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# Alternative Trading Systems in the Corporate Bond Market

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## Abstract

We investigate the trading of corporate bonds on alternative trading system (ATS) platforms. We draw a key distinction between request-for-quote (RFQ) and electronic communication network (ECN) trading protocols, which balance investors' preference for immediacy and anonymity. Trades on ATS platforms are smaller and more likely to involve investment-grade bonds. Trades on ATS platforms are more probable for older, less actively traded bonds from smaller issues and for bonds traded by more dealers where inventory is high. Moreover, dealer participation on ATS platforms is associated with lower customer transaction costs of between 24 and 32 basis points.

Key words: corporate bonds, TRACE, electronic trading

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## Executive Summary

We investigate the trading of corporate bonds on alternative trading system (ATS) platforms. Most ATS provide at least one of the two most common electronic trading protocols. The first is the request-for-quote (RFQ) protocol in which platforms solicit bids and offers which counterparties can meet. The second type are automated matching systems which provide immediately executable liquidity. We refer to this method as the electronic communication network (ECN) protocol. The usage of these electronic trading protocols, which have not been comprehensively studied before in the context of the corporate bond market, can improve pre-trade transparency and price discovery in the corporate bond market. In this paper, we assess the types of securities that trade more frequently on ATS platforms and in each type of protocol, and estimate the impact of ATS platforms on transaction costs.

Adoption of electronic trading in corporate bonds has been slower in the U.S. than for other asset classes, as noted by the BIS (2016). In this paper, we first analyze the corporate bond transactions on electronic platforms that are registered as an ATS in the U.S. Trades on these platforms are flagged in FINRA's Trade Reporting and Compliance Engine (TRACE), but TRACE does not collect information on the protocol used. As of December 2017, 16 ATS platforms reported corporate bond trades to TRACE. On average, the monthly trading volume on ATS platforms represents 2.1% of the total corporate bond market volume and 16.1% of trades. The percentage of dealers (40.5%) and bonds (56.4%) trading on ATS platforms, however, suggest that ATS platforms cover a large segment of traded bonds.

ATS platforms primarily facilitate smaller trades. The median trade size reported on ATS platforms is $15,000, compared to $35,000 across all reported trades. In addition, only 2.0% of trades on ATS platforms are $1 million or more, compared to 14.5% in the total market. Investment grade bonds are more likely to trade on an ATS platform, as well as older, less actively traded bonds from smaller issues. Bonds traded by more dealers, or bonds with higher inventory levels, are also more likely to trade on an ATS platform. Bonds with these characteristics are also more likely to trade on ATS platforms that have received an exemption from some reporting obligations under Rule 6732 than ATS platforms that have not received such an exemption.

Comparing customer-to-customer bond transaction chains that include at least one interdealer trade while controlling for other bond and trade characteristics, we find that dealer participation on ATS platforms is associated with lower customer transaction costs of between 24 and 32 basis points, depending on the specification of the regression model.

## Section 1. Introduction

In the last 20 years, electronic trading networks have evolved to bring together market participants, facilitate price discovery, and provide liquidity across a variety of asset classes. Relative to other asset classes, market participants have been slow to adopt the new technologies for the trading of corporate bonds, and they continue to trade predominantly on bilateral voice over-the-counter (OTC) markets (BIS (2016)).[1] In this paper, we first describe the different types of electronic trading protocols available to participants in the current corporate bond market. Then we focus on trading on ATS platforms, where we can measure trading probability conditioned on characteristics of the corporate bond, and the impact on transaction costs.

Electronic trading takes many forms. The majority of electronic corporate bond volume is pursuant to request-for-quote (RFQ) protocols.[2] Similar to voice OTC trading, RFQ protocols enable participants seeking liquidity to broadcast, usually anonymously, buying or selling interest to select other participants. The quotes participants submit in response to the request are for the soliciting party only, and expire at the end of the session. The quotes may or may not be binding depending on the specifics of the trading protocol (SIFMA (2016)).

Alternatively, market participants may utilize other protocols offered by ATS platforms that aggregate and match the orders of multiple buyers and sellers using established, non-discretionary methods for matching. Electronic limit order books, with firm quotes where participants can receive an immediate execution, are a prominent subset of such protocols. As these protocols are similar to the ECNs in the U.S. equity and Treasury markets, we will refer to this subset of protocols as ECN protocols. It has been suggested that the protocols, which have not been comprehensively studied before, have the potential to improve pre-trade transparency and price discovery in the corporate bond market through the consolidation and display of orders (Harris, Kyle, and Sirri (2015)).

Electronic trading platforms' offerings are not limited to one type of trading protocol, and many trading platforms offer more than one trading protocol. For example, electronic platforms can offer both RFQ trading protocols and ECN trading protocols (SIFMA (2016)).

The predominance of RFQ protocols over other protocols may reflect the potential for additional costs for participants if they were to seek liquidity through an ECN protocol. Participants seeking liquidity may have additional exposure to information leakage and adverse selection when routing orders pursuant to an ECN protocol. The costs depend on the characteristics of the trading protocol, including the number of participants that can view or execute the order and the length of time that the orders are actionable. For these reasons, market participants seeking liquidity may prefer to route orders using an RFQ protocol rather than an ECN protocol.

We first investigate trading activity at the level of the electronic ATS platform. For this analysis, we use the information reported to TRACE. With the TRACE data, we can identify all corporate bond trades on registered ATS platforms, but not the type of the trading protocol through which the trade was executed. This analysis focuses on the market shares of competing platforms over

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[1] Internationally, BIS (2016) reports that approximately 40% of investment grade corporate bonds and over 20% of high yield corporate bonds trade electronically. Corporate bonds had the least amount of electronic trading of any of the security classes considered in the report (e.g., U.S. Treasuries).

[2] *See infra* note 13 and related discussion. This finding relies on self-reported figures for volume on non-ATS electronic platforms.

time. The sample period begins in August 2016 after the second of two regulatory changes that enable us to identify all trades on ATS platforms. The sample period ends in December 2017.

As of December 2017, 16 ATS platforms report corporate bond trades to TRACE. Trading on ATS platforms represents 2.1% of the average monthly trading volume and 16.1% of average monthly trades in the corporate bond market, with the majority of trades between dealers. The number of dealers and bonds that trade on ATS platforms, however, suggest that ATS platforms cover a large segment of the overall market. For example, 353.9 dealers (40.5%) and 11,719.5 bonds (56.4%) that trade in a given month have at least one trade executed and reported on an ATS platform. Dealers who trade on an ATS platform are larger, with reported trading volume 18.9 times greater than dealers not reporting an ATS trade. Trading on ATS platforms, however, is not dominated by large dealers; the ten largest dealers account for a smaller share of ATS platform trading volume (42.3%) than OTC market trading volume (58.7%). A dealer is more likely to trade on an ATS platform when the aggregate dealer inventory for the bond being traded has recently increased, suggesting ATS platforms are used to manage excess inventory. Bonds trading on an ATS platform have on average 2.7 times greater trading volume than bonds not trading on an ATS platform.

Although ATS platforms may reduce search costs by providing easier access to other traders, market participants may also face a higher risk of information leakage and adverse selection when attempting to trade on these venues. As a result of this trade-off, market participants should be more likely to trade on an ATS platform in situations where these risks are less important. Consistent with this view, we find that proxies of such risks are associated with less trading on ATS platforms. For example, information leakage is likely less of a concern for the liquidity seeker when attempting to make a smaller trade. We find that the median trade size on ATS platforms is $15,000 and only 2.0% of trades are $1 million or more. In addition, Han and Zhou (2013) show that information asymmetry and adverse selection are larger for high yield than for investment grade bonds. We find that 73.4% of corporate bonds that trade on ATS platforms are investment grade, compared to 66.2% of the total market. A multivariate analysis confirms investment-grade bonds are more likely to trade on ATS platforms controlling for other characteristics.

Search costs are higher when investors have more difficulty finding counterparties. ATS platforms can reduce search costs by providing easier access to more counterparties. Empirically, we find that bonds of smaller issue size and older vintage are more likely to trade on an ATS platform. This is true both unconditionally and when controlling for other characteristics. Controlling for other characteristics, bonds with lower recent trading volume are more likely to trade on ATS platforms. Together, these results suggest that ATS platforms are particularly useful for bonds where finding a counterparty is more difficult.

The size of trades and the characteristics of the bonds differ between ATS platforms that have received an exemption from some of their TRACE reporting obligation under FINRA Rule 6732 (6732 ATSs) and those ATS platforms that have not received an exemption (non-6732 ATSs). Where an exception has been granted, a 6732 ATS does not have a reporting obligation for trades that meet the conditions in the rule.[3] An exemption under FINRA Rule 6732 simplifies the

[3] Trades subject to the exemption must be between FINRA members, not pass through any ATS account, not involve the ATS exchanging securities or funds on behalf of subscribers, and the ATS must not take either side of the trade for clearing or settlement purposes. The ATS must provide FINRA data on exempted trades on a monthly basis, remit to FINRA a transaction reporting fee for the exempt trades, and enter into written agreements with the members trading requiring them to report the trade and

reporting obligations for an ATS platform, lowering the regulatory burden of reporting trades and so requesting an exemption may be more worthwhile for a platform with a larger number of trades. As of the end of 2017, four ATS platforms have filed for and received an exemption under this Rule. Platforms that have received exemption may not rely on it for the majority of their trades.

The four 6732 ATSs facilitate the majority of trades on ATS platforms, and the trading patterns we observe across all ATS platforms predominantly reflect the trades on 6732 ATSs. 6732 ATSs differ along a number of dimensions from non-6732 ATSs. For example, a larger number of dealers and bonds trade on 6732 ATSs than non-6732 ATSs. Similarly, trades on 6732 ATSs are smaller, with a median trade size of $15,000 compared to a median trade size on non-6732 ATSs of $500,000.[4] The clientele of the platforms also appear to differ. For example, nearly all trading by discount retail brokerages on ATS platforms is on 6732 ATSs.

Next, we estimate the potential gains to customers from dealer participation on ATS platforms. Using a methodology similar to Li and Schürhoff (2018), we identify sequences of trades that begin with a customer sale and end with a customer purchase (i.e., trade chains). For the trade chains with an interdealer trade, we compare customer transaction costs between the chains that include and do not include a dealer transaction on an ATS platform. Holding the length of the trade chain constant, we estimate that a trade on an ATS platform is associated with lower customer transaction costs of between 24 and 32 basis points. As a way to assess the relative importance of the difference in transaction costs, the average customer transaction cost in our sample is 115 basis points.

