LIQUIDITY-BASED TRADING FEES AND EXCHANGE VOLUME

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Abstract

If changes in make fees have the same effect on exchange volume as changes in take fees, then any split of the total fee to makers and takers will generate the same revenue from these fees to the exchange. We find that both volume and revenue are not equally sensitive to changes in make fees and take fees. Keeping the amount of the total fee constant, a fee-structure change that favors takers leads to an increase in both volume and revenue. These relations are more pronounced when traders' response to fee changes is more likely constrained by the tick size.

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1. Introduction

In recent years, equity and option markets in the U.S. and Europe have been levying liquidity-based trading fees on executed transactions. On average, an exchange collects a total fee of 5 cents per 100 shares traded.[1] Instead of splitting the fee equally between participants that take and those that make liquidity, an exchange, on average, charges the take side 25 cents per 100 shares, i.e., a positive take fee, and gives a rebate to the make side of 20 cents per 100 shares, i.e., a negative make fee, to promote liquidity making.[2,3] It is possible, although uncommon, for exchanges to charge a fee to orders that make liquidity, i.e., a positive make fee, and provide a rebate to orders that take liquidity, i.e., a negative take fee.[4] Notably, this liquidity-based pricing policy is employed by all 14 registered equity exchanges in the United States. While this pricing model has attracted a lot of attention from regulators and industry participants, the impact of these fees on exchange volume and revenue has not yet been empirically explored in the literature. Existing empirical studies that examine these liquidity-based trading fees focus on a single fee-change event and individual securities in terms of cost from the perspective of the traders. In contrast, we assesses the relations between liquidity-based trading fees and exchange trading volume and revenue across all U.S. exchanges over a three-year period.

Exchanges facilitate interactions between makers and takers of liquidity, i.e., generate volume, by trying "to get both sides of the market on board" (Rochet and Tirole, 2006). Importantly, volume is a measure that proxies for the total benefits that accrue to both sides of the market, rather than to specific market participants (Alexandrov and Spulbe, 2013; Rochet and Tirole, 2003). To the extent that trading fees impact volume, changes in fees can have important

[1]The statistics are based on our sample discussed in the next section.

[2]Orders that take or access liquidity are orders that execute against a protected quotation on an exchange according to the SEC's Regulation National Market System (Reg NMS). That is, they are marketable orders, which are either market orders or buy (sell) limit orders whose limits are at or above (below) the current market price. Conversely, orders that make liquidity, are nonmarketable orders, which are buy (sell) limit orders with a limit price below (above) the current market price.

[3]The sum of the make and take fee (equivalent to the net difference between the access fee and the liquidity rebate) is the total net fee that an exchange collects. Throughout the paper we use "net" and "total" fee interchangeably.

[4]For the remainder of the paper we will refer to an exchange's inflows as positive fees, and its outflows as negative fees.

implications; for example, a change in the trading fee structure that reduces volume presumably decreases the combined welfare of the make and take side of the market. Further, because the effect of trading fees on volume, and consequently, revenue is of primary interest to exchanges (Foucault, 2012) better understanding these fees also sheds light on the underlying motivations of trading venues and their decisions, which shape the market environment.

We empirically explore three questions in this paper. First, we study how the total fee impacts exchange trading volume and revenue. A positive total fee provides revenue to the exchange for providing services when trades are completed (Colliard and Foucault, 2012; Harris, 2013).[5] A negative total fee has also been observed in practice (e.g., Direct Edge, NYSE Amex).[6] Practitioners argue that one possible motivation for implementing a negative total fee structure is to increase volume and gain market share in the long term. Theory predicts the exchange's trading volume decreases in the total fee (Foucault, Kadan, and Kandel, 2013; Colliard and Foucault, 2012; Constantinides, 1986). However, an increase in the total fee can motivate more aggressive quotes and thus, a greater likelihood of a transaction to occur, in which case the exchange's trading volume can be positively related to the total fee (Colliard and Foucault, 2012). Therefore, the relation between the trading volume on an exchange and the total fee charged by the exchange is ultimately an empirical question.

Second, we explore whether the breakdown of the total fee to make and take sides affects exchange trading volume and revenue. Theory suggests that an increase in the make and take fees, all else equal, negatively impacts traders' monitoring benefit (Foucault, et al., 2013) and positively affects the propensity to refrain from trading (Constantinides, 1986). In both cases, the prediction is that trading volume will decrease in the make and take fees. In addition, we examine whether the exchanges can use the structure of the fees to alter relative supply and demand of liquidity and, in doing so, attract order flow and increase the number of transactions. If changes in make fees have the same effect on exchange volume as changes in take fees, then

[5]Some of the services that the exchanges offer are collecting orders, displaying orders when permitted, and arranging trades when possible (Harris, 2013).

[6]In 2009 Direct Edge introduced a fee structure involving a rebate of 32 cents per 100 shares and a fee of 28 cents per 100 shares,resulting in a loss on the exchange of 4 cents per 100 shares.

any split of the total fee to makers and takers will generate the same revenue from these fees to the exchange.

