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Abstract

Utilizing subsets of trades in which dealers act purely as agents, purely as market-makers, and as both, 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 find that agent-related spreads are large and comparable in magnitude to market-making spreads. In their role as agents, dealers face liquidity-search 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 market risk variables, agent-related spreads are not, depending instead on liquidity driven variables. While market-making spreads are inversely related to trade size, agent-related spreads increase with trade size before leveling off and then declining -- possibly indicating that agent-dealers devote less search time to relatively small trades. Market makers trade both with dealers functioning as agents and directly with investors; our evidence indicates that market makers derive an information benefit from direct interaction with traders especially when risk and information asymmetry is high. Except for very small trades, explicit transaction costs of non-dealer customers are lower when they trade directly with market-making dealers than when they route trades through a dealer acting purely as an agent. Our evidence indicates that bond traders tend to employ agent-dealers when the cost of the agent is low relative to the trader's internal search costs. Finally, we show that many existing studies have underestimated average overall trading costs in the corporate bond market by failing to account for both the agent-dealer spread and market-making dealer spread on trades which involve both. Given our findings on the size and economic determinants of agent-related dealer costs, our results have significant implications for the extensive empirical literature on dealer spreads in 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, as in most over-the-counter markets, 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 dealer can function purely as an agent, purely as a 'market-maker', or both. If a trade goes through an agent-dealer, the customer's total transaction costs include two spreads: that of the agent-dealer and that of the market-making dealer (hereafter principal-dealer). Agent-dealer spreads impound counterparty search costs (Duffie, 2012) and customer interface costs and benefits. The principal-dealer's spread impounds market-making costs, i.e., inventory and asymmetric information costs and risks. As in other over-the-counter markets,[2] existing empirical studies of corporate bond dealer spreads generally do not distinguish between the two spreads and have treated dealer spreads as primarily representing market making costs. By treating trades that go through an agent dealer as two separate trades, not parts of the same trade, most extant estimates of corporate bond trading costs based on the TRACE data, tend to underestimate total bond transaction costs.[3]

In this paper, we separately investigate dealer spreads arising from dealers' market-making and agent roles, and analyze their determinants. We also explore the possible informational advantage market making dealers gain from dealing directly with customers, rather than with a dealer acting for the customer. Further, we investigate how the customer's monetary trading costs differ depending on

[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.

[3] Two exceptions are Zitzewitz (2011), one of two two estimates by Goldstein, Hotchkiss and Sirri (2007).

whether the trade is routed through an agent-dealer rather than conducted directly with a market-making dealer and what determines which trades take which route.

We are able to separately estimate the agent-related and market-making components of dealer spreads 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 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 serving 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 managing customer orders and relationships. On the other hand, in these cases, Dealer B serves 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 bond trades do not go through a separate agent-dealer. In these trades, a dealer sells directly to a customer from its bond inventory or retains bonds bought directly from a customer in its inventory. In these cases, the dealer acts in dual capacity – as an agent for the customer and as a market making 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 and customer-interface costs, but not search costs. Importantly, the customer interface costs of an agent-dealer are likely different from those of a dual-capacity-dealer. Clearly, a customer interface entails costs of managing customer relationships for both agent-dealers and dual-capacity-dealers. However, the direct customer interface may provide significant benefits to a dual-capacity-dealer. 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.[4] On trades routed through an agent-dealer, the principal-dealer does not get access to this information.[5] Hence, *net* customer

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

[5] Since she does not maintain an inventory in this bond, and thus faces no asymmetric information risk, the agent-dealer in this trade does not directly derive any benefits from trying to distinguish between informed and uninformed traders. The dual-capacity-dealer's inventory management may also benefit from observing who is trading.

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.[6] 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 likely lower on these bonds.

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, we expect search costs, and hence agent dealer spreads, to be higher for assets with low liquidity -- specifically bonds with low trading volume, low ratings, and longer terms-to-maturity.[7] Also on the basis of this literature, we expect more trades to be routed through agent-dealers when the order flow originates from traders who have lesser ability to do their own search, or from traders with lower bargaining power. 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.

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

[7] 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).

If some search and customer interface costs per trade are relatively fixed per trade, then 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 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 a priori.[8]

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

We also examine which trades tend to involve agent- and principal-dealers and which are conducted directly with dual-capacity-dealers. From the customer's point of view, the decision likely depends on: (1) the added cost, if any of routing the trade through an agent dealer, (2) the relative search/negotiation abilities of the customer and the agent/dealer, (3) any desire by informed traders to

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[8] 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.

disguise their identity from the market-maker. Expecting differential search costs between customers and agent-dealers to be higher on less liquid bonds and issues with more information asymmetry, we expect more of these trades to involve agent-dealers. In general we expect small traders, specifically those making small trades, to have less search or negotiation ability and thus tend to employ agent-dealers. On the other hand, larger traders might be more informed and thus wish to hide their identity from the market-maker.

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 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 and agent-dealer riskless principal purchases. 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 trade 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's 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.[9] This also makes it possible to sign the paired D trade as a principal-dealer sale at it's ask price. Likewise, if a B and a D trade are for exactly the same quantity and

[9] As discussed below, Zitzewitz (2011), which we became aware of between drafts of this paper, takes the same approach to identifying "paired trades." Dick-Nielsen (2014) takes a similar approach to identifying "agency transactions" but requires in addition that the two trades be at exactly the same price which eliminates most of what we regard as agent-dealer transactions.

within a few seconds of each other, we 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. Using this procedure, 39.3% of S trades are identified as 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 viewed as dual-capacity-dealer sales and purchases direct with customers. 58.6% of interdealer trades are paired (and therefore signed as being at the bid or ask) using 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. Price differences between unpaired S and B trades represent dual-capacity dealer spreads.

With the exception of Zitzewitz (2011), most previous estimates of bond trading costs using the TRACE data treat paired S and D trades as two separate trades, not two parts of the same trade. Thus, we argue that they tend to underestimate total trading costs on trades involving both agent-dealer and principal-dealer spreads. Extending the model of Edwards, Harris, and Piwowar (2007) (hereafter "EHP (2007)") to distinguish between agent-dealer, principal-dealer, and dual-capacity-dealer spreads, we explore how recognizing that some trades involve two spreads (not just one) impacts the resulting transaction cost estimates.

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 index 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, as compared with principal-dealers who do not normally know the ultimate trader's identity, dual-capacity-dealers appear to benefit from knowing the trader's identity and thus possibly being able to judge if the trader is informed or uninformed. Our evidence indicates that this benefit is greatest on large trades, when market uncertainty is high, and on issues with more information asymmetry. 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 and/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 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. Seven, except for very small trades, customers face have significantly lower total explicit trading costs if they trade directly with a dual-capacity-dealer rather than through an agent-dealer. Eight, with the exception of Zitzewitz (2011) and one of the two measures of Goldstein, Hotchkiss, and Sirri (2007), the procedures used to date to estimate bond market transaction costs from the TRACE data tend to underestimate total transaction costs because they fail to recognize that some transactions involve two trades and spreads. Also our results help explain why previous bond transaction cost estimates vary so widely. Nine, suggesting that trades are more likely to be routed through an agent-dealer when the customer's search costs are high relative to those of agent-dealers and when information asymmetry is high, we find that the likelihood of employing an agent-dealer is higher when: (1) the monetary cost difference is small, (2) liquidity is low, (3) trade size is small, (4) the issue is low rated and/or long maturity.

Our results have important implications for the extensive extant empirical research on dealer spreads in other OTC markets which hitherto has also not separated dealers' agent-related and making-making roles and costs and tended to focus on dealers' making-making role. 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 to and in some cases different from market-making costs. Our results on 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 – should also be applicable to other OTC markets.