Overall, the results of this paper indicate the economic importance of and trade-offs associated with ATS platforms and the protocols they offer in today's market. ATS platforms seem to be a preferred venue when information leakage is a lesser concern, such as for small trades in investment grade corporate bonds. Market participants may prefer other venues where the costs associated with information leakage are more significant. These result are similar to Hendershott and Madhavan (2015). In contrast to Hendershott and Madhavan (2015), however, our results indicate that ATS platforms are more likely to facilitate trades for older, smaller issues where locating a counterparty may be more difficult.

Our sample incorporates a larger number of electronic trades in our analysis than the study by Hendershott and Madhavan (2015) due to the larger number of platforms in our sample and the increase in electronic trading that has occurred over time. Hendershott and Madhavan (2015) study approximately 29,000 electronic trades per month between January 2010 and April 2011. With the TRACE data, we study approximately 225,000 electronic trades on ATS platforms per month. Our sample also encompasses platforms offering ECN protocols more similar to electronic trading for equities than the RFQ platform studied by Hendershott and Madhavan (2015).

The remainder of the paper is organized as follows. In **Section 2**, we provide background describing electronic trading in corporate bonds and TRACE reporting obligations of FINRA members. We describe the sample data in **Section 3** and demonstrate the effect of recent

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identify it as taking place on the ATS. *See* https://www.finra.org/rules-guidance/rulebooks/finra-rules/6732.

[4] In the analysis measuring customer costs, we are able to identify few trade chains with a trade on a non-6732 ATS. The reduction in customer costs, therefore, reflect the trades on 6732 ATSs.

regulatory changes on our ability to identify the trades on ATS platforms in the TRACE data. We examine the trading on ATS platforms in **Section 4**, and we examine the relationship between ATS platform use and customer transaction costs in **Section 5**. **Section 6** concludes.

## Section 2. Background

In this section, we describe the different venues for the trading of corporate bonds (i.e., voice OTC markets, RFQ protocols, and ECN protocols), and the factors that may influence its selection by market participants. We also describe the reporting obligations of FINRA members to TRACE.

### 2.1 Choice of Trading Venue

Corporate bonds trade in both voice OTC and electronic markets. The choice of trading venue may impact the likelihood of a transaction, the price obtained, the broker-dealers' costs to identify a counterparty, the amount of information leakage, and the exposure to adverse selection. Market participants may be particularly sensitive to the choice of venue due to the large number and heterogeneity of corporate bonds, and the infrequency in which many corporate bonds trade.

Traditionally, corporate bonds trade in voice OTC markets. In these markets, participants solicit bids, including trade size and price, from one or more participants to purchase or sell a bond. Participants incur costs to conduct the bilateral and sequential solicitation of other participants (Duffie, Gârleanu, and Pedersen (2005)). With the bilateral and sequential solicitation, however, participants can limit the disclosure of their trading intentions and potentially reduce the costs associated with information leakage.

Corporate bonds also trade in electronic markets.[5] A majority of electronic corporate bond volume is executed pursuant to RFQ protocols.[6] An RFQ protocol is the electronic equivalent of a voice OTC market. Participants seeking liquidity (initiators) can solicit bids or offers, including trade size and price, to purchase or sell a bond from other participants (respondents). Unlike the voice OTC markets, initiators can broadcast buying or selling to more than one participant simultaneously. Although initiators reduce their costs to search for a trading counterparty, the simultaneous broadcast can increase the amount of information leakage. Respondents are under no obligation to respond to a solicitation, and the quotes respondents submit are for the soliciting party only. Quotes can be open for negotiation, and expire at the end of the session. Initiators have discretion over whether or not to trade after receiving quotes, and respondents generally make a binding second commitment before confirmation.[7]

Hendershott and Madhavan (2015) model the choice of trading venue between RFQ protocols and voice OTC markets. Their model describes the choice of venue as a tradeoff between an increase in dealer price competition and an increase in the cost of information leakage. Although an RFQ

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[5] Electronic trading in the corporate bond market greatly increased in the early 2000s. *See* http://www.algomi.com/bond-market/brief-history-of-electronic-bond-platforms. *See* SIFMA (2016) for a description of the existing electronic platforms for the trading of U.S. corporate and municipal securities.

[6] *See infra* note 14 and related discussion.

[7] An initiator that executes a trade may receive information regarding the second best price (i.e., the "cover price"). The disclosure of the cover price, however, may be dependent on the parties to the trade. For example, *see* https://www.reuters.com/article/us-pimco-marketaxess/marketaxess-allows-pimco-to-trade-by-its-own-rules-idUSKBN1I528W.

protocol increases dealer competition, resulting in better bond prices, the simultaneous disclosure of trading intentions to multiple participants increases the cost from information leakage. They find empirical results consistent with their model; RFQ protocols facilitate the trades of corporate bonds when participants are more likely to respond to a request and participants are likely to incur fewer costs from information leakage.

ATS platforms offer a variety of protocols that bring together the orders of multiple buyers-and-sellers and use established, non-discretionary methods to match those orders. The majority of trading on the most active ATS platforms takes place via ECN protocols that involve a live and executable order book.[8] Participants seeking liquidity via ECN protocols may have additional exposure to information leakage but may also benefit from increased price competition when placing orders. Participants who place non-marketable limit orders provide a free option to the other participants to trade at the posted quote (Hendershott and Madhavan (2015)). The cost of the free option increases with the number of participants that may execute the order and the length of time the orders are live and executable. The additional exposure to information leakage and the cost of keeping quotes for many instruments current are possible explanations for the predominance of electronic trading executed pursuant to RFQ protocols.

Another protocol offered by some ATS platforms is session trading where orders are submitted, matched, and then executed. Session trading is generally not continuously available, occurring at pre-defined times or triggered by a trade through another protocol, and typically occurs at prices provided by a third party or at a midpoint of indications of interest.

Trading protocols can also vary among other dimensions which can impact the potential costs to trade. For example, protocols may offer the ability of participants to specify who receives a request-for-quote or views their orders. This feature may reduce the likelihood of transaction or the probability that best price is received, but also can reduce the potential adverse selection of the participants seeking liquidity. Trades may also be subject to a "last look" where the liquidity provider has a final opportunity to confirm or deny an attempt to trade at a price it quoted. This reduces the risk of adverse selection for the liquidity provider but may increase the risk of adverse selection and information leakage for the responding party. Some platforms set a minimum size requirement for trades.

The method of trading, as well as the information, bargaining power, and preference for immediacy and anonymity, will factor into a participant's choice of trading venue. Another factor is the amount of available liquidity. Pagano (1989) shows that because the depth and liquidity of a market depends on the entry decisions of all potential participants, and when transaction costs are otherwise equal, trading will tend to concentrate where participants expect others to send their orders. The selection of trading venues with more liquidity by market participants is consistent with the empirical evidence; although the total number and market share of electronic platforms have increased over time, trading appears to concentrate on few platforms. The success of electronic trading platforms is dependent on gaining traction among participants. Electronic trading platforms that enter the market may attempt to compete for market share with the existing platforms by offering new technology innovation or targeting a specific segment of the market.

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[8] Conversations with several of the four 6732 ATSs indicate a majority of their trades are pursuant to such protocols.

### 2.2 TRACE Reporting

TRACE facilitates the mandatory reporting and dissemination of OTC market transactions in order to assist price discovery and improve execution quality. Securities eligible for TRACE reporting are U.S. dollar-denominated debt securities issued by a domestic or foreign private issuer (other than restricted securities that are not sold pursuant to Rule 144A), issued or guaranteed by an executive agency or Government-Sponsored Enterprise, or issued by the U.S. Department of Treasury.[9]

Each FINRA member that is a party to a reportable transaction in a TRACE-eligible security has a reporting obligation.[10] Member firms that act as an introducing or executing broker-dealer are considered a party to a transaction, and therefore have a reporting obligation. Non-members, including customers and non-member affiliates of member firms, do not have a reporting obligation. A trade report includes the security identifier, date, time, size (par value), and price of the transaction. A report also identifies the member firm's side of the transaction (buy or sell), their capacity as a principal or agent, and the other parties to the transaction. The required reporting time varies between categories of TRACE-eligible securities. Member firms must report a secondary corporate bond transaction as soon as practicable, but no later than within 15 minutes of the time of execution.

Electronic platforms may or may not have a reporting obligation. The reporting obligation of an electronic platform is dependent on whether the platform is a party to the trade. Some electronic platforms are registered as ATSs.[11] An ATS platform is a party to all transactions executed through its system, and therefore has a reporting obligation.[12] An ATS platform is a party to every trade regardless of whether the trade is pursuant to an ECN protocol or to another protocol (e.g., RFQ protocol).

An electronic platform that is not an ATS is not necessarily a party to all trades executed through its system so may not always have a reporting obligation.[13] One circumstance where an electronic

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[9] *See* FINRA Rule 6710.

[10] A transaction in a TRACE-eligible security is reportable unless an exception applies. Exceptions include the sale from an issuer to an underwriter or initial purchaser, a transfer for the sole purpose of creating or redeeming an instrument (e.g., an exchange-traded fund), and a transaction resulting from the exercise or settlement of an option or a similar instrument. *See* FINRA Rule 6730.

[11] In general, a trading platform that meets the SEC's functional definition of an "exchange" must register as a national securities exchange or comply with Regulation ATS, which requires registration as a broker-dealer. *See* Securities and Exchange Commission, Regulation of Exchanges and Alternative Trading Systems, Release No. 34-40760.

[12] *See* FINRA Regulatory Notice 14-53. For a trade between two counterparties, an ATS separately reports a purchase of securities from the first counterparty and a sale of securities to the second counterparty. An ATS may also involve a third-party intermediary that provides clearance and settlement services. The third-party intermediary is a party to the trade and also has a reporting obligation. The presence of a third-party intermediary, however, does not absolve the ATS from its reporting obligations.

[13] Two such electronic platforms are operated by Bloomberg L.P. (Bloomberg) and MarketAxess Corporation (MarketAxess). Bloomberg's electronic fixed-income trading platforms are operated outside of its registered broker-dealer, Bloomberg Tradebook LLC, which was previously subject to Regulation ATS but not for trading of corporate bonds and ceased operating its ATS in September 2016. MarketAxess is registered as a broker-dealer and subject to Regulation ATS, but not for the trading of corporate bonds. In

platform that is not an ATS would be a party to a trade through its platform and thus have a reporting obligation is if the platform takes a side to a trade. This may occur when counterparties on the platform remain anonymous through execution and the platform acts as a riskless counterparty to both sides of the trade. In order to facilitate this type of interaction on an RFQ platform, the operator would be required to establish a FINRA-registered broker-dealer to serve as the riskless counterparty. The intermediating broker-dealer would have TRACE reporting requirements.