Third, trading fees may be of particular interest if their effect is exacerbated by trading frictions such as minimum quote price increments. Theory predicts that if there is no market friction, i.e., zero tick size, traders can adjust their quotes to reflect the cost of trading induced by fees charged to either side of the market (Colliard and Foucault, 2012; Foucault, et al., 2013; Chao, Yao, and Ye, 2015). Therefore, we also explore whether the effects of fees on volume are more pronounced when the tick size induces a binding lower bound on bid-ask spread, which may constrain the traders' ability to adjust their quotation and neutralize any effects of the fees.

To examine these questions, we hand-collect liquidity-based trading fee data for all 14 registered exchanges in the United States from the SEC filings and press announcements for each day over a three-year period from January 1, 2008 to December 31, 2010.[7] Exchanges have different fee menus for each of the three "Tapes" of securities.[8] In addition, exchanges employ tiered pricing within each tape based on market participants' total executed volume and liquidity provided to the platform within a certain pre-specified time, usually a month. We collect the make and take fees for each tape on an exchange for both the basic and the most competitive tier, which results in a sample of 108 exchange-tape fee-change events. Notably, when an exchange increases its fee, in nominal terms, the fees charged by other exchanges become relatively more attractive. To capture the effect of fee changes that make a particular exchange relatively more or less attractive than its rivals, we convert the fees in nominal terms to relative-to-rivals terms. We employ regression analysis to study the effect of liquidity-based trading fees, in monimal and relative terms, on exchange trading volume and, ultimately,

[7]The list of registered exchanges is available at `http://www.sec.gov/divisions/marketreg/mrexchanges.shtml`. Our sample includes the NYSE Amex LLC (formerly the American Stock Exchange), BATS Exchange Inc., BATS Y-Exchange Inc., Nasdaq OMX BX Inc. (formerly the Boston Stock Exchange), Chicago Board Options Exchange Incorporated (CBOE Stock Exchange [CBSX]), Chicago Stock Exchange Inc., EDGA Exchange, Inc., EDGX Exchange, Inc., International Securities Exchange LLC (ISE), the Nasdaq Stock Market LLC, National Stock Exchange Inc. (formerly the Cincinnati Stock Exchange), New York Stock Exchange LLC, NYSE Arca Inc., and Nasdaq OMX PHLX Inc. (formerly Philadelphia Stock Exchange).

[8]Tape A securities are listed on the NYSE exchange, Tape B securities are listed on the NYSE-Arca-, Amex-, and regional exchanges, and Tape C securities are Nasdaq listed.

revenue.

We show that an increase in an exchange's total fee is associated with a statistically significant reduction in the exchange's trading volume, consistent with the general theoretical predictions in the literature (Foucault, et al., 2013; Colliard and Foucault, 2012; and Constantinides, 1986). Specifically, we document that a 1-cent increase per 100 shares in the total fee [9] for a given day decreases an exchange's trading volume by 1.30%. Our calculations show this 1-cent increase in the total fee per 100 shares, evaluated at the average fee and volume, increases exchange revenue by 18.52% on that day. This result holds for various empirical specifications and is consistent with an inelastic relationship between total fee and trading volume, i.e., revenue increases as the fee increases (the negative quantity effect is outweighed by the positive price impact).[10,11]

Further, when separating the total fee into the make and take sides, we find that an exchange's volume (i) is negatively related to make and take fees as theoretically hypothesized (Foucault, et al., 2013; Constantinides, 1986) and (ii) is not equally sensitive to changes in make versus take fees. Our results indicate that, if an exchange holds its make fee constant and increases its take fee by 1-cent per 100 shares, its trading volume decreases by 2.10%. However, holding the take fee constant, an increase in the make fee by 1 cent per 100 shares decreases trading volume by 0.97%. Correspondingly, a 1-cent increase in the make fee, evaluated at the average fees, leads to a 18.91% increase in exchange revenue, while the 1-cent increase in the take fee increases revenue by 17.51%. Exchange volume (revenue) is more (less) sensitive to changes in the take fee than to the make fee. Hence, this inference implies that, on average, if an exchange wants to increase its total fee, increasing its make fee (providing smaller rebates) will generate more revenue. However, conditional on decreasing the total fee, decreasing the take fee would generate more volume. More important, we provide evidence that keeping the total

[9] A 1-cent per 100 shares change in the total fee is exemplary because, on average, an exchange has a total fee of 4.98 cents per 100 shares and changes its total fee by 1.36 cents per 100 shares across all events.

[10] If an increase in the fee causes an increase in revenue, then it can be said that volume is inelastic, because the increase does not have a large impact on changes in volume. The logic is the same as in the total revenue test in mainstream economics.