The rest of this paper is organized as follow. The next section briefly reviews the extant empirical literature on bond market transaction costs. Section 2 describes the TRACE data. In section 3, we develop our hypotheses regarding likely determinants of agent-dealer, principal-dealer and dual-capacity-dealer spreads. In section4, we estimate and analyze agent-dealer spreads on riskless principal trades, and principal-dealer spreads on paired agent-dealer trades. In section 5, we estimate and analyze dual-capacity-dealer spreads on trades directly between dual-capacity-dealers and non-dealer customers. In section 6, we use all trades and our extension of the EHP (2007) model, to estimate and analyze all three spreads. We also explore the costs and benefits to dual-capacity-dealers of the direct customer interface. In section 7, we explore the cost differences between transactions involving both agent- and principal-dealers and those directly with dual-capacity dealers and analyze which trades tend to take one path or the other. Section 8 explores the bias in extant transaction cost estimates from failing to recognize that some transactions involve two trades and spreads and attempts to explain the great disparity among previous bond transaction cost estimates. Section 9 concludes.

1. Empirical Literature on Corporate Bond Transaction Costs

In recent years, most empirical estimates of bond transaction costs have been based on either of two databases and employ either of two econometric approaches. The two databases are: (1) insurance company trades from the National Association of Insurance Commissioners (NAIC) and (2) the National Association of Securities Dealer's Trade Reporting and Compliance Engine (TRACE) which since 2005 reports virtually all bond trades by security dealers.[10] According to Bessembinder, Maxwell, and Venkataraman (2006) the insurance database accounts for about 12.5% of the dollar volume on TRACE. Since NAIC's average trade size is much larger than TRACE's, the NAIC share of trades is considerably smaller. The two primary approaches are (1) estimating transaction costs as the difference between paired purchase and sale prices (which normally differ by trade time and trade size) of the same bond and (2) multivariate regression in which each transaction price is regressed on variables to control for buys versus sells, bond characteristics, and market conditions.[11] We employ the first procedure in sections 4 and 5 below and the second in the remaining sections.

Transaction costs estimates based on the insurance data are generally much lower than those based on TRACE. Sample overall roundtrip transaction cost estimates using the former database include: Chakravarity and Sarkar (2003): about \$0.21, Bessembinder, Maxwell, and Venkataraman (2006): \$0.18-\$0.19, Schultz (2001): about \$0.27, Hong and Warga (2000): \$0.13 for investment

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[10] Hong and Warga (2000) report that spreads on the NYSE's electronic bond market are comparable to those from the NAIC database

[11] Examples of the former include Hong and Warga (2007), Chakravarty and Sarkar (2003), Goldstein Hotchkiss, and Sirri (2007), Feldhutter (2012). Examples of the latter include EHP (2007), Goldstein Hotchkiss, and Sirri (2007), and Bessembinder, Maxwell, Venkataraman (2006).

grade and $0.19 for speculative grade.[12] Based on the TRACE data, EHP (2007) estimate roundtrip transaction costs at $1.24 for the average retail size trade and $0.48 for the average institutional size trade; for BBB rated bonds, Goldstein, Hotchkiss, and Sirri (2006) estimate spreads at $2.35 for trades of less than ten bonds to $0.50 for trades of 1000 or more comparing same day trades; Zitzewitz (2011) estimates average roundtrip trading costs at $2.52 for small trades and $0.58 for large with higher costs on paired trades than on unpaired. Certainly part of the difference is due to the fact that the typical insurance company trade is much larger than the typical TRACE trade but note that TRACE spread estimates for large trades still substantially exceed those obtained from the insurance company data. Our results below help explain this gap. Feldhutter (2012) is something of an outlier among the TRACE studies. His imputed roundtrip transaction cost estimates range from $0.68 for trades of 10 bonds to $0.23 for trades of 1000 bonds. The likely reasons for this difference between his and other TRACE estimates will discuss below.

The papers most relevant to ours are EHP (2007), Zitzewitz (2011), and Sirri (2014). EHP(2007) do not distinguish between agent-dealer, principal-dealer, and dual-capacity-dealer trades but develop the spread estimation procedure which we expand to incorporate these trade types. Zitzewitz (2011)'s and Sirri(2014)'s procedures for distinguishing between paired and unpaired trades are roughly the same as our procedure for distinguishing among agent-dealer, principal-dealer, and dual-capacity-dealer trades.[13] Zitzewitz, who also utilizes TRACE data, attributes paired trades to the paired dealer passing on trades to another "ultimate" dealer so his paired dealer is essentially the same as our agent-dealer and his ultimate dealer is essentially the same as our principal-dealer. Sirri (2004) examines trading costs on municipal bonds. Since he allows up to 30 days for the first dealer to pass the bonds on to another dealer, both dealers in his paired trades bear some inventory

[12] If a study estimated the spreads in percentage terms rather than dollars, we converted to dollars assuming the bond traded at par.

[13] We became aware of the Zitewitz and Sirri papers between versions of this paper so our procedures were developed independently. Zitewitz (2011) finds that trading costs on paired trades are higher than those on unpaired and are split roughly 50-50 between the paired and ultimate dealers.

risks so do not fit our agent-dealer and principal-dealer classifications as closely. By distinguishing between agent-dealers, principal-dealers, and dual-capacity-dealers, we seek to separate dealer's agent and market making roles and explore: the determinants of these three spreads, what they imply about the costs and risks faced by different type dealers, the possible informational advantage dual-capacity-dealers gain from the direct customer interface, and the relative costs and benefits of employing an agent-dealer.

2. Data

We obtain bond transaction prices from the non-enhanced version of the 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. Expanding on Dick-Nielsen (2009), we drop TRACE 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,[14] 5) a 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

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[14] TRACE flags observations in which dealers report that there was a separate commission that is not included in the price but TRACE does not report what the commission was. We drop the few observations that indicate that there is a commission since we cannot observe the amount.

the trade price and settlement date reported on TRACE together with the coupon and maturity from the FISD database and drop the observation if the two yields differ by more than ten basis points.[15]

To illustrate our trade classification procedure discussed in the introduction, consider the sample of all trades in Alcoa's 5.5% 2017 notes between 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, 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" 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 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. Since there is no accompanying B or S trade, we classify it as "interdealer-unpaired". In this case, unlike the D trades in trades 1 and 4, we cannot

[15] 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 was issued or after it was retired. If TRACE does not report a yield, we assume the price is correct.

determine if trade 6 was at the bid or ask.[16] 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. Similarly, in trades 14, 15, and 16, an S trade is accompanied by two D trades for the same quantity at the same price. There appear to be two possibilities. First, although the NASD requires both parties to an interdealer trade to report, it supposedly only includes the selling dealer's report on non-enhanced TRACE. One possibility is that both were included by mistake. Second, as explained by Sirri (2014), 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. Since our focus is on agent-dealer spreads (whether involving one agent-dealer or several) and principal-dealer spreads, we are not interested in separating intermediate interdealer trades. Hence we 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 or about 13.5 trades per bond per week.[17]

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).[18] 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. By this measure, 34.2% of B trades and 39.3% of S trades go

[16] These 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.