Two recent changes to the TRACE reporting obligations of ATSs greatly increased our ability to identify trades on electronic platforms. We discuss the regulatory changes in further detail in the next section, and demonstrate their effect on our ability to identify trades on ATS platforms.

## Section 3. Data

We use the supervisory version of TRACE data to document the extent of trading on ATS platforms, the characteristics of the bonds that trade on them, and the differences in transaction costs between trade chains that involve an ATS platform trade and those that do not. We also compare the trades on ATS platforms to the trades off ATS platforms.

### 3.1 Overview

The primary dataset that we use in the analysis is the supervisory version of TRACE data. Similar to the academic version of TRACE data, the supervisory version identifies FINRA members with a unique identifier.[14] The supervisory version, however, identifies member firms uniquely with their Market Participant Identifier (MPID). Non-member affiliates of member firms (affiliates) are identified with an "A," and customers of member firms are identified with a "C." The academic version also provides transaction-level data on a 36-month delayed basis, whereas the supervisory version does not have a similar delay.

The supervisory version also does not censor the total par value of the trade. The real-time public version of TRACE data disseminates investment grade bond trades greater than $5 million as "5MM+," and high-yield or unrated bond trades greater than $1 million par value as "1MM+." The total par value of these trades are publicly available after an 18-month delay.

There are two limitations to analyzing all electronic trading using these data. The first limitation is the inability to identify all trades on electronic platforms. Specifically, we do not observe all trades that were executed on an electronic platforms that are not registered as an ATS platform. Instead, we are only able to identify the trades on non-ATS electronic platforms when the platform

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the fourth quarter of 2017, MarketAxess reported that trades on its system accounted for 17.6% of U.S. high-grade trading volume as reported to TRACE. MarketAxess offers all-to-all trading through the RFQ protocol for the trading of corporate bonds, *see* http://investor.marketaxess.com/static-files/f432852c-be4e-4799-8782-3973f69f3014. MarketAxess has announced that it will offer an ECN protocol in the second half of 2019, *see* https://www.thetradenews.com/marketaxess-outlines-plans-open-trading-live-order-book/.

[14] We supplement the trade data with bond characteristic information (e.g., type, rating, issue date, and issue size) from TRACE bond master files. This information is sourced from Thompson Reuters Datascope.

takes a side to the trade.[15] **Table 3.1** summarizes the trades on electronic platforms that we are able to identify in the TRACE data depending on the classification of the platform, the trading protocol, and whether the platform takes a side to the trade.

**Table 3.1 Trades Identifiable on Electronic Platforms**

| Electronic Platform Reporting Obligations | | | |
|---|---|---|---|
| **ATS Platform** | **ECN Trading Protocol** | **Takes a Side to the Trade** | **Identifiable on TRACE** |
| Yes | Yes | Yes | Yes |
| | | No | Yes |
| | No | Yes | Yes |
| | | No | Yes |
| No | Yes[16] | N/A | N/A |
| | | N/A | N/A |
| | No | Yes | Yes |
| | | No | No |

The second limitation is the absence of information that identifies the trading protocol within an ATS platform. Electronic platforms may utilize more than one protocol to facilitate trading (SIFMA (2016)). To our knowledge, there are no discernable patterns in the data to distinguish between trades pursuant to different trading protocols within a platform (e.g., ECN protocol and RFQ protocol). The trades on ATS platforms that we identify in the TRACE data, therefore, relate to the ECN protocol as well as other protocols offered by the platform. As a result of this limitation, we are unable to examine only those trades that are pursuant to an ECN protocol. We are also unable to accurately compare trades occurring on different protocols.

We obtain data from August 2012 to December 2017. We clean the data for corrections and cancellations. Electronic platforms generally facilitate secondary market trades. We therefore exclude primary market trades from the sample. We also account for multiple trade reports for the same trade. We include each trade in our analysis only once regardless of whether the trade is between dealers or on an electronic platform. We discuss our procedure to account for multiple trade reports in the Appendix.

## 3.2 Regulatory Changes to TRACE Reporting

The limitations of TRACE aside, the data allow us to study corporate bond trades on ATS platforms. In particular, the data allow us to study corporate bond trades on ATS platforms following the second of two regulatory changes. The two regulatory changes allowed us to identify previously unidentifiable ATS platforms and ATS platform trades in the TRACE data.

[15] *See supra* note 14 and related discussion. Our results regarding trades on ATS platforms may not generalize to non-ATS electronic platforms. Some market participants have expressed that the clientele and trade characteristics may differ.

[16] Under the framework of this paper, an electronic platform that offers an ECN trading protocol would likely need to either register as a national securities exchange or comply with Regulation ATS. We should therefore not encounter trades on electronic platforms that do not register as an ATS but offer ECN trading protocols.

The first regulatory change is amendments to FINRA rules requiring that ATS platforms obtain a single, unique MPID that is exclusive to the platform for the purposes of TRACE reporting.[17] A FINRA member that operates an ATS platform cannot use more than one MPID for a single ATS platform, and cannot use a single MPID for more than one ATS platform. Prior to the effective date, a member firm could use the same MPID for transactions executed in operation of an ATS platform and for other purposes. This limits our ability to attribute trades to a single ATS platform prior to the effective date. The effective date of the regulatory change was February 2, 2015.

The second regulatory change is the adoption of FINRA Rule 6732.[18] Under the rule, an ATS platform can file for an exemption from its TRACE reporting obligations for certain trades between FINRA members. Although a 6732 ATS would not have a reporting obligation, the member firms that are parties to these trades would identify the ATS platform when reporting. The rule adoption did not change the reporting obligations for non-6732 ATSs. The rule adoption, however, did clarify the reporting obligations for all ATS platforms and therefore may have increased the number of trades on non-6732 ATSs that are identifiable in the TRACE data. The effective date of the rule adoption was July 18, 2016.

Four ATS platforms received an exemption under FINRA Rule 6732 prior to the end of the sample period in December 2017.[19] A platform that has received an exemption may not necessarily rely on the exception for the majority of its trades. An exemption would have a greater effect on simplifying compliance with TRACE reporting obligations for ATS platforms that facilitate a greater number of trades. Whether an ATS platform has been granted an exemption, therefore, may relate to the amount of trading activity on its system. In the analysis below, we separately examine the trades on 6732 ATSs and non-6732 ATSs to account for this potential difference.

### 3.3 Identification of ATS Platforms and Time-Series Summary

We identify trades on ATS platforms by MPID. We use FINRA lists to identify the MPIDs of ATS platforms.[20] The lists include, at a point in time, the active ATS platforms in all OTC fixed-income markets. Using the FINRA lists we are able to identify 20 MPIDs in the TRACE data that relate to ATS platforms within the sample period.

We present a time-series summary of the trading activity on ATS platforms that we are able to identify in the TRACE data. The summary describes the current amount of trading activity on ATS platforms, as well as the effects of the two regulatory changes on the reporting of electronic trades. The two regulatory changes split the sample into three time periods: August 2012 to January 2015, February 2015 to July 2016, and August 2016 to December 2017.

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[17] For a description of the rule, *see* FINRA Regulatory Notice 14-07 and FINRA Rules 6160, 6170, 6480, and 6720.

[18] For a description of the rule, *see* FINRA Regulatory Notice 16-15 and FINRA Rule 6732.

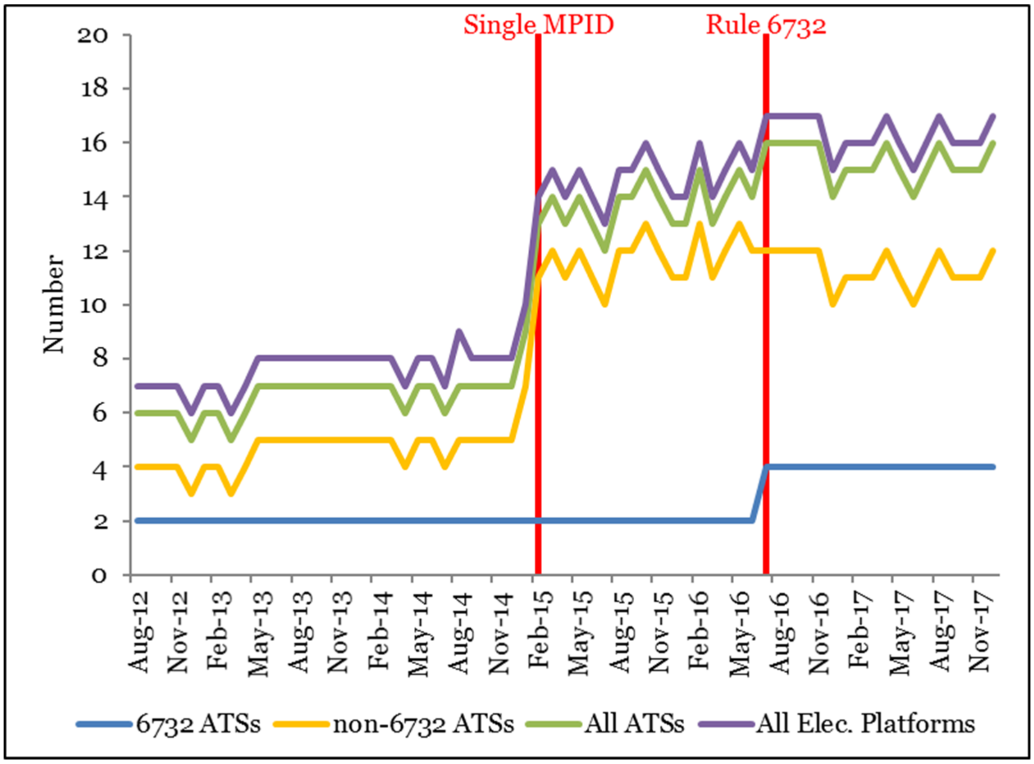
[19] The four ATSs are ICE BondPoint, TMC Bonds LLC, TradeWeb Direct LLC, and Trumid ATS. A fifth ATS platform, Euronext Synapse LLC, has since been granted an exemption. The dates at which each ATS was granted an exemption can be found at https://www.finra.org/rules-guidance/guidance/exemptive-letters.

