1} X_{j,i,n-1}) + \Upsilon \Delta Y_{i,n-1,n} + \varepsilon_{i,n-1,n}$$

where $P_{i,n}$ is the trade n price of bond i and $P_{i,n-1}$ is the price of the previous trade of the same bond. The m subscript represents the trade type, i.e., 1) agent-dealer sales, 2) dual-capacity-dealer sales, 3) principal-dealer sales to agent-dealers, 4) agent-dealer purchases, 5) dual-capacity-dealer purchases, or 6) principal-dealer purchases from agent-dealers. $Q_{m,i,n}$ = 1 if trade n of bond i is of type m and 0 otherwise. $X_{j,i,n}$ represents variable j (e.g., VIX, bond rating, trade size, etc.) for bond i at the time of trade n. For ease of interpretation, the results are reported in transaction cost form, e.g, for principal-dealer spreads we report $\beta_{j,a} - \beta_{j,b}$ where $\beta_{j,a}$ is the coefficient for principal-dealer sales to agent-dealers and $\beta_{j,b}$ is the coefficient for principal-dealer purchases from agent-dealers. White standard errors are reported in parentheses. * and ** denote parameter estimates significantly different from zero at the .05 and .01 levels respectively.

	Principal-dealer spreads	Agent-dealer spreads	Dual-capacity dealer spreads	Implied customer interface costs of dual-capacity-dealers
Intercepts (α_m)	0.3015** (.0152)	-0.0649** (.0155)	2.5311** (.0131)	2.2296** (.0182)
VIX index (x100)	2.0707** (.0222)	-0.0342 (.0206)	1.3507** (.0185)	-0.7200** (.0256)
MOVE index (x100)	0.7286** (.0072)	0.0017 (.0067)	0.1199** (.0057)	-0.6087** (.0083)
log of avg. daily bonds traded - 6 months	-0.1599** (.0010)	-0.0380** (.0012)	-0.0635** (.0012)	0.0973** (.0013)
log of years to maturity	0.2976** (.0028)	0.5364** (.0026)	0.4370** (.0021)	0.1393** (.0032)
average rating	0.0435** (.0005)	0.0287** (.0005)	0.0363** (.0003)	-0.0072** (.0006)
Log of trade size (in bonds)	-0.1225** (.0035)	0.1917** (.0034)	-0.6206** (.0017)	-0.4981** (.0037)
Reciprocal of trade size	0.2909** (.0150)	-0.3142** (.0148)	-1.7373** (.0147)	-2.0237** (.0186)
Square root of trade size	-0.0065** (.0006)	-0.0052** (.0006)	0.0025** (.0002)	0.0031** (.0006)
Average ΔP for same rating/maturity bonds	0.4382** (.0041)			
Adjusted r-square	.437			

Table 9 - Estimated Spreads by Trade Size based on Table 8 estimations

Spreads are estimated for different trade sizes based on the equation (2) estimation results in Table 8 for sample mean values of the non-size variables. In Panel A, we report estimates of round-trip spreads for the three dealer types and for the net customer interface costs of dual-capacity-dealers. In panel B, we report estimated total spreads for trades that go through both an agent-dealer and a principal-dealer vs. trades that are executed by customers directly with a dual-capacity-dealer.

Panel A - Estimated spreads for trades involving both an agent-dealer and a principal-dealer

	Principal-dealer spreads	Agent-dealer spreads	Dual-capacity-dealer spreads	Customer interface costs of dual-capacity-dealers
5	$1.070	$1.391	$2.494	$1.423
10	$0.950	$1.507	$2.260	$1.310
25	$0.809	$1.605	$1.841	$1.033
50	$0.704	$1.637	$1.498	$0.793
100	$0.598	$1.620	$1.158	$0.561
250	$0.446	$1.495	$0.745	$0.300
500	$0.317	$1.288	$0.482	$0.165
1000	$0.171	$0.939	$0.285	$0.114

Panel B - Estimated spreads for trades involving an agent-dealer (and a principal-dealer) vs. trades executed directly by customers with a dual-capacity-dealer

Trade size	Agent dealer spreads + principal-dealer spreads	Dual capacity dealer spreads	Difference	
5	$2.461	$2.494	$-0.033	
10	$2.457	$2.260	$0.197	
25	$2.414	$1.841	$0.573	
50	$2.341	$1.498	$0.844	
100	$2.218	$1.158	$1.060	
250	$1.941	$0.745	$1.196	
500	$1.605	$0.482	$1.123	
1000	$1.110	$0.285	$0.825	

Table 10 - Comparing our Transaction Cost Estimates with estimates based on Edwards, Harris, Piwowar (2007)

We compare our estimates of corporate bond trading costs based on the equation (2) estimates in Table 8 with trading cost estimates based on estimates of equation (1) from Edwards, Harris, Piwowar (2007). Equation (2) estimates total round-trip spreads on trades that go through an agent-dealer as consisting of two spreads: the agent-dealer's spread on the riskless principal trade and the principal-dealer's spread on the trade with the agent-dealer. It also estimates separate spreads for dual-capacity-dealer trades (with non-dealers) and principal-dealer trades (with agent-dealers). Equation (1) estimates a single dealer spread for all trades.

Trade size (in bonds)	Transaction costs based on estimates of equation (1)	Transaction Costs based on estimates of equation (2)	
		Trades involving an agent-dealer	Dual-capacity-dealer trades
5	\$2.045	\$2.461	\$2.494
10	\$1.944	\$2.457	\$2.260
25	\$1.684	\$2.414	\$1.841
50	\$1.447	\$2.341	\$1.498
100	\$1.199	\$2.218	\$1.158
250	\$0.873	\$1.941	\$0.745
500	\$0.639	\$1.605	\$0.482
1000	\$0.424	\$1.110	\$0.285