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

[18] 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.

through agent-dealers, the remainder directly with dual-capacity-dealers.[19] Similarly 58.6% of D trades can be duly paired and signed; the remaining 41.4% are interdealer-unpaired. 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 non-enhanced TRACE and trades of speculative grade bonds of more than 1000 bonds are reported as 1MM+.[20] 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. 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 trades between dual-capacity-dealer and their customers. 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 section 7 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, in which case she likely has lower

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[19] As Sirri (2014) notes and documents, agent-dealers may wait longer than a minute to pass the trade on to a principal dealer or may accumulate several trades before passing the position off to an principal dealer, though we capture these if within one minute. Thus, if anything our statistics understate the number of agent-dealer trades and over-state dual-capacity-dealer trades. Note however that if the agent dealer holds the bonds in inventory for some time before passing them on, she faces inventory risk by functioning as a market-maker for this period, cannot be viewed as a pure agent.

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

internal search costs. For larger size trades, monetary transaction costs are considerably lower if the customer deals directly with a dual-capacity-dealer. Hence it is not surprising that many small trades involve an agent-dealer and that most large trades do not.

3. Hypothesized determinants of dealer spreads

In this section, we develop hypotheses concerning the likely 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) the traded bond's liquidity, 3) variables likely correlated with the bond's specific risk and information asymmetry, and 4) trade size. These are described in the next subsection; then hypothesized relations for the different spreads in the following subsections.

3.1. Independent variables

We expect market-making costs, but not agent 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 $\rho = 0.769$. To our knowledge, no studies have tested the impact of stock market and interest rate risk as measured by the VIX and MOVE indices on dealer spreads. Since our November 2008 - December 2010 data period includes part of the financial crisis period, in some estimations we also include 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,.... C=22, and D=25. Thus a higher number means a lower rating. Separately, we include a dummy variable to indicate issues where both rating agencies have withdrawn or suspended their rating. Numerous studies have found that dealer spreads in general are higher on lower rated and longer maturity bonds.[21] Our interest is to estimate their impact on market-making and agency costs separately.

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 months after.[22] 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 per trade, costs per bond should be an inverse function of trade size and numerous studies find that dealer spreads in

[21] Such papers include: Hong and Warga (2000), Chakravarity and Sarkar (2003), Bessembinder, Maxwell, Venkataraman (2006), EHP (2007).

[22] 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. A number of studies include similar measures and generally find that spreads decline with trading activity.

general vary inversely with trade size. 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. Statistics for our major variables are presented in Table 3. We next discuss how we expect the different dealer spreads to vary with these variables.

\3.2. 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 agent-dealer costs and spreads to be less sensitive to the risk and asymmetric information variables than the costs and spreads of principal-dealers and dual-capacity-dealers although it is possible that agent-dealers' search costs increase if principal-dealers are 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. Search costs will also depend on the 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 agent-dealer spreads should be an inverse function of trade size. On the other hand, the likely incremental payoff of additional search is lower on small trades. For example, suppose the expected payoff to additional search costing $100 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. Thus we anticipate lower search effort on small trades which implies a positive relation between trade size and agent-dealer spreads. Hence we have conflicting hypotheses regarding the relation between trade size and agent-dealer spreads. Since the marginal benefit of additional search is greater, the greater the price dispersion, we also expect more search effort and larger spreads on longer maturity and lower rated bonds.

3.3. 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 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 principal-dealer 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 due to fixed costs is reinforced by the economics of search discussed in section 3.2. 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 principal-dealers adjust their bid/ask prices (though they may), but because of sampling. If instance, if agent-dealers do little search, the observed principal-dealer sale price may not be at the lowest principal-dealer ask price. Furthermore, 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. Note that while fixed costs and the economics of search imply different trade size – spread relations for agent-dealers, both imply that principal-dealer spreads should vary inversely with trade size.

3.4. Dual-capacity-dealers 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 trade size and to be higher on lower rated bonds. Since dual-capacity-dealers buy and sell directly to customers, they, like agent-dealers bear costs of managing the customer relationship (which we term "customer interface costs") but do not have agent-dealer's search costs.

Since dual-capacity-dealers have customer interface costs and principal-dealers do not, the difference between dual-capacity-dealer spreads and corresponding principal-dealer spreads on equivalent trades provides a measure of the dual-capacity-dealer's customer interface costs. While managing the customer interface clearly imposes additional costs on the dual-capacity dealer we hypothesize that dealing directly with customers provides benefits as well. 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.

4. Agent-dealer and principal-dealer spreads

As noted above, the literature as taken two approaches to estimating bond dealer spreads. In the first, spreads are estimated by pairing purchase and sale prices on trades close in time. In the second, spreads are estimated using a regression based on successive trades. We utilize the first procedure in this section and the next and the second in section 6.

4.1 Descriptive statistics

As noted in the introduction, the difference between the agent-dealer's 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 the 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. The difference between a principal-dealer's sale and purchase prices represents the principal-dealer's compensation for bearing inventory and asymmetric information risks.

Average agent-dealer spreads on riskless principal sales and purchases, presented in the second and third columns respectively of Table 4, are $0.743 and $0.299 respectively. [23] 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 4 do not. Another possibility is that the agent-dealer is providing this service as part of a bundle of services to its client compensated through wrap or other fees in which case the spreads in Table 4 understate true transaction costs. [24]

In the final column of Table 4, 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 vice-versa, 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, 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, which is

[23] 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. To prevent outliers possibly caused by such TRACE data errors dominating the results, all estimated spreads are winsorized at the 0.5% and the 99.5% level.

[24] 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.

comparable in magnitude with average round trip agent-dealer spreads of $1.04. Principal-dealer spread estimates without the same day restriction are presented in sections 4.2 and 4.3.

4.2. Regression results

In Table 5, regression results are presented for agent-dealer and principal-dealer spreads. Separate coefficients were estimated for agent-dealer sales and purchases but since our data indicates that total roundtrip transaction costs are sometimes levied in the sale and other times in the purchase, the implied impacts on roundtrip spreads are reported in Table 5.[25] This also facilitates comparison with the principal-dealer spread regressions, 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. 48.4% of our matches are on the same day, 78.0% within two days and 89.3% within one week. To control for interest rate changes between different trade dates, 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.[26]

Regression results with White standard errors are reported in Table 5. We estimate regressions both with and without the time period dummies which are themselves correlated with the VIX and MOVE indices. Since trade size differs, separate size variables are included for both the

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

[26] 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.

purchase and sale. For consistency with the other variables and regressions, the combined impact on roundtrip spreads is reported in Table 5.

4.2.1. Results - bond market risk

Our hypothesis that due to inventory and asymmetric information risks, principal-dealer spreads should vary directly with bond market risk is clearly confirmed. As shown in the third and fifth columns in Table 5 Panel A, the coefficients of both the VIX and MOVE indices are large, positive, and significant at the .001 level. According to the coefficients in the third column, a one standard deviation rise in the VIX (MOVE) raises the spread about \$0.345 (\$0.242). Spreads were also higher in the financial crisis period. The results in the last column of Panel A 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 5 Panel A 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, VIX and MOVE's coefficients are significant but the coefficients are much smaller (for instance the coefficients in column 4 imply that a one standard deviation change in the VIX is associated with only a \$0.027 change in the agent-dealer spread) and MOVES's coefficient is negative. The coefficients of the time dummies imply that agent-dealer spreads were actually slightly lower in 2008 financial crisis period. Previous studies have found that dealer spreads are higher on low rated bonds but have not tested whether spreads vary with measures of market risk, such as the VIX and MOVE indices, and have not distinguished between agent-dealer and principal-dealer spreads.