[20] The lists are publicly available on the FINRA website. *See* https://www.finra.org/filing-reporting/otc-transparency/finra-equity-ats-firms-list. FINRA first posted the lists in February 2015.

Our measures of trading activity include the number of ATS platforms as well as the percentage of bonds traded, the percentage of total market volume (both overall and by trade size), and the percentage of dealer trades and customer or affiliate trades on ATS platforms. We separately report the trading activity on all ATS platforms, 6732 ATS platforms, and non-6732 ATSs. We also report the trading activity on all electronic platforms, including those platforms that do not offer an ECN protocol for the trading of corporate bonds, to the extent it can be identified in TRACE.[21] We present the time-series summary with a series of figures.

**Figure 3.1** presents the number of ATS platforms over the sample period that we are able to identify in the TRACE data.

**Figure 3.1 Number of ATS Platforms**




The figure demonstrates that 16 platforms facilitated corporate bond trades as of December 2017. The figure also permits us to infer the impact of the unique MPID requirement on our ability to identify ATS platforms in the TRACE data. The number of ATS platform MPIDs in the TRACE data increase from nine prior to the regulation to fourteen after the regulation. Many of the MPIDs in the FINRA lists were not present prior to the regulatory change. This suggests that the increase in the number of MPIDs is a consequence of the new reporting requirement.

The next two figures, **Figure 3.2** and **Figure 3.3**, present the percentage of total monthly trading volume on ATS platforms and the percentage of total monthly trading volume on ATS platforms by trade size.

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[21] We identify the additional electronic platforms by MPID in TRACE. We obtain the MPIDs from a recent survey (SIFMA (2016)). We may not identify all trades on these platforms. *See supra* note 11 and related discussion.

**Figure 3.2 Percent Monthly Trading Volume**

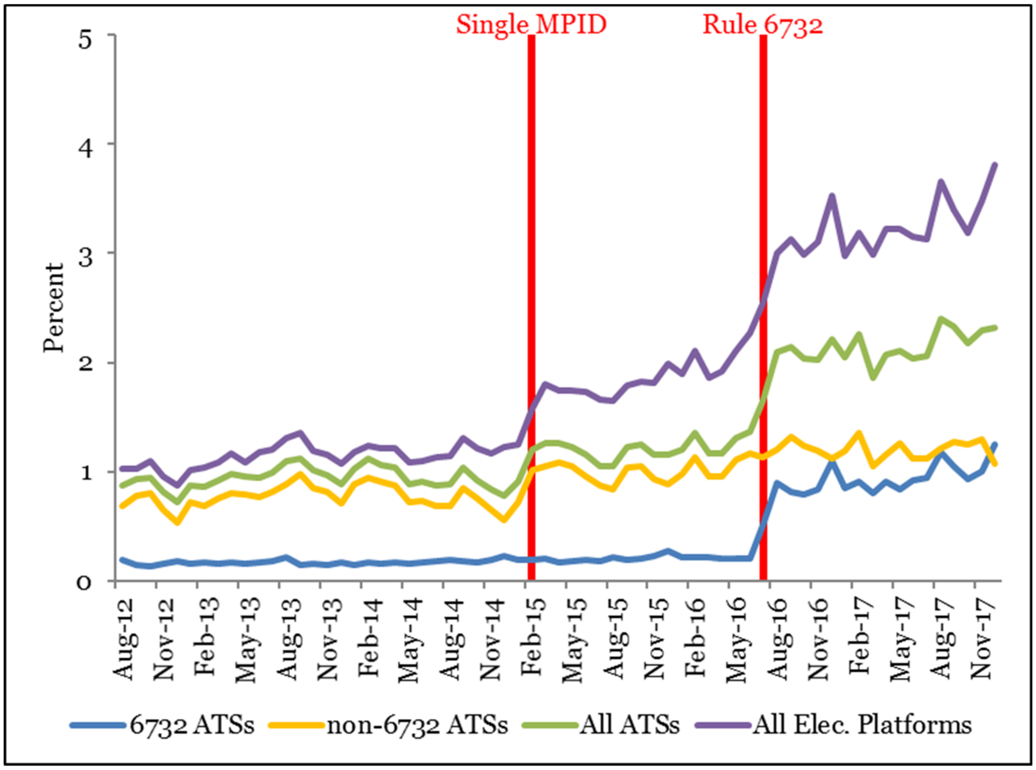

**Figure 3.3 Percent Monthly Trading Volume by Trade Size**

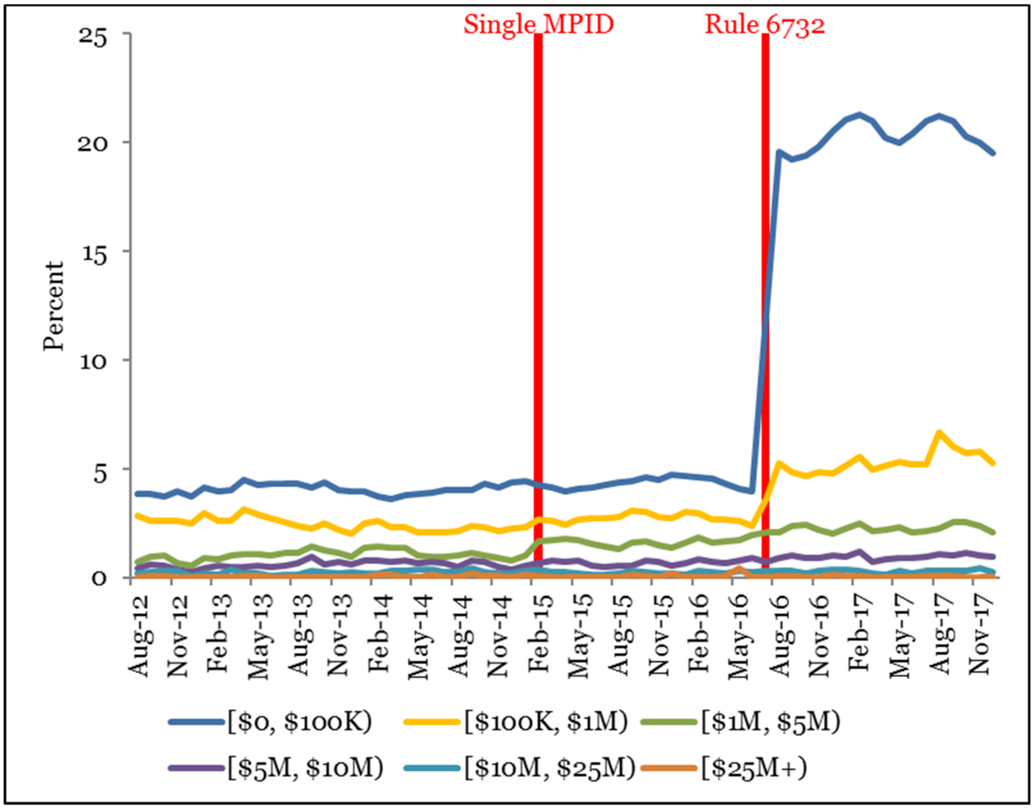


**Figure 3.2** shows that the total trading volume on ATS platforms is small relative to the total market. **Figure 3.3** shows, however, that the relative volume of small trades is material and important. As of December 2017, only 2.3% of the total trading volume is on ATS platforms. For trades less than $100,000, however, 19.5% of the trading volume is on ATS platforms. **Figure 3.3** also shows that the adoption of FINRA Rule 6732 greatly increased our ability to identify small trades on ATS platforms. Prior to the rule adoption, the percentage of trading volume that we are able to identify for small trades is less than five percent.

Finally, **Figure 3.4** presents the percentage of all dealer trades on ATS platforms, and **Figure 3.5** presents the percentage of all customer or affiliate trades on ATS platforms.