4.2.2. Bond liquidity

Our hypothesis that, due to inventory costs, principal-dealer spreads vary inversely with how actively a bond is traded is 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 search costs and spreads vary inversely with trading volume is also confirmed though agent-dealer spreads are much less sensitive to trading volume than principal-dealer spreads. Several previous studies, e.g., Hong and Warga (2000), and Bessembinder, Maxwell, Venkataraman (2006), find that dealer spreads in general vary inversely with trading volume while Goldstein, Hotchkiss, and Sirri (2006) find a direct relationship. None separate agent-dealer and principal-dealer spreads.

4.2.3. Rating and maturity

Previous studies have consistently found that dealer spreads in general are higher on longer maturity and lower rated bond issues but have not separated agent-dealer and principal-dealer spreads. In section 3.3, we argued that since price variability is higher on longer term and lower rated issues, principal-dealers' inventory risks are higher which should lead to higher spreads on these issues. In section 3.2 we argued that this higher price variability raises the expected marginal payout to additional search leading to higher search costs for agent-dealers on longer term and lower rated issues. Our Table 5 results are consistent with both hypotheses. The coefficients in the final columns imply that principal-dealer spreads are about \$0.54 higher on 20-year bonds than on 5-year notes and that agent-dealer sale spreads are about \$0.74 higher. 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.

4.2.4. Trade size

The presence of three trade size variables in the regressions makes it difficult to determine from the coefficients in Panel A of Table 5 how spreads vary with trade size. Hence, similar to EHP (2007), we use the coefficient estimates in Panel A to estimate spreads on trade sizes ranging from 5 to 1000 bonds. The results are shown in Panel B assuming all non-size variables are at their sample means.[27] EHP(2007) and others find that dealer spreads in general decline as trade size increases. We hypothesized the same for principal-dealer spreads. Consistent with this, in Panel B, estimated principal-dealer spreads decline monotonically as trade size increases falling from $1.59 for a trade of 5 bonds to $0.63 for a trade of 1000 bonds.

In contrast to principal-dealer spreads, we had conflicting hypotheses for agent-dealer spreads in section 3.2. The presence of fixed trading costs should cause agent-dealer spreads, like principal-dealer spreads to fall as trade size rises. However, we hypothesized that as trade size sizes the expected marginal benefit of additional search rises leading to more extensive search and therefore higher search costs on larger trades. Consistent with this, estimated agent-dealer spreads in Panel B actually increase slightly until trade size exceeds 50 bonds, then decline. The null that spreads on trades of 50 and 25 bonds are equal is rejected at the .0001 level. If the decline in agent-dealer spreads as trade size increases beyond 50 bonds is due to fixed trading costs, then this pattern should be observed over small trades as well. Thus, the finding that spreads actually rise initially suggests 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 size trades.

[27] 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.

5. 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. As before we measure these spreads as the difference between the prices of dual-capacity-dealer sales and purchases where 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 1,780,076 dual-capacity-dealer sale-purchase pairs of which 69.2% are same day pairs.

In Table 6 Panel A, we estimate basically the same spread regressions dual-capacity-dealers as were estimated in Table 5 for principal-dealer-spreads on trades with agent-dealers. As noted above, non-enhanced TRACE truncates the reported trade sizes at 5000 bonds for investment grade bonds and 1000 for speculative grade. While almost no agent-dealer and principal-dealer trades were truncated, a number of dual-capacity-dealer trades are. Hence, we add zero-one dummy variables to denote truncated trade sizes on dual-capacity-dealer trades expecting negative coefficients.

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 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 5. Similarly, spreads are higher in 2008 and early 2009 than later but the differences are not as great as in Table 5. Dual-capacity-dealer spreads are higher on lower rated and longer maturity bonds.

In Panel B, we use the coefficients from Panel A to estimate spreads on different size trades following the same procedure as in Table 5 assuming all non-size variables are at their sample means. As observed in Table 5 for trades of principal-dealers, spreads decline monotonically and sharply with trade size from $2.79 for trades of 5 bonds to $0.42 for trades of 1000 bonds.

Comparing Panel B of Table 6 with Panel B of Table 5 for trades of the same size, we generally observe that dual-capacity-dealer spreads exceed principal-dealer spreads for all but very large trades which is what one would expect since dual-capacity-dealers must bear all customer relationship costs. Total transactions costs appear lower for trades directly with dual-capacity-dealers for all but very small trades. However, because Tables 5 and 6 are estimated from different samples we cannot test whether these estimated costs are significantly different. Hence we leave fuller consideration of these cost and spread comparisons for the next section.

6. All Trades: Combined Sample Evidence

Above we observed that one econometric approach in the literature to estimating bond transaction costs involves pairing similar sale and purchase transaction that are close in time. We followed this procedure in sections 4 and 5. The second, pioneered by Harris and Pinowar (2006) and EHP (2007), involves estimating a regression based on successive trades regardless of type using regression variables to control for trade type. In this section we take this approach employing an extension of the EHP (2007) procedure. This has several advantages. First, we are able to reduce noise by comparing trade prices closer in time. For example, when estimating dual-capacity-dealer spreads, we compared each dual-capacity-dealer sale to the closest dual-capacity-dealer purchase. The two trades could be several days apart. By using price differences between successive trades regardless of type, time differences are smaller. Second, by estimating the model using entire sample instead of separate subsamples we are able to obtain covariances and thus test for differences between agent-dealer, principal-dealer, and dual-capacity-dealer spreads. Third, we are able to compare our spread estimates with those obtained using the EHP (2007) procedure, which does not distinguish between agent-dealer, principal-dealer, and dual-capacity-dealer trades. For sales or purchases by agent-dealers, the trade just before or just after is generally the accompanying trade between the agent-dealer and a principal-dealer. Thus we suspect that EHP (2007)'s procedure picks up only the agent-dealer spread as the total transaction cost.

6.1. Estimation procedure

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:

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

In equation 1 (their equation 6), $r_{i,n-1,n}$ is the return on bond issue *i* between trades *n-1* and *n*. $Q_{i,n}$ is a dummy variable which =1 if trade *n* for bond *i* is a S trade (whether by an agent-dealer or a dual-capacity-dealer), = -1 if trade *n* is a B trade and =0 if a D trade (whether a sale to or purchase from an agent-dealer, or an unpaired interdealer trade). $S_{j,i,n}$ represents size measure *j* for trade *n* of bond *i*.[28] $\Delta Y_{k,n-1,n}$ measures the change in yield index *k* from *n-1* to *n*.[29] EHP (2007) estimate equation (1) separately for each bond *i,* then calculate representative spreads using a weighted average of the coefficients.

Our approach builds on theirs 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 or 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 three trade types: dealer sales, dealer purchases, and interdealer trades, we recognize seven: 1) agent-dealer sales, 2)

[28] 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.

[29] 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 $\sum_{k=1}^{3} \gamma_{k,i}\, \Delta Y_{k,i,n-1,n}$ controls for changes in market rates between the two trades. As above we use a single variable based on the return on bonds of the same rating and similar maturity.

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. We estimate:

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

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.[30] 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 (which they are able to do since all their independent variables are time series); then average the $\beta_{j,i}$ coefficients over all bonds *I*, 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.[31] Again we require 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

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[30] 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.

[31] 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 separate estimations of our model would require J+2 observations of each trade type m where J is the number of independent variables.

same bonds. The mean time between any two trades of the same bond is 0.34 days, but this is highly skewed, with 87.0% of the successive trade pairs on the same day.

6.2 Results

Estimation results are reported in Table 7. To give the results economic meaning, we report the implied impact of variable *j* on our three roundtrip spreads: agent-dealer spreads, principal-dealer spreads, and dual-capacity dealer spreads, rather than the individual coefficients, $\beta_{j,m}$. Thus in Panel A of Table 7 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: $(\beta_{j,\text{ agent-dealer sales}} - \beta_{j,\text{ principal-dealer sales}}) +$

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

Standard errors for the coefficient combinations corrected for heteroskedasticity and autocorrelation using the NeweyWest procedure are reported in parentheses. '*' and '**' denote coefficient combinations significantly different from zero at the 5% and 1% levels respectively. The estimated impact of a one standard deviation change in each variable is shown in brackets.

6.2.1. Market risk variables

As hypothesized, since market-making risks should increase in periods of greater price uncertainty and paralleling our results in sections 4 and 5, principal-dealer spreads and dual-capacity-dealer spreads are positively and strongly correlated with both the VIX and MOVE indices. Indeed, as measured by the effect of a one standard deviation change [shown in brackets in Table 7 Panel A], these two variables are the most important in explaining variations in principal-dealer spreads. A one-standard deviation increase in the VIX is associated with an increase in principal-dealer spreads of

$0.239, and in dual-capacity-dealer spreads of $0.157. A one-standard deviation increase in the MOVE index is associated with an increase in principal-dealer spreads of $0.254 cents, and dual-capacity-dealer spreads of $0.042. 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 Panel A, agent-dealer spreads are not significantly related to either the VIX or MOVE indices.

6.2.2. Liquidity

Consistent with our previous results, and our hypothesis that both market-making and search costs are higher for illiquid bonds, Table 7 shows that principal-dealers, agent-dealers, and dual-capacity-dealers all demand more compensation for bonds with lower trading volume; all three spreads are significant negative functions of the bond's trading activity. The impact is greatest for dealers acting purely in market-making capacity, i.e., principal-dealers (for which the estimated impact of a one standard deviation change is $0.214).

6.2.3. Rating and maturity

Paralleling our results in sections 4 and 5, 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 possibly also lower liquidity). The higher agent-dealer spreads are likely due to lower liquidity and higher search costs. Bond maturity appears especially important in explaining agent-dealer and dual-capacity-dealer spreads. As compared with five year notes, the estimates in Panel A imply that agent-dealer roundtrip spreads on twenty year bonds are about $0.743 higher and dual-capacity-dealer spreads about $0.606 higher. The estimated difference in roundtrip spreads between Aa and Ba rated bonds is $0.258 for agent-dealers, $0.391 for principal-dealers, and $0.327 for dual-capacity-dealers.

6.2.4. Trade Size

In Panel B of Table 7, we report estimated spreads by trade size based on the equation 2 regression coefficients. For these calculations, we assume that the non-size variables are at their sample means. As compared with the subsample results in Tables 5 and 6, the agent-dealer spread estimates in Panel B of Table 7 are slightly higher and the principal-dealer and dual-capacity –dealer spread estimates slightly lower. The patterns as trade size rises are identical to those estimated earlier in that principal-dealer and dual-capacity-spreads decline monotonically and sharply while agent-dealer spreads rise until trade size exceeds about 50 bonds, then decline. Agent-dealer spreads on trades of 5, 10, or 25 bonds are significantly lower than those on trades of 50 bonds at the 1% level. Since the presence of fixed costs implies that spreads should decline monotonically, our interpretation of this result is that agent-dealers devote less search to small trades.

6.3. Customer interface benefits of dual-capacity-dealers

As argued above, since dual-capacity-dealers bear both the cost of making a market and of managing the customer relationship while principal-dealers costs are solely market-making costs, the difference between the two spreads on equivalent bonds and trades provides a measure of the implied net customer interface costs of dual-capacity-dealers. As discussed in section 3.4, 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. The principal dealer is denied this information since the trader employs an agent.

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 3.4, 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 interface costs to be negatively correlated with the VIX and MOVE indices. Results on these hypotheses are presented in Panel A of Table 8. As expected, net customer interface costs are higher for more liquid bonds and decrease significantly with an increase in risk. A one standard deviation increase in MOVE or VIX decreases customer net interface costs (and hence arguably increases information benefits for dual-capacity-dealers from customer interface) by $0.212 and $0.083 respectively. Net customer interface costs are also significantly lower for bonds with greater credit risk. Surprisingly, they appear lower on longer maturity bonds.

Finally, as shown in Panel B, net 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 dual-capacity-dealers deriving more informational benefits from knowing the trader's identity on larger trades. Indeed on trades of 500+ bonds, estimated net customer interface costs are negative implying that on large trades the informational benefit from interfacing with directly with customers exceeds the costs of managing the customer relationship.

7. Trades with and without agent-dealers

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

We now explore which types trades tend to go through agent-dealers and which do not and how trading costs differ if a customer deals directly with a dual-capacity-dealer versus employing an agent-dealer. We start with the second issue. Testing cost differences is complicated by the fact that we can never observe what trading costs would have been if traders had made the other choice. Also it needs to be kept in mind that we only observe explicit trading costs. If a trader does not employ an agent, she bears search costs which we cannot observe. With these caveats in mind, we explore how estimated monetary costs differ.

Based on our estimations of equation 2, in Panel A of Table 9 we report estimated spreads on trades employing agent-dealers, consisting of both the agent-dealer and principal-dealer spreads, and on trades directly with a dual-capacity-dealer (which are repeated from Panel B of Table 7 for comparison), and the difference. For very small transactions, the cost difference is small and transaction costs are actually lower for trades involving an agent-dealer for trades of only five bonds. As trade size rises, transaction costs decrease rapidly for direct trades with dual-capacity-dealers, and much more slowly for trades executed through agent-dealers. Hence, for moderate and large trades, monetary costs are considerably higher if the trader employs an agent. This cost pattern is consistent with our observation in Table 2 that trades involving agent-dealers tend to be small. Nonetheless, since a large proportion of trades in the 50 to 250 bond range go through agent-dealers, it appears that monetary cost is not the sole criterion. One obvious reason is that if the trader does not employ an agent-dealer, she has to conduct hers own search among dual-capacity-dealer s for the best price. 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.

Since agent-dealers bear the search costs when they are involved and the traders when they deal directly with market makers, we expect the cost difference between trades involving an agent-dealer and trades directly with a dual-capacity dealer to be higher when search costs are high or the search is more extensive. Thus we expect a greater cost difference for thinly traded bonds. Also, since the expected marginal benefit of additional search is higher when price dispersion is high, we expect a greater cost difference on long maturity and low rated bonds and when market uncertainty is high. In Panel B of Table 9, we report estimates of the implied impact of one unit changes in each of these variables on the cost difference. All our hypotheses are confirmed. The cost difference is significantly higher on (1) bonds with low trading volume, (2) longer maturity bonds, (3) low rated bonds, and (4) when MOVE and or VIX indices are high.

7.2 What determines agent-dealer involvement?

Next we consider what influences whether a trade goes through agent- and principal-dealers or is direct with a dual-capacity-dealer. Note that this is determined by both the trader and the dealer. If a trader places a buy order with a dealer who does not carry the bonds in inventory, that dealer has to obtain the bonds from another dealer. However, the dealer likely previously decided which bonds he would keep in inventory and which not. If a trader places a sell order with a dealer, that dealer can decide whether to keep the bonds in inventory or trade them to another dealer. From the trader's viewpoint, we expect this choice to depend on relative costs including the trader's internal search costs. Holding the trader's internal search costs constant, we would expect the likelihood that the trade goes through agent- and principal dealers to be an inverse function of the differential between the total of agent-dealer and principal dealer spreads on the trade and the dual-capacity-dealer spread. If this spread difference is small, the trader may choose to route the trade through an agent dealer since she saves on search costs. While we cannot observe the actual spread difference, we can estimate it based on our equation 2 estimates and parameters of the bond and trade.[32]

[32] Since our estimated cost difference is based on our estimates of equation 2 using our entire sample while a trader doing a similar estimation would only have past data. This would lead to some measurement error which would tend to bias its coefficients toward zero in the probit estimation, i.e., toward falsely finding that the cost difference has no impact.