**Figure 3.4 Percent of Dealer Trades Executing on ATS**

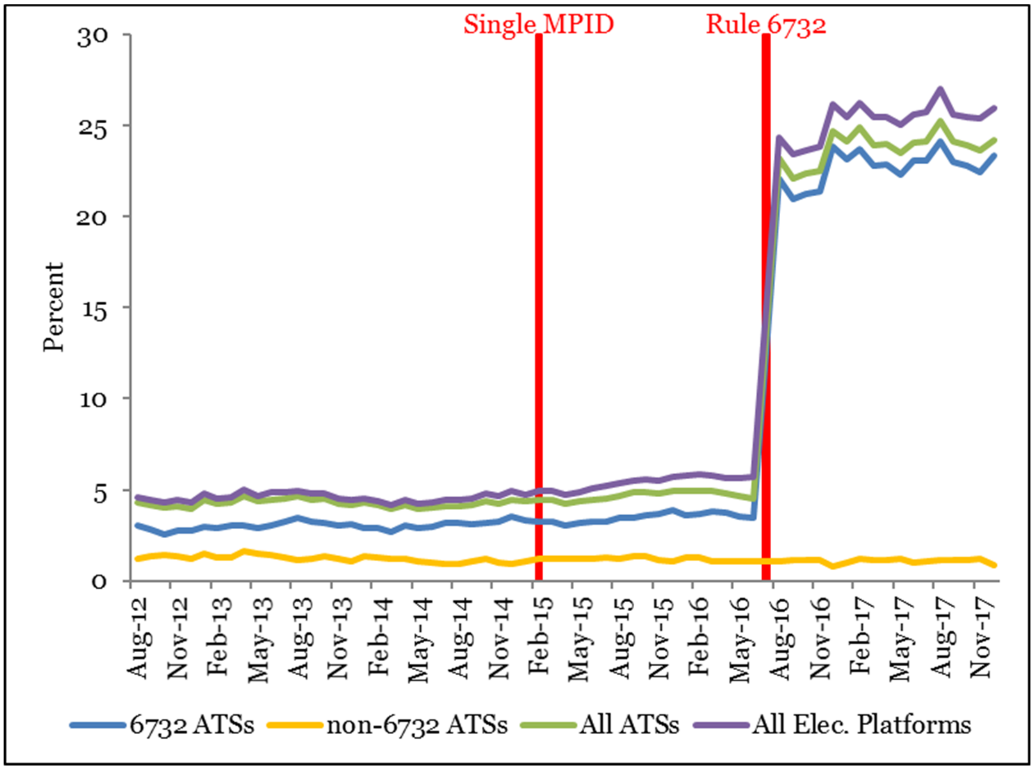


**Figure 3.5 Percent of Customer or Affiliate Trades Executing on ATS**

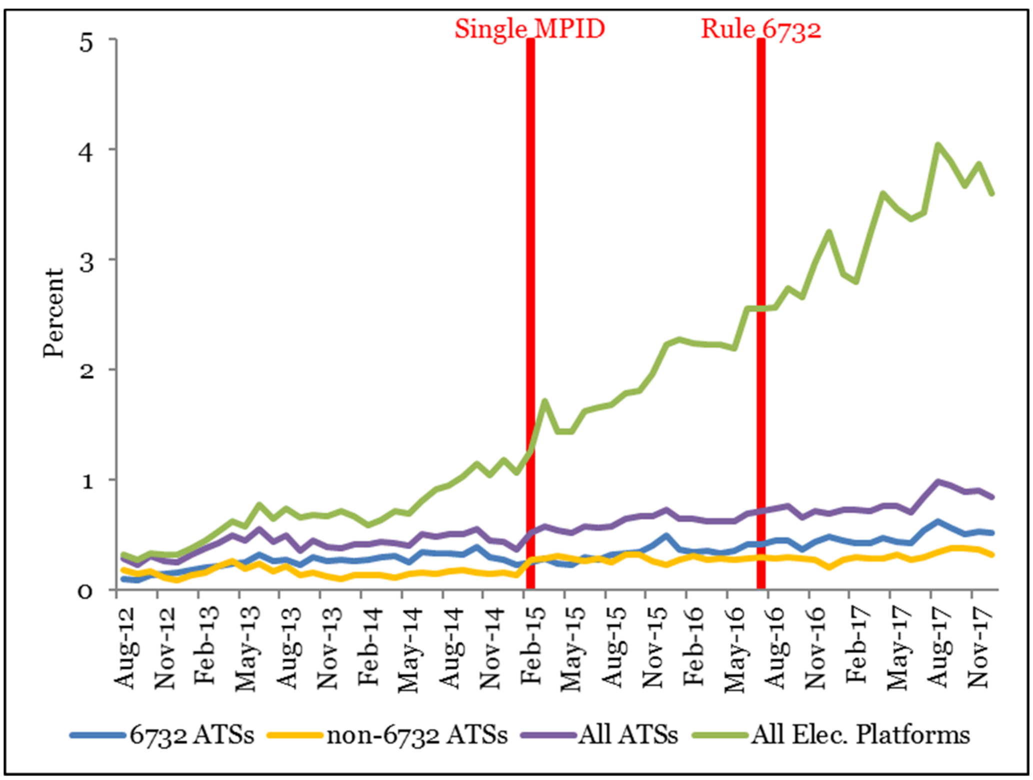

**Figure 3.4** shows that ATS platforms facilitate a large percentage of dealer trades, and **Figure 3.5** shows that ATS platforms directly facilitate few customer or affiliate trades.[22] This is indicative of ATS platforms as primarily dealer markets. From August 2016 to December 2017, dealers represent 98.3% of the total number of counterparties that trade on ATS platforms. As of the end of the sample period, 24.2% of dealer trades are on an ATS platform.[23] The majority of dealer trades on an ATS platform (96.4%), however, are on a 6732 ATS. Similar to the increase in the volume of small trades on ATS platforms, the adoption of FINRA Rule 6732 increased our ability to identify dealer trades on ATS platforms, and in particular on 6732 ATSs.

In sum, the two regulatory changes increased our ability to identify trades on ATS platforms. The unique MPID requirement increased the number of ATS platforms that we are able to identify in the TRACE data, and FINRA Rule 6732 increased the number of trades on ATS platforms that we are able to identify. The increase in the number of trades on ATS platforms in the latter part of the sample period, however, is driven by an increase in small dealer trades on 6732 ATSs.

## Section 4. Trading on ATS Platforms

In this section, we examine the trades on ATS platforms using the TRACE data. We use the TRACE data to describe the overall trading on ATS platforms. The sample period of the TRACE is data is from August 2016 to December 2017.

We examine several measures of trading activity on ATS platforms. The measures include the amount of trading volume, the number and trading activity of dealers, the number and trading activity of bonds, and trade size. We also examine the characteristics of the bonds that trade on ATS platforms. Finally, we estimate models describing the choice of trading venue.

### 4.1 Market Coverage

**Table 4.1** presents the amount of trading volume on all ATS platforms, and separately on 6732 ATSs and non-6732 ATSs. As a comparison, the table also presents total market volume over the corresponding sample periods. The table describes trading volume with monthly averages.

**Table 4.1 Average Dollar Volume per Month Executing on ATS**

| Volume ($B) | | | |
|---|---|---|---|
| ATS Platform | 6732 ATSs | non-6732 ATSs | Total Market |
| 15.0 | 6.5 | 8.5 | 699.4 |

The TRACE data indicate that ATS platforms facilitate a small percentage of overall corporate bond volume. On average, the monthly volume on ATS platforms represents 2.1% of the total

[22] **Figure 3.5** also shows that the percentage of customer trades on all electronic platforms steadily increased over the sample period. The increase is the result of trades on the other electronic platforms that do not offer an ECN protocol for the trading of corporate bonds. Some dealers, including discount brokerages, display quotes from ECN protocols to their customers. These customers may initiate some of the dealer traders on these platforms.

[23] In addition, over half (52.7%) of the interdealer trades reported to TRACE are on an ATS platform. This measure includes multiple reports relating to the same trade.

market volume ($15.0 billion of $699.4 billion). A relatively large percentage of trading volume is on 6732 ATSs. Although 6732 ATSs account for approximately one-fourth of the number of ATS platforms, the average volume per month on 6732 ATSs is 43.6% of the total volume on all ATS platforms ($6.5 billion of $15.0 billion).

Trading volume may not reflect the full economic significance of the trading on ATS platforms. ATS platforms facilitate a higher proportion of trades (16.1%) than trading volume. Because ATS platforms offer pre-trade transparency, participants trading in the broader corporate bond market may still benefit from the price discovery on ATS platforms. As noted by Alan and Schwartz (2013), prices are a public good and can be used for non-trading purposes such as marking-to-market. Wider market coverage may also indicate the value of ATS platforms as an outside option for those with access to the platforms, and evidence that the potential growth of these platforms may not be constrained by the infeasibility of trading certain bonds electronically. The extent of these benefits is affected by the market coverage of ATS platforms. We measure market coverage by the number and trading activity of the dealers and bonds that trade on ATS platforms. Similar to **Table 4.1**, **Table 4.2** presents the number of dealers that trade on ATS platforms. The table describes the number of dealers with monthly averages.

**Table 4.2 Average Number of Dealers per Month Executing a Trade on ATS**

| Number of Dealers | | | |
|---|---|---|---|
| | | | |
| **ATS Platform** | **6732 ATSs** | **non-6732 ATSs** | **Total Market** |
| 353.9 | 316.8 | 118.9 | 874.5 |

The TRACE data indicate that 40.5% of the active dealers trade on an ATS platform (353.9 of 874.5 dealers). The dealers that trade on ATS platforms, however, engage in more trading activity than dealers not trading on ATS platforms. For example, dealers that trade on at least one ATS platform per month have 18.9 times the amount of trading volume ($2,080.2 to $109.9 million) and trade 11.7 times more bonds (601.2 to 51.4) than dealers that do not trade on an ATS platform. The dealers that trade on ATS platforms, therefore, are the large more active dealers. However, the ten largest dealers account for a smaller proportion of ATS platform volume (41.9%) than OTC volume (59.6%). On average, dealers that trade on at least one ATS platform trade on 2.8 ATS platforms, including 1.6 6732 ATSs, and dealers that trade on multiple ATS platforms trade more actively than dealers that trade on one ATS platform.

The majority of dealers that trade on ATS platforms trade on 6732 ATSs (316.8 of 353.9 dealers, or 89.5%). A smaller percentage of dealers (33.6%) trade on non-6732 ATSs. This difference is consistent with the percentage of dealer trades between 6732 ATSs and non-6732 ATSs (e.g., **Figure 3.4**).

The dealers that trade on ATS platforms include discount retail brokerages. In the aggregate and on average, these discount brokerages trade $2,432.2 million per month. Approximately one-third of their total corporate bond volume ($817.9 million) is reported as occurring on ATS platforms, with nearly all of the volume on 6732 ATSs. Retail investors are likely able to observe and access the quotes displayed on ECN protocols.[24] Dealers anticipating participation by less-informed investors will generally reduce spreads to reflect the lower risk of adverse selection by

[24] For example, *see* https://www.sec.gov/spotlight/fixed-income-advisory-committee/bondsavvy-comment-letter-pre-trade-transparency-for-retail-investors-in-the-us-corporate-bond-market.pdf.

informed traders. In OTC markets, however, dealers may charge less favorable prices to uninformed traders (whether retail or institutional) who not only lack private information about the prospects of the security but also knowledge of the prices available to trade (Green, Hollifield, and Schurhoff (2007)). The last effect is less likely on ATS platforms because pricing information is easier to obtain.

Similar to **Table 4.2**, **Table 4.3** presents the number of bonds that trade on ATS platforms. The table describes the number of bonds with monthly averages.

**Table 4.3 Average Number of Bonds per Month Executing on ATS**

| Number of Bonds | | | |
|---|---|---|---|
| **ATS Platforms** | **6732 ATSs** | **non-6732 ATSs** | **Total Market** |
| 11,719.5 | 11,039.6 | 3,074.5 | 20,765.1 |

The TRACE data indicate that 56.4% (or 11,719.5 of 20,765.1) of the bonds that trade each month trade on an ATS platform. The bonds that trade on an ATS platform, however, have more reported trading activity than bonds that do not trade on an ATS platform. For example, bonds that trade on at least one ATS platform each month have 3.6 times more trading volume ($46.4 to $17.2 million) and are traded by 2.7 times more dealers (20.4 to 5.6) than bonds that do not trade on an ATS platform. On average, bonds that trade on at least one ATS platform each month trade on 2.4 ATS platforms. The majority of the 2.4 ATS platforms (2.0), however, are 6732 ATSs.

Among the 11,719.5 bonds that trade each month on an ATS platform, 94.2% trade on a 6732 ATS. A smaller percentage of bonds (26.2%) trade on a non-6732 ATS. The number of bonds that trade on a 6732 ATS relative to a non-6732 ATS is consistent with the difference in the number of trades between the two classifications.

In sum, the evidence indicates that although only a small proportion of trading volume takes place on ATS platforms, a much larger proportion of bonds are traded on ATS platforms. The price discovery on these platforms may also benefit the broader market.