Holding the estimated spread differential constant, we expect traders to tend to employ agent-dealers when the trader's internal search costs are high or the agent-dealer search services are more valuable. We have argued above that the expected marginal benefit of a more extensive search is higher when the price distribution is wide. We also posit that the agent dealer's search expertise is more valuable on these bonds. Thus, we expect use of agent dealers to be positively correlated with bond maturity and our rating variable (which is highest for low rated bonds) and expect employment of agent dealers to be positively correlated with the VIX and MOVE indices. Holding the spread differential constant, we expect higher employment of agent-dealers on small trades since these traders likely have limited ability to conduct their own search. Finally, again holding the spread differential constant, we expect more trades to go through agent-dealers when the bonds are thinly traded because agent-dealers have more search ability than individual traders.

To test these hypotheses, we estimated the probit relations reported in Table 10. The decision variable was equal to 1 if the trade involved agent- and principal-dealers and 0 if directly with a dual-capacity dealer. Thus a positive coefficient indicates a greater tendency for the trade to go through agent-dealers and principal-dealers. Separate probit relations were estimated for customer sales (i.e., dealer buys) and customer buys (dealer sales). Our hypotheses regarding the spread differential, trading volume, trade size, and the MOVE index are all confirmed. Holding the other variables constant, trades are more likely to involve both agent- and principal-dealers -- and less likely to be directly with dual-capacity-dealers -- when: (1) the additional spread as compared with trades directly with dual-capacity-dealers is small, (2) the bond is thinly traded, (3) trade size is small, and (4) interest rate uncertainty is high. However, while bond maturity, rating, and the VIX have the hypothesized signs in the customer sales estimation, they do not in the customer buys estimation.[33]

[33] One possibility is that this is due to the data issue discussed in section 4. The prevalence of many zero agent-dealer spreads suggests that the roundtrip trading cost is sometimes accessed in the sale and sometimes in the purchase and sometimes in both. For this reason we have focused on roundtrip trading costs until this section. It is possible that this varies with rating and maturity.

8. Comparing our transaction cost estimates with previous studies.

Finally, we discuss extant bond trading cost estimates in light of our findings. In section 1, we noted that spreads estimated from the insurance company trade database are consistently much lower than those estimated from the TRACE data (with exception of Feldhutter (2012)). Certainly, a major reason for this is that insurance company trades tend to be large but still the spread estimates from TRACE for institutional size trades generally exceed those obtained from the insurance dataset. We suspect that an additional reason is that as sophisticated active investors, insurance companies do their own search and trade directly with dual-capacity-dealers whose spreads are considerably lower on large trades than the agent-dealer and principal-dealer combination. They also trade primarily in investment grade bonds on which spreads are lower.

We also observed in section 1that among the spreads estimated using the TRACE data, Feldhutter (2012) obtains much lower spread estimates than EHP (2007), Goldstein, Hotchkiss, and Sirri (2006), Zitzewitz (2011) or this paper. The reason is readily apparent. Working with data before TRACE attached the S, B, and D flags, Feldhutter was unable to identify customer buys and sales so estimated the trading cost as the difference between the highest trade price and the lowest where the trades were within 5 minutes of each other and for the same volume. Thus his estimation procedure picked up only the agent-dealer spread, and excluded the principal-dealer spread on trades involving both and the time-volume requirement eliminates most dual-capacity-dealer trades.

Goldstein, Hotchkiss, and Sirri (2007) utilize paired trades. In their DRT spread estimate, the spread is estimated as the difference between the price at which a dealer sells bonds to a non-dealer customer and the price at which the same dealer buys the same bonds (not necessarily the same volume) from a non-dealer customer. The sample is restricted to trade pairs within 1 to 5 days and to BBB rated bonds. This sampling procedure tends to restrict the sample to trades by dual-capacity-dealers so the resulting spread estimates primarily represent dual-capacity-dealer spreads. In their "regression" procedure, Goldstein et al (2007) utilize S and B trades customers dropping the same dealer requirement so this sample adds agent-dealer trades with non-dealer customers to the DRT sample. Thus this procedure picks up both agent-dealer and principal-dealer spreads on trades involving both and dual-capacity-dealer spreads on those trades and the resulting spread estimates represent an overall average of total transaction costs. This would seem to explain why their regression spread estimates exceed their DRT estimates.

As noted above, an important 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 (our agent-dealer purchases and dual-capacity-dealer purchases from non-dealer customers), and 3) interdealer or "D" trades (our trades between principal-dealers and agent-dealers, and unpaired interdealer trades). They estimate a single overall spread between S and B trades which we suspect tends to underestimate average overall bond transaction costs. In their procedure each trade is compared with the immediately preceding and following trade. D trades are considered as equally likely to be at the bid or ask and thus represent 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 this 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. Since the trades involving an agent-dealer tend to be small, we expect this underestimation of total transaction costs to be greatest on smaller trades.

To explore how much difference this makes, we estimate equation (1) over the same sample with the same variables as in our earlier estimation of equation (2) and report the resulting transaction cost estimates in Table 11. Our equation (1) estimation 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, maturity, liquidity, and market uncertainty 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 derived from the estimation of equation (1) with those from derived from equation (2) (which are reproduced in columns 3 and 4 of Table 11), 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 duplicate EHP's estimates.

As reported in Table 11, 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. For trades of 100 or more bonds, equation 1 substantially underestimates spreads on trades involving an agent-dealer and slightly overestimates spreads on trades directly with a dual-capacity dealer.

In summary, excluding Zitzewitz (2011), and the regression estimates of Goldstein, Hotchkiss, and Sirri (2007), most transaction cost estimates derived from the TRACE data have tended to underestimate overall bond transaction costs (especially on small trades) because they have essentially treated trades involving both an agent-dealer and a principal-dealer as two separate unrelated trades rather than two components of the same trade. Since based on buys and sells by insurance companies, spread estimates derived from the National Association of Insurance Commissioners data do not have this problem but only estimate spreads on large trades by sophisticated institutional investors. The fact that their spread estimates are only a fraction of those estimated here is likely because (1) they are much lower larger on average, (2) are restricted to investment grade bonds, (3) likely directly with dual-capacity-dealers after an effective search.

9. 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 theories underpinning market-making, search costs, and the informational benefits to dealers from direct customer access.

We document several interesting results. First, dealer costs arising from their agent role are large and comparable in magnitude to the costs arising from their market-making role. Second, as expected since principal-dealers hold bond inventories but agent-dealers do not, agent-related dealer costs vary 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 with these risk measures. Third, while market-making costs decline sharply as trade size increases (consistent with earlier evidence), agent-related costs tend to first increase with trade-size, then level off and decline, consistent with agent-dealers (probably rationally) conducting less price search on smaller trades. Fourth, consistent with market-making costs being affected by risk and liquidity factors, and agent-related costs by liquidity and search costs, both market-making costs and agent-related costs increase as trading volume decreases, and are higher for lower rated and longer maturity bonds,. Fifth, except for very small trades, explicit transaction costs (i.e., total spreads) are significantly lower if the trader trades directly with a dual-capacity-dealer rather than trading through an agent-dealer. The differential between the sum of the agent-dealer and principal dealer spreads on a trade and dual-capacity-dealer spreads on a similar size trade appears positively related to likely determinants of the agent-dealer's search costs. Six, holding determinants of a trader's internal search cost constant, the likelihood that a trade goes thru both agent- and principal-dealers versus being conducted directly with a dual-capacity-dealer is an inverse function of the estimated spread differential between the sum of the agent-dealer and principal dealer spreads and the dual-capacity-dealer spread on the trade. Holding this spread differential constant, this likelihood appears to be a positive function of the agent-dealer's search advantage over the trader's. Seventh, net customer interface costs faced by dual-capacity-dealers are reasonably large in magnitude, albeit significantly smaller than market making costs, but decrease sharply on a per-bond basis as trade size increases. 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, by failing to recognize that many trades on TRACE involve two spreads, that of the agent-dealer and the market-making principal-dealer, most studies based on TRACE have tended to underestimate total transaction costs – especially for smaller trades. Estimates based on the insurance company data appear smaller than those based on TRACE data because insurance companies likely do their own search rather than employing agents and conduct large trades in high grade bonds.

Our results have 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 the final column. 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 - Independent Variables

Means, medians, and standard deviations are reported for our main independent variables for the sample of 5,382,070 trades and the sample of 3859 bonds. The latter give less actively traded bonds greater weights. The rating variable varies from AAA=1 to D=25. The mean and median ratings of 8.47 and 8.50 respectively fall between BBB+ and BBB. The average daily trading volume is the average number of bonds traded per day over a six month period from three months before the trade date to three months after.

Variable	Trade sample			Bond sample		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
VIX	29.74	25.61	11.52			
MOVE	119.95	111.90	34.89			
Trade size (bonds)	32.95	25.00	887.43			
Rating	8.47	8.50	3.80			
Maturity (years)	9.42	7.02	7.65			
Avg. daily trading volume (bonds)	4.62	2.51	6.05			

Table 4 - 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 only)
	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 5 Panel A- 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 trading volume over a six month period, 4) the log of the bond's maturity, 5) the bond's rating from AAA=1 to D=25, 6) time dummies, and 7) measures of trade size. For principal-dealer spreads based on trades on different days, an independent variable measuring the average price change on bonds of the same rating and similar maturity is included. Size variable coefficients represent the estimated combined effect on both bid and ask prices. 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	
	Agent-dealer spreads	Principal-dealer spreads	Agent-dealer spreads	Principal-dealer Round trip
Intercept	-0.3100** (.0115)	1.1485** (.0195)	-0.3941** (.0124)	1.8918** (.0217)
VIX index (x100)	-0.0222 (.0152)	2.9930** (.0222)	0.2305** (.0208)	1.4641** (.0355)
MOVE index (x100)	0.0078 (.0049)	0.6938** (.0068)	-0.0146* (.0057)	0.1427** (.0088)
log of avg. daily trading volume	-0.0225** (.0008)	-0.2839** (.0015)	-0.0244** (.0008)	-0.2920** (.0015)
log of years to maturity	0.5310** (.0019)	0.3778** (.0031)	0.5341** (.0020)	0.3906** (.0031)
rating	0.0346** (.0003)	0.0454** (.0005)	0.0355** (.0003)	0.0483** (.0005)
dummy for withdrawn rating	0.0658** (.0132)	0.3498** (.0190)	0.0877** (.0126)	0.4369** (.0189)
log of trade size (in bonds)	0.1886** (.0025)	-0.1682** (.0044)	0.1870** (.0024)	-0.1609** (.0042)
reciprocal of trade size	-0.3386** (.0109)	0.2664** (.0231)	-0.3298** (.0101)	0.4338** (.0228)
square root of trade size	-0.0524** (.0005)	-0.0056** (.0008)	-0.0522** (.0005)	-0.0062 (.0006)
2008 November - December			-0.1267** (.0103)	1.0949** (0.0185)
2009 first quarter			-0.0021 (.0064)	0.8926** (.0107)
2009 second quarter			0.0216** (.0046)	0.7820** (.0074)
2009 second half			0.0658** (.0031)	0.3475** (.0038)
Average price change on same rating/maturity bonds		0.5889** (.0034)		0.5927** (.0034)
Adjusted r-square	.206	.273	.209	.283
Observations	1,343,578	1,087,358	1,343,578	1,087,358

Panel B - Estimated Round-trip Agent-dealer and Principal-dealer Spreads by Trade Size			
Based on the coefficient estimates in Panel A (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. Standard errors based on White estimates of the variance-covariance matrix are reported in parentheses.			
Trade size (# bonds)	Agent-dealer	Principal-dealer	Total
5	$0.985 (0.0018)	$1.588 (0.0028)	$2.573
10	$1.101 (0.0014)	$1.456 (0.0022)	$2.558
25	$1.198 (0.0014)	$1.273 (0.0019)	$2.470
50	$1.227 (0.0018)	$1.150 (0.0027)	$2.377
100	$1.208 (0.0023)	$1.029 (0.0037)	$2.237
250	$1.078 (0.0031)	$0.870 (0.0050)	$1.948
500	$0.867 (0.0040)	$0.749 (0.0065)	$1.616
1000	$0.513 (0.0060)	$0.627 (0.0100)	$1.140

Table 6 Panel A - Spread Regressions for Dual Capacity Dealer Trades

Roundtrip spreads on direct trades between a dual-capacity-dealer and a 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, 6) time dummies, and 7) 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. White standard errors are reported in parentheses. Size variable coefficients represent the estimated combined effect on both bid and ask prices. * 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	2.8876**	(.0122)		3.1574**	(.0142)
VIX index (x100)	1.6081**	(.0149)		1.0975**	(.0241)
MOVE index (x100)	0.1630**	(.0047)		-0.0098	(.0062)
Log of avg. daily trading volume	-0.1171**	(.0011)		-0.1241**	(.0011)
Log of years to maturity	0.5172**	(.0018)		0.5192**	(.0018)
Average rating	0.0669**	(.0003)		0.0682**	(.0003)
Dummy for withdrawn rating	0.6917**	(.0110)		0.7359**	(.0109)
2008 November - December				0.2751**	(.0124)
2009 first quarter				0.3623**	(.0074)
2009 second quarter				0.3203**	(.0051)
2009 second half				0.1008**	(.0030)
Log of trade size (in bonds)	-0.7052**	(.0019)		-0.7068**	(.0019)
Reciprocal of trade size	-2.0344**	(.0174)		-2.1014**	(.0174)
Square root of trade size	0.0328**	(.0002)		0.0329**	(.0002)
Trade size truncated	-.3741**	(.0039)		-.3825**	(.0039)
Average ΔP on same rating/maturity bonds	0.5593**	(.0053)		0.5595**	(.0053)
Adjusted r-square	.313			.315	
Observations	1,783,076			1,783,076	

Panel B – Estimated Roundtrip Spreads for Dual-Capacity-Dealers		
Based on the coefficient estimates in Panel A, spreads are estimated for round-trip trades directly between a dual-capacity-dealer and a non-dealer customer. Spreads are estimated setting the non-trade size variables at their overall sample means. Standard errors of the size estimated based on White estimates of the variance-covariance matrix are reported in the final column.		
Trade Size	Estimated Spread	Standard error of estimated spread
5	$2.785	0.0026
10	$2.530	0.0022
25	$2.067	0.0017
50	$1.686	0.0015
100	$1.3139	0.0015
250	$0.871	0.0018
500	$0.600	0.0020
1000	$0.417	0.0020

Table 7 - Transaction Cost Relations based on Successive Trades for 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. Newey-West standard errors are reported in parentheses. * and ** denote parameter estimates significantly different from zero at the .05 and .01 levels respectively. As a measure of relative importance, the estimated impact on the spread of a one standard deviation change in each non-size independent variable is shown in brackets in Panel A. The estimated relation includes the usual three size variables. Estimates of the spreads for various size trades based on these coefficients are reported in Panel B where the non-size variables are at their sample means.