## 4.2 Trade Size

Although greater dealer participation on 6732 ATSs may lead to greater price competition, it may result in the dealers seeking liquidity to incur greater costs from information leakage. Dealers can reduce this risk by decreasing order size (Hendershott and Madhavan (2015)). **Table 4.4** presents the size of trades on ATS platforms. The table describes trade size with averages and percentiles over the sample periods. **Table 4.5** presents the percentage of block trades on ATS platforms. The table describes the percentage of block trades from $1 to $5 million, $5 to $10 million, $10 to $25 million, and greater than $25 million over the sample periods. As a comparison, the tables also present the size and percentage of block trades among all trades.

**Table 4.4 Summary of Trade Size Executing on ATS**

| | Size ($K) | | | | | |
|---|---|---|---|---|---|---|
| **Category** | **Avg.** | **p5** | **p25** | **p50** | **p75** | **p95** |
| ATS Platforms | 82.5 | 2.0 | 8.0 | 15.0 | 40.0 | 250.0 |
| 6732 ATS | 37.9 | 2.0 | 8.0 | 15.0 | 30.0 | 135.0 |
| non-6732 ATS | 918.4 | 9.0 | 121.0 | 500.0 | 1,000.0 | 3,500.0 |
| Total Market | 618.6 | 3.0 | 10.0 | 35.0 | 250.0 | 3,000.0 |

**Table 4.5 Percentage of Block Trades Executing on ATS**

| | Blocks (%) | | | | |
|---|---|---|---|---|---|
| **Category** | **$1-5M** | **$5-10M** | **$10-25M** | **$25M+** | **Total** |
| ATS Platforms | 1.8 | 0.1 | 0.0 | 0.0 | 2.0 |
| 6732 ATS | 0.2 | 0.0 | 0.0 | 0.0 | 0.2 |
| non-6732 ATS | 32.4 | 2.7 | 0.4 | 0.0 | 35.5 |
| Total Market | 11.0 | 2.3 | 1.0 | 0.1 | 14.5 |

The TRACE data indicate that the median trade size on ATS platforms is $15,000. The median trade size, however, relates to trades on 6732 ATSs and not non-6732 ATSs. For example, whereas the median trade size on 6732 ATSs is $15,000, the median trade size on non-6732 ATSs is $500,000. The TRACE data also indicate that 6732 ATSs facilitate few block trades; 2.0% of trades on 6732 ATSs are block trades, whereas approximately one-third of trades on non-6732 ATSs (35.5%) are block trades.

### 4.3 Bond Characteristics

**Table 4.6** presents the characteristics of the bonds that trade on ATS platforms. The table categorizes bonds by credit rating (investment grade, IG, or high yield, HY), vintage (less than two years, New, or two years or greater, Old), and issue size (less than $500 million, Small, or $500 million or greater, Large). As a comparison, the table also presents the characteristics of all bonds that trade over the corresponding sample periods. The table presents bond characteristics with the percentage of trades per category.

**Table 4.6 Characteristics (%) of Bonds Executing on ATS**

| | Credit Rating % | | Vintage % | | Issue Size % | |
|---|---|---|---|---|---|---|
| **Category** | **IG** | **HY** | **New** | **Old** | **Small** | **Large** |
| ATS Platforms | 73.4 | 26.6 | 27.7 | 72.3 | 27.0 | 73.0 |
| 6732 ATS | 74.6 | 25.4 | 26.8 | 73.2 | 27.8 | 72.2 |
| non-6732 ATS | 49.1 | 50.9 | 44.1 | 55.9 | 9.8 | 90.2 |
| Total Market | 66.2 | 33.8 | 34.3 | 65.7 | 22.0 | 78.0 |

The TRACE data indicate that a greater percentage of bonds that trade on ATS platforms (relative to the total market) are investment grade, older vintage, and of smaller issue size. The TRACE data also indicate that the characteristics of the bonds that trade on 6732 ATSs are different than the bonds that trade on non-6732 ATSs. For example, whereas approximately three-quarters (74.6%) of the bonds that trade on 6732 ATSs are investment grade, just less than half (49.1%) of the bonds that trade on a non-6732 ATS are investment grade. A greater percentage of bonds that trade on 6732 ATSs have been trading for two years or longer (73.2% to 55.9%) and of larger issue size (27.8% to 9.8%) than bonds that trade on non-6732 ATSs.

We formally test for the relationship between bond characteristics and trading venue with two models. Each model describes a different choice of trading venue. The first model describes the trading activities occurring on or off an ATS platform. The second model describes the trading activities occurring on a 6732 or non-6732 ATS.

We measure the choice of trading venue for each bond and trade date. The measure, *Venue*, is equal to the number of bond trades on one venue divided by the total number of bond trades on both venues. We include four variables controlling for bond characteristics. The variables are intended to capture differences in the credit rating of the bond (*InvGrade*), the issue amount (*IssueSize*), the days since issuance (*Age*), and the days until maturity (*Maturity*). *InvGrade* is an indicator variable equal to one if the bond is investment grade, and zero otherwise. The set of bond characteristics we include in our model is consistent with Hendershott and Madhavan (2015).

We also include three variables to control for recent bond trading activity. The variables are the trading volume of the bond (*Volume*), the number of unique dealers trading the bond (*Dealers*), and the absolute value of the aggregate change in dealer inventory (*Inventory*). We measure the variables over intervals of twenty trading days prior to the trade date. *Inventory* controls for dealer risk capacity. The variable has been found in other contexts to describe the risks of market makers (e.g., Comerton-Forde et al. (2010)).

We specify the following regression to model the choice of trading venue:

$$Prob(Venue) = \propto + \beta 1 \cdot InvGrade + \beta 2 \cdot IssueSize + \beta 3 \cdot Age + \beta 4 \cdot Volume + \beta 5 \cdot Maturity + \beta 6 \cdot Dealers + \beta 7 \cdot Inventory$$

We estimate the model using a general linear model with a binomial error distribution to account for the truncated dependent variables. **Table 4.7** presents the coefficient estimates and marginal effects (dy/dx) for these models.[25] The *t*-statistics are presented in parentheses below the coefficient estimates.

[25] We standardize the marginal effects at the average of the dependent variable, so our estimates are the percentage change in the dependent variable needed to increase the probability by 1%.

**Table 4.7 Probit Model Estimates**

| | on ATS = 1<br>off ATS = 0 | | 6732 ATS = 1<br>non-6732 ATS = 0 | |
|---|---|---|---|---|
| | Aug. 2016 - Dec. 2017 | | Aug. 2016 - Dec. 2017 | |
| | **Coeff. Est.** | **ME** | **Coeff. Est.** | **ME** |
| | | | | |
| *Constant* | 0.291 | | 0.219 | |
| | (143.70) | | (6.14) | |
| *InvGrade* | 0.065 | 9.07% | 0.195 | 11.53% |
| | (214.88) | | (33.81) | |
| *IssueSize ($ par)* | -0.0347 | -2.19% | -0.046 | -6.58% |
| | -(237.69) | | -(17.85) | |
| *Age (Days)* | 0.0193 | 8.22% | 0.045 | 13.88% |
| | (152.64) | | (19.00) | |
| *Volume ($ par)* | -0.0024 | -24.61% | -0.012 | -19.63% |
| | -(28.32) | | -(6.84) | |
| *Maturity (Days)* | -0.0010 | -137.70% | -0.040 | -13.58% |
| | -(7.17) | | -(19.65) | |
| *Dealers (#)* | 0.0042 | 11.49% | 0.004 | 36.53% |
| | (411.42) | | (23.29) | |
| *Inventory ($ par)* | 0.0023 | 30.66% | 0.002 | 180.11% |
| | (34.06) | | (1.08) | |
| Pseudo-$R^2$ | 0.36 | | 0.21 | |

For all explanatory variables, the results are directionally consistent between the two models. Investment grade bonds, older bonds, less active bonds, bonds closer to maturity, with larger dealer networks, and larger changes to dealer inventories are more likely to trade on an ATS platform or on a 6732 ATS.

Investment grade bonds are more likely to trade on an ATS rather than off, and, conditional on trading on an ATS platform, on a 6732 rather than a non-6732 ATS. The marginal effect for investment grade bonds range from 9.1% to 11.5%. This suggests that a bond portfolio with 10% more investment grade bonds will be 1% more likely to trade on an ATS. As documented by Han and Zhou (2013), microstructure measures of adverse selection are larger for high yield than for investment grade bonds. The sign and significance of investment grade bonds is consistent with market participants trading on ATS platforms and 6732 ATSs when such risks are less relevant.

The previous summary findings indicate that corporate bonds trading on at least one ATS platform are traded by more dealers. Consistent with this finding, we find that the variable *Dealers* is positively related to trading on an ATS platform. This suggests that trading on ATS platforms is positively influenced by the potential level of dealer participation. Participation by other dealers may relate to greater price competition (Hendershott and Madhavan (2015)), and is consistent with positive effects of network externalities.[26] The economic significance of *Dealers* is similar to credit rating.

[26] Research by Hendershott et al. (2017), however, suggests that transaction costs may increase once a dealer network reaches a certain threshold (e.g., twenty dealers).

ATS platforms also appear to facilitate the trading of corporate bonds when the level of those bonds in aggregate dealer inventory has risen. This suggests that dealers utilize ATS platforms to reduce excess inventory, and with the increase in trading on these platforms (e.g., **Figure 3.2**), that ATS platforms are becoming a potentially more important source of liquidity.

The need for new sources of liquidity in the corporate bond market has likely grown because of changes in the capital commitment of dealers. Bessembinder et al. (2018) find a 33% reduction in the daily capital commitment of bank affiliated dealers. Bao, O'Hara, and Zhou (2016) note that since the implementation of the Volcker Rule in 2014, the dealers affected by the regulation have decreased their corporate bond inventories. The marginal effect of *Inventory*, however, is weak. In the first model (describing the trading on and off ATS platforms), a 30.7% increase from average inventories only increases the probability a trade takes place on an ATS platform by 1%.

Smaller and older issues with lower levels of recent trading activity are more likely to trade on an ATS platform or a 6732 ATS. This result contrasts with Hendershott and Madhavan (2015), who find that larger and newer issues are more likely to trade electronically. Finding a counterparty may be more difficult for smaller, older, and thinly traded bonds so this result suggests ATS platforms are particularly valuable in situations where search costs are high.

## Section 5. Customer Trading Costs

Lastly, we examine the relationship between dealer participation on ATS platforms on customer transaction costs. Customers compensate dealers for order processing costs, the risk of adverse selection, and inventory risk (Huang and Stoll (1997)). In OTC markets, customers also compensate dealers for search costs (Duffie, Gârleanu, and Pedersen (2005)). Participation on ATS platforms may lower dealer costs to intermediate orders, which could reduce customer transaction costs.

To measure customer transaction costs, we identify sequences of trades that begin with a customer sale and end with a customer purchase (i.e., trade chains). We measure customer transaction costs as the difference between the price of the initial customer sale and the price of the final customer purchase. The difference between the sale price and purchase price from the same trade chain captures the total (shared) costs to customers to purchase and sell the bond. How those costs are shared between buyer and seller are not a part of this analysis.

In this framework, customer transaction costs compensate dealers for the risk of market making, providing intermediation services, and the return from purchasing and selling the bond. We compare the difference in transaction costs between chains that include a dealer transaction on an ATS platform and chains that do not include a dealer transaction on an ATS platform. This comparison provides an indication of the relationship between dealer participation on ATS platforms and the costs they collectively incur to intermediate trades.

### 5.1 Methodology

We use the TRACE data from August 2016 to December 2017 for this analysis. We identify trade chains using a similar algorithm as Li and Schürhoff (2018), who apply it to the municipal bond market. Each trade chain starts with a customer sale to a dealer. For each of these transactions, starting from the earliest, we then match the initial dealer purchase to the subsequent dealer sale.[27] We match purchases to sales by dealer MPID, bond CUSIP, and par value (size) of the trade.

If the dealer sale is to another dealer, then we match the second dealer purchase to the subsequent dealer sale. A trade chain ends if the first dealer sale, or any other subsequent dealer sale, is to a customer. The trade chain also ends if we are not able to match a dealer purchase to a subsequent sale, or in the rare case where the chain exceeds seven trades. After a trade is identified as part of one complete trade chain, it may not be included in another.

Our algorithm differs from that of Li and Schürhoff (2018) in three respects. First, we only match trades within the same day, and we exclude trade chains that span more than two hours. Li and Schürhoff (2018) include trade chains that span up to thirty days. We use this more restrictive approach to minimize the effects of intraday price changes on our measure of customer trading costs. We also use this more restrictive approach to minimize the effects from matching unrelated trades. To the extent that short holding periods are anticipated by dealers, however, a smaller component of transaction costs may be attributable to inventory risk. We do include trade chains that span up to thirty days in a separate analysis as a robustness check.

Second, we require all trades in a chain to have the same par value. Li and Schürhoff (2018) include "split" chains where the final dealer in a chain sells less than the full par value to a customer.[28] Trade size has also been found by other researchers to be a significant determinant in bond transaction cost (e.g., Edwards, Harris, and Piwowar (2007)). By including trade chains with the same par value, we reduce the variation in customer costs that relates to trade size although this assumption reduces the number of trade chains analyzed.

Third, to account for potential reporting discrepancies, we restrict the next trade in a chain to have a report time no less than fifteen minutes prior to the report time of the prior trade. Li & Schürhoff (2018) match dealer purchases to dealer sales that may have been executed ten days prior. This may incorporate short sales into their analysis and introduce reporting discrepancies into their sample.

We calculate customer transaction costs as:

$$CustomerCost = 10^4 \cdot \frac{(P^{DC} - P^{CD})}{P^{CD}}$$

where $P^{CD}$ is the price of the initial customer sale, and $P^{DC}$ is the price of the final customer purchase. We measure *CustomerCost* in basis points. *CustomerCost* measures the combined transaction costs of the two customers purchasing and selling the bond. We do not attempt to allocate the cost between the customers.

We apply a series of additional requirements for us to include a trade chain as part of the final sample. We first require trade chains to include at least one interdealer trade. Choi and Huh

[27] We do not impose strict chronological ordering on the chains. A trade that occurs earlier in the identified chain may take place up to 15 minutes after the subsequent trade in the chain to account for the possibility of a delay in reporting or a dealer arranging the sale of a bond before its purchase.

[28] Li and Schürhoff (2018) report median customer costs that are 30 basis points greater for split chains than for non-split chains. Sirri (2014) also includes chains where a dealer splits one purchase into multiple subsequent sales.

(2017) note that the customer purchase price is significantly lower when a dealer purchases a bond from one customer and sells to another in a short period of time. The authors argue that this result is due to "customer liquidity provision" where one of the customers effectively acts as a dealer. We exclude trade chains without at least one interdealer trade to control for these instances.

Second, we require broker-dealers to be reported as trading in a principal capacity in the initial purchase from the customer and the final sale to the customer of each trade chain. Trades where dealers act in an agency capacity may relate to advisory accounts, and customers may not be charged a commission on a per trade basis. In such cases, the measure of customer transaction costs would not reflect total dealer compensation.

Third, we require *CustomerCost* to be greater than zero and less than 500 basis points. Otherwise, trade chains may relate to mismatched trades or to reporting discrepancies. Fourth, we require bond characteristic information to be available. Finally, we require that the trade chain span less than two hours. There are 17,299 trade chains in the final sample. **Table 5.1** presents the effect of each restriction on the number of observations in the final sample.

**Table 5.1: Number of Trade Chains**

| Sample Restriction | Total | Trade on ATS Platform | No Trade on ATS Platform |
|---|---|---|---|
| | | | |
| Same Trade Size | 343,632 | | |
| One Interdealer Trade | 73,714 | 52,042 | 21,672 |
| Principal Trades | 27,150 | 17,613 | 9,537 |
| Customer Costs Less than 500bp | 26,284 | 17,213 | 9,071 |
| Information Available | 23,246 | 17,112 | 6,134 |
| Less than Two Hours | 15,438 | 11,426 | 4,012 |

**Table 5.2** describes the trade chains in the final sample including *CustomerCost*, chain length (*ChainLength*), trade size (*TradeSize*), and the amount of time in minutes from the start to the completion of the chain (*Time*). The table also describes the characteristics of the bonds (*InvGrade*, *IssueSize*, *Age*, *Volume*, and *Dealers*).[29]

**Table 5.2: Summary of Trade Chains**

| | Avg. | P5 | P25 | P50 | P75 | P95 |
|---|---|---|---|---|---|---|
| | | | | | | |
| *CustomerCost (bp)* | 115.2 | 10.4 | 29.2 | 82.0 | 172.3 | 332.9 |
| *ChainLength* | 3.6 | 3.0 | 3.0 | 3.0 | 4.0 | 5.0 |
| *TradeSize ($K)* | 427.9 | 4.0 | 10.0 | 20.0 | 50.0 | 2,000.0 |
| *Time (minutes)* | 34.5 | 0.0 | 1.8 | 21.2 | 60.8 | 105.8 |
| *InvGrade* | 0.6 | 0.0 | 0.0 | 1.0 | 1.0 | 1.0 |
| *IssueSize ($K)* | 871.8 | 5.4 | 250.0 | 500.0 | 1,000.0 | 2,850.0 |
| *Age (days)* | 2,193.7 | 233.5 | 902.9 | 1,572.7 | 2,621.8 | 7,031.6 |
| *Maturity (days)* | 23,123.0 | 139.6 | 779.4 | 1,769.4 | 3,394.6 | 10,293.4 |
| *Volume ($M)* | 87.0 | 0.0 | 2.3 | 29.0 | 99.3 | 349.6 |
| *Dealers* | 34.5 | 1.0 | 12.0 | 29.0 | 51.0 | 87.0 |

[29] *See* **Section 4.3** for a description of these measures.

The average trade chain has a customer transaction cost of 115.2 basis points and a median of 82.0 basis points. The average chain in the sample involves between three and four trades, or one or two interdealer trades and two customer trades. Fifty percent of the chains in the sample were completed within 21.2 minutes. The distribution of trade size is heavily skewed; although the size of the median trade chain is $20,000, the size of the average trade chain is approximately $427,900.

**Table 5.3** further describes the length of the trade chains in the final sample. The table separately describes the length of the trade chains dependent on whether the chain includes a trade reported on an ATS platform (*ATSP* = 1) or does not include a trade reported on an ATS platform (*ATSP* = 0).

**Table 5.3: Summary of Trade Chains**

| | | | ***Time* (minutes)** | | ***CustomerCost* (bp)** | |
|---|---|---|---|---|---|---|
| ***Length*** | ***ATSP*** | **Number** | **Avg.** | **Median** | **Avg.** | **Median** |
| | | | | | | |
| 3 | 0 | 2,932 | 30.7 | 14.6 | 88.1 | 52.9 |
| | 1 | 4,875 | 28.8 | 10.3 | 109.6 | 76.2 |
| 4 | 0 | 1,024 | 45.9 | 38.5 | 146.2 | 116.3 |
| | 1 | 4,715 | 33.8 | 19.5 | 118.3 | 85.5 |
| 5 | 0 | 52 | 43.0 | 40.0 | 148.1 | 112.1 |
| | 1 | 1,506 | 50.1 | 45.6 | 147.0 | 118.8 |
| 6 | 0 | 4 | 39.0 | 17.4 | 126.0 | 106.0 |
| | 1 | 328 | 56.6 | 53.7 | 145.9 | 105.7 |
| 7 | 0 | 0 | n/a | n/a | n/a | n/a |
| | 1 | 2 | 78.3 | 78.3 | 169.7 | 169.7 |

The number of trade chains with or without a trade reported on an ATS platform are similar. In general, chains with a trade reported on an ATS platform are completed in a shorter period of time than chains without a trade reported on an ATS platform. Chains without a trade reported on an ATS platform, however, may be more likely to span more than two hours and therefore not be included in the sample. In unreported tests, the time span for chains with three or four trades is significantly shorter at the ninety-nine percent confidence level if at least one of the trades is reported on an ATS platform.

## 5.2 Multivariate Analysis

We formally test for differences in customer transaction cost between trade chains with a trade reported on an ATS platform and trade chains without a trade reported on an ATS platform. We regress *CustomerCost* on *ATSP* and control variables. The control variables include *ChainLength*, *TradeSize*, *InvGrade*, *IssueSize*, *Age*, *Maturity, Volume*, and *Dealers*. Previous research finds that bond rating, issue size, and bond vintage are significant determinants of transaction cost (e.g., Edwards, Harris, and Piwowar (2007); and Li and Schürhoff (2018)). Dealer networks and volume control for recent bond trading activity.