	Principal-dealer spreads	Agent-dealer spreads	Dual-capacity dealer spreads
Intercepts (α_m)	0.3015** (.0257)	-0.0649** (.0192)	2.5311** (.0209
VIX index (x100)	2.0707** (.0440) [$0.239]	-0.0342 (.0232) [$0.004]	1.3507** (.0290) [$0.157]
MOVE index (x100)	0.7286** (.0134) [$0.254]	0.0017 (.0072) [$0.001]	0.1199** (.0088) [$0.042]
log of avg. daily trading volume	-0.1599** (.0018) [-$0.214]	-0.0380** (.0016) [-$0.051]	-0.0635** (.0019) [-$0.084]
log of years to maturity	0.2976** (.0056) [$0.186]	0.5364** (.0037) [$0.335]	0.4370** (.0036) [$0.273]
average rating	0.0435** (.0009) [$0.165]	0.0287** (.0006) [$0.109]	0.0363** (.0006) [$0.138]
Average ΔP for same rating/maturity bonds	0.4382** (.0041)		
Adjusted r-square	.437		

Table 8 Panel B - Estimated Spreads by Trade Size			
Spreads are estimated for different trade sizes based on the equation (2) estimation results for sample mean values of the non-size variables.			
	Principal-dealer spreads	Agent-dealer spreads	Dual-capacity-dealer spreads
5	$1.372 (0.0043)	$1.089 (0.0039)	$2.494 (0.0048)
10	$1.252 (0.0038)	$1.205 (0.0036)	$2.260 (0.0041)
25	$1.110 (0.0036)	$1.304 (0.0036)	$1.841 (0.0033)
50	$1.006 (0.0040)	$1.335 (0.0039)	$1.498 (0.0028)
100	$0.899 (0.0046)	$1.319 (0.0043)	$1.158 (0.0025)
250	$0.747 (0.0054)	$1.194 (0.0048)	$0.745 (0.0026)
500	$0.619 (0.0062)	$0.986 (0.0055)	$0.482 (0.0026)
1000	$0.473 (0.0081)	$0.637 (0.0076)	$0.285 (0.0025)

Table 8 - Determinants of the Net Cost of Direct Customer Interface for Dual-capacity-dealers

Based on the difference between spreads of dual-capacity-dealers and principal-dealers as estimated in equation 2, we estimate and test determinants of the benefits and costs to dual-capacity bond dealers of knowing the trader's identity. In panel A, estimates of the impact of the non-size variables on the net cost, i.e., costs minus benefits, of direct customer interface are presented. Standard errors of the estimates based on Newey-West variance-covariance matrix are shown in parentheses and estimates of the impact of a one standard deviation change in each variable in brackets. In Panel B, estimates of the net cost are reported for various trade sizes with standard error estimates in parentheses for mean values of the non-size variables . * and ** denote coefficients and estimates signficantly different from zero at the 5% and 1% level respectively

Panel A – Non-size variable coefficients

VIX (x100)	MOVE (x100)	Log of trading volume	Log of years to maturity	Rating			
-0.7200** (0.0486) [-$0.083]	-0.6087** (0.0100) [-$0.212]	0.0973** (0.0025) [$0.130]	0.1393** (0.0063) [$0.087]	-0.0072** (0.0001) [-$0.027]			

Panel B - Estimated net costs for various trade sizes (bonds)

5	10	25	50	100	250	500	1000
$1.122 (0.0060)	$1.008** (0.0052)	$0.7312** (0.0045)	$0.492** (0.0045)	$0.2591** (0.0049)	-$0.002 (0.0057)	-$0.136** (0.0065)	-$0.187** (0.0084)

Table 9 - Costs of Agent Assisted Trades vs Trades Directly with Market Makers

Based on the estimates of equation 2, we estimate the difference in roundtrip trading cost between trades involving an agent dealer (consisting of both the agent-dealer and principal-dealer spreads) and trades that do not (dual-capacity-dealer spreads). In Panel A we report estimated spreads for different size trades when the non-size variables are at their sample means. In Panel B we report coefficient estimates of the impact of the non-size variables on the cost difference. Standard errors based on Newey-West standard errors are shown in parentheses. * and** denote estimates significantly different from zero at the .05 and .01 levels respectively.

Panel A

Trade Size (bonds)	Agent-dealer + principal-dealer spreads	Dual-capacity-dealer spreads	Difference
5	\$2.461** (0.0048)	\$2.494** (0.0048)	-\$0.033** (0.0063)
10	\$2.457** (0.0043)	\$2.260** (0.0041)	\$0.197** (0.0054)
25	\$2.414** (0.0040)	\$1.841** (0.0033)	\$0.573** (0.0047)
50	\$2.341** (0.0045)	\$1.498** (0.0028)	\$0.844** (0.0048)
100	\$2.218** (0.0052)	\$1.158** (0.0025)	\$1.060** (0.0054)
250	\$1.941** (0.0062)	\$0.745** (0.0026)	\$1.196** (0.0064)
500	\$1.605** (0.0074)	\$0.482** (0.0026)	\$1.123** (0.0076)
1000	\$1.110** (0.0105)	\$0.285** (0.0025)	\$0.825** (0.106)

Panel B

Variable	VIX	MOVE	Log of trading volume	Log of years to maturity	Rating
	0.6858** (0.0503)	0.6104** (0.0155)	-.1353** (0.0027)	0.3971** (0.0065)	0.0360** (0.0011)

Table 10 - Determinants of Agent-Dealer Involvement		
Probit equation estimates are presented for trades which involve both agent-dealers and principal-dealers and trades handled solely by dual-capacity-dealers. The decision variable equals 1 for non-dealer customer trades with agent-dealers (who then immediately trade with principal-dealers) and 0 for non-dealer customer trades directly with dual-capacity-dealers. Thus a positive coefficient indicates that the variable is associated with a greater tendency for the trade to go through an agent-dealer. The spread difference variable is the estimated difference between the trading cost if the trade goes through an agent dealer (the estimated agent-dealer and principal-dealer spreads) and the cost if the trader trades directly with a dual-capacity dealer (the dual-capacity-dealer spread) based on the estimates of equation 2. The other variables are those used in previous tables. Standard errors (shown in parentheses) are based on Huber-White variance/covariance estimates. * and ** denote coefficients significantly different from zero at the .05 and .01 levels respectively.		
Variable	Customer sales	Customer buys
Estimated spread difference	-2.1274** (0.0123)	-0.6096** (0.0055)
Log of avg. daily trading volume	-0.1138** (0.0012)	-0.1224** (0.0008)
Log of years to maturity	0.4170** (0.0036)	-0.2385** (.0017)
Rating	0.0289** (0.0005)	-0.0249** (0.0004)
VIX (x100)	0.0946** (0.0167)	-0.0695** (0.0117)
MOVE (x100)	0.8272** (0.0074)	0.1599** (0.0040)
Trade size (x100)	-0.0938** (0.0006)	-0.0012** (0.0001)
Intercept	-0.5966** (0.0115)	1.4704** (0.0082)
McFadden r-square	.141	.130

Table 11 - Comparing our Transaction Cost Estimates with Estimates Based on the Edwards, Harris, Piwowar (2007) procedure

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) which approximates the Edwards, Harris, Piwowar (2007) model. 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

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