We specify the following regression to model customer transaction cost:

$$CustomerCost = \propto + \beta 1 \cdot ATSP + \beta 2 \cdot ChainLength + \beta 3 \cdot TradeSize + \beta 4 \cdot Log(TradeSize) + \beta 5 \cdot InvGrade + \beta 6 \cdot IssueSize + \beta 7 \cdot Age + \beta 8 \cdot Maturity + \beta 9 \cdot Volume + \beta 10 \cdot Dealers$$

We use an ordinary least squares model to estimate parameters. We cluster the standard errors by bond and trade date. **Table 5.4** presents the regression results.

**Table 5.4: OLS Model Estimates**

| | *CustomerCost* | | | |
|---|---|---|---|---|
| | **Coeff. Est.** | | | |
| | **Two Hours** | **One Day** | **Thirty Days** | **Commonly Traded** |
| | | | | |
| *Constant* | 218.500 | 245.800 | 260.000 | 175.000 |
| | (22.81) | (19.93) | (36.89) | (11.74) |
| *ATSP* | -24.190 | -31.150 | -32.030 | -30.380 |
| | (9.94) | (10.05) | (19.78) | (9.21) |
| *Chain Length* | 11.430 | 19.990 | 23.310 | 12.360 |
| | (10.11) | (14.18) | (31.46) | (6.69) |
| *TradeSize ($M)* | 0.000 | 0.000 | 0.000 | 0.000 |
| | (4.48) | (3.15) | (6.86) | (4.90) |
| *Log(TradeSize)* | -12.580 | -14.110 | -10.590 | -10.920 |
| | (19.70) | (16.93) | (20.53) | (10.93) |
| *InvGrade* | -1.720 | -28.150 | -80.960 | 9.068 |
| | (0.95) | (11.70) | (56.76) | (3.34) |
| *IssueSize ($M)* | -19.350 | -20.610 | -35.720 | -17.840 |
| | (19.26) | (16.44) | (53.24) | (14.10) |
| *Age* | 0.001 | 0.003 | 0.006 | 0.003 |
| | (3.15) | (4.88) | (19.53) | (4.81) |
| *Maturity* | 0.000 | 0.000 | 0.000 | 0.000 |
| | (22.84) | (17.95) | (22.98) | (18.81) |
| *Volume ($B)* | 7.159 | 11.970 | 99.650 | -1.598 |
| | (1.22) | (1.64) | (25.99) | (0.22) |
| *Dealers* | 0.445 | 0.294 | 0.607 | 0.788 |
| | (12.35) | (6.25) | (21.87) | (15.66) |
| | | | | |
| # Obs. | 15,438 | 23,240 | 138,771 | 6,431 |
| Adj. $R^2$ | 0.12 | 0.08 | 0.09 | 0.15 |

The first column of **Table 5.4** presents the regression results with the test sample. The results indicate that customer transaction costs are 24 basis points lower if at least one trade is on an ATS platform. This is suggestive of the potential decrease in dealer costs to intermediate trades when trading on an ATS platform, holding constant the characteristics we previously showed as correlated with the likelihood of ATS trading.

The results for variables we include as controls are also consistent with the previous literature. For example, the results indicate that each additional interdealer trade is associated with an 11 basis point increase in customer costs. Li & Schürhoff (2018) and Sirri (2014) also find that longer chains are associated with higher customer costs. In addition, consistent with Edwards, Harris, and Piwowar (2007), larger trades, trades of investment grade bonds, and trades of bonds with larger issue sizes are associated with lower customer costs. Larger dealer networks and trading volume both positively relate to customer transaction costs. Although both variables would suggest lower dealer search costs, these variables could instead relate to longer intermediation chains and therefore greater total customer costs. Trading volume is also only marginally statistically significant.

We believe the two-hour requirement limits the extent to which other factors could influence the measurement of customer costs used in these tests. This includes the risk premium for dealers to hold bonds in inventory, changes in bond price, and the possibility that we falsely identify two unrelated trades as part of the same chain. This requirement, however, reduces the size of the final sample and may introduce a selection bias. As a robustness check, we re-estimate the regressions using trade chains that span less than one day and, similar to Li and Schürhoff (2019), trade chains that span less than thirty calendar days. The second and third columns of **Table 5.4** present the results. The results remain substantively the same. For the one day sample, a trade on an ATS platform is associated with lower customer costs by 31 basis points; and for the thirty day sample, a trade on an ATS platform is also associated with lower customer costs by 32 basis points.

An alternative explanation can be that the lower transaction costs reflect the unobservable characteristics of order flow, i.e., the characteristics of order flow uncorrelated with our control variables. For example, the trades on ATS platforms may reflect when attractive quotes are available via the ATS. It is possible that the regression results relate to systematic differences, not accounted for by the control variables, between the bonds that trade on and do not trade on ATS platforms. To address this possibility, we restrict the test sample to include only those bonds with at least one trade chain involving an ATS and one trade chain not involving an ATS. After the additional restriction we find that a trade on an ATS platform is associated with lower customer costs of 30 basis points, similar to the previous estimates.

## Section 6. Conclusion

In this paper, we analyze the impact of electronic trading technology in the corporate bond market through the trading activity on ATS platforms. Although the trading volume pursuant to ECN protocols is small relative to RFQ protocols (or voice OTC markets), the market coverage of ATS platforms suggests that participants likely benefit from the pre-trade transparency and price discovery that ECN protocols provide.

This paper demonstrates the importance of dealer reporting obligations for analyzing securities markets. Two recent regulations increased not only the number of ATS platforms but also the number of trades on ATS platforms that we are able to identify with the TRACE data. With this information, we are able to investigate the current role of ATS platforms to facilitate corporate bond trades and their economic implications.

Our results show that not all trades are equally likely to occur on ATS platforms. Consistent with investors avoiding ATS platforms for trades where adverse selection and information leakage are important considerations, trades on ATS platforms are smaller and more likely to involve investment-grade bonds. Consistent with investors preferring ATS platforms for trades where search costs are substantial, trades on ATS platforms are also more likely for older, less actively traded bonds from smaller issues and for bonds traded by more dealers where inventory is high.

We also demonstrate substantial heterogeneity within the category of ATS platforms we study. We show that the same characteristics which influence a bond trading on an ATS platform rather than in the OTC market also have similar effects on whether a bond trades on 6732 ATS or non-6732 ATS.

Finally, we estimate the gains to customers from dealer participation on ATS platforms. We identify sequences of trades that begin with a customer sale and end with a customer purchase (i.e., trade chains). For the trade chains with an interdealer trade, we compare customer transaction costs between the chains that include and do not include a dealer transaction on an ATS platform. Controlling for other observable trade characteristics, trade chains involving a trade on an ATS platform are associated with between a 24 and 32 basis point reduction in customer transaction costs.

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## Appendix

### A.1 Measuring Trading Activity

As discussed in **Section 3**, each FINRA member that is a party to a reportable transaction in a TRACE-eligible security has a reporting obligation. A trade between two member firms, therefore, results in two observations in the TRACE data: a sell by the first member firm (sell-side) and a purchase by the second member firm (buy-side). A trade between a member firm and a customer or an affiliate, however, results in just one observation in the TRACE data: a sell or purchase by the member firm.

Electronic platforms may also have a reporting obligation for trades executed on its system. Trades on an electronic platform which also has a reporting obligation increases the number of observations in the TRACE data. For example, a trade between two member firms on an electronic platform with a reporting obligation results in four observations in the TRACE data: a sell by the first member firm to the platform, a purchase by the platform from the first member firm, a sell by the platform to the second member firm, and a purchase by the second member firm from the platform.

We account for the multiple trade reports when measuring trading activity. If we do not account for multiple trade reports, then we would include some trades more than once depending on whether the counterparties are FINRA members and whether an electronic platform also had a reporting obligation. This would result in an overestimation of the trading activity on electronic platforms with a reporting obligation (e.g., non-6732 ATSs), and an inaccurate comparison of the trading activity between platforms with different reporting obligations (e.g., 6732 ATSs and non-6732 ATSs). We account for the multiple trade reports by including some observations in the final sample and excluding others. Overall, the filter that we apply to the TRACE data ensures that we include each trade only once in the final sample.

**Table A.1** outlines the filter that we apply to the TRACE dependent on the classification of each counterparty to a trade (i.e., dealer, customer, or affiliate) and the reporting obligation of an electronic platform, if any. The table also separates trades dependent on whether an electronic platform has a reporting obligation.

**Table A.1 Filter to Measure Trade Volume**

| **Trades with no Electronic Platform Reporting Obligation** | | | | |
|---|---|---|---|---|
| **Party 1 (sell-side)** | **Party 2 (buy-side)** | **Reporting Obligation** | **Side** | **Data Filter** |
| Dealer 1 | Dealer 2 | Dealer 1 | S | Keep |
| | | Dealer 2 | B | Drop |
| Dealer 1 | Cust./Affil. | Dealer 1 | S | Keep |
| Cust./Affil. | Dealer 2 | Dealer 2 | B | Keep |
| | | | | |
| **Trades with Electronic Platform Reporting Obligation** | | | | |
| **Party 1 (sell-side)** | **Party 2 (buy-side)** | **Reporting Obligation** | **Side** | **Data Filter** |
| Dealer 1 | Dealer 2 | Dealer 1 | S | Keep |
| | | Platform | B | Drop |
| | | Platform | S | Drop |
| | | Dealer 2 | B | Drop |
| Dealer 1 | Cust./Affil. | Dealer 1 | S | Keep |
| | | Platform | B | Drop |
| | | Platform | S | Drop |
| Cust./Affil. | Dealer 2 | Platform | B | Keep |
| | | Platform | S | Drop |
| | | Dealer 2 | B | Drop |

As an alternative, we could combine trade reports to create one record. Matching trade reports to create one record, however, is made difficult by differences in the reports including the time of the execution. In addition, certain trading protocols allow one-to-many trades or many-to-many trades, which also preempt us collapsing multiple reports to create one record.

In **Figure 3.4** and **Figure 3.5**, we measure trading activity with the percentage of all dealer or customer and affiliate trades on ATS platforms. We measure dealer or customer and affiliate trades with the number of dealers and customers or affiliates on either side of a trade. For example, the number of dealers that are a party to an interdealer trade is two. For customer or affiliate trades, the number of dealers is one and the number of customers or affiliates is one. We do not include electronic platforms for this measure. Similar to trading activity, we account for multiple observations relating to the same trade in the TRACE data. We use this measure in lieu of the number of trades due to the difficulty to match one-to-many or many-to-many trades on an electronic platform to create one record.