[11] We acknowledge that each of the exchanges are multiproduct firms and they also receive revenue from other sources, such as selling data on both the consolidated tape and low-latency feeds.

fee unchanged, a different split of this total fee to makers and takers has a differential effect on volume and thus an exchange's revenue. We show that a fee-structure change that favors the takers (an increase in the make fee of 1 cent per 100 shares and a simultaneous decrease in the take fee of the same magnitude) leads to an increase in an exchange's trading volume and subsequently to an increase in its revenue by 1.17%. In contrast, a fee-structure change that favors the makers (an increase in the take fee of 1-cent per 100 shares and a simultaneous decrease in the make fee of the same magnitude) leads to a decrease in trading volume and a 1.16% decrease in revenue. These inferences are evaluated at the average values of fees given the parameters in our analysis. Notably, because a different split of the total fee to the make and take sides produces differential effects on volume and revenue, liquidity-based pricing policy is an important tool for exchanges to balance discrepancies in participation rates between makers and takers.

Because volume is a measure of total benefits accrued to both makers and takers, the fact that volume changes more when the take fee changes, shows that the total benefit to both sides is influenced more by changes in the take fee versus changes in the make fee. For example, both sides benefit more when the take fee is reduced (both sides lose more when the take fee is increased). One explanation is that as long as there are standing limit orders, an increase in market orders, after the take fee has been reduced, will result instantaneously in transactions (first order effect); while a make fee reduction (or a greater rebate) might lead to more limit orders but not necessarily to transactions right away (second order effect). Our results show that changes in take fees have a first order effect on trading volume while changes in the make fee have a second order effect. Hence, it is important not to overlook the role of the take side in contributing to exchange's liquidity and revenue.

In addition, we also document that the aforementioned results about the relation between trading fees and volume are particularly pronounced when the tick-size is a binding constraint on the bid-ask spread, i.e., when the quoted bid-ask spread is small as theorized (Foucault, et al., 2013). The tick-size in the U.S. is currently one cent and therefore traders cannot fully neutralize the fees in quoted prices. Our results about the effect of the total fee, as well as the

breakdown of the total fee between makers and takers on an exchange's trading volume, are amplified when the absolute quoted bid-ask spread is small.

Our paper contributes to the scant literature on make and takes fees. We study the effect of the fees on volume from the perspective of the exchanges rather than from the perspective of market participants. Specifically, we provide evidence on the relation between fees, volume and exchange's revenue over a three-year period across all U.S. exchanges. The exchange-level analysis also provides us with the opportunity to assess the effect of fee changes on exchanges' revenue, as well as enabling back-of-the-envelope estimates of money transfers between exchanges, makers, and takers in the equity markets in the U.S.. The empirical evidence so far focuses on a single fee-change event and individual securities. For example, Malinova and Park (2015) examine an introduction of a negative make fee for a subsample of stocks on the Toronto Stock Exchange and find that the liquidity rebate structure leads to decreased spreads, increased depth, increased volume, and intensified competition in liquidity provision.[12] Skjeltorp, Sojli, and Tham (2016) study an increase of the rebate on the take side on the Boston Stock Exchange and document positive cross-sided liquidity externalities where liquidity demand begets liquidity supply. Lutat (2010) looks at a removal of a positive make fee on the SWX Europe Exchange and finds no effect on spreads but an increase in the number of shares quoted at the top of the order book.[13] Panayides, Rindi, and Werner (2016) look at fee changes in BATS and find that simultaneous reduction in make and take fees results in a deterioration of market quality.

The findings we report in our study raise interesting issues in regards to the nature of competition among exchanges. While the following analyses are beyond the scope of our paper

[12]Yao and Ye (2014) look at the Direct Edge exchange that operates two trading platforms, EDGA and EDGX. These platforms are almost identical except for the fee structure. They show that the taker-maker market takes a high market share for stocks with relatively high tick-sizes.

[13]The make-and-take fee pricing model has also been introduced on the options markets. Battalio, Shkilko, and Van Ness (2015), and Anand, Hua, and McCormick (2016) explore the make-and-take fee pricing model and the payment-for-order flow model in application to equity options exchanges and show evaluations of market quality that ignore take fees can be misleading and that neither structure dominates on all dimensions. Relatedly, Harris (2013) shows that quoted prices are more informative when adjusted for make and take fees. His results suggest that maker-taker pricing affects average bid-ask spreads and average quotation sizes for stocks often trading at one-tick spreads. Battalio, Corwin, and Jennings (2016) document a negative relation between take fees and limit order execution quality and the relative take fee level.

due to data limitations, it would be of interest if future researchers are able to examine how the level of competitiveness of the trading environment affects how fees are set by exchanges; how fees, in turn, impact the intensity of competition across exchanges; whether and when fee changes are proactive or reactive; etc. Even though all registered exchanges have adopted make and take fees to compete for order flow, trading volume, and ultimately revenue, our data is not rich enough to provide meaningful tests to focus on fee competition in an industrial-organization setting.[14] Thus, our analysis focus on the broad cross-section of fees which provides a general understanding of the fees overall impact on volume and revenue at the exchange level.

2. Liquidity-Based Trading Fees – Overview, Data, and Variables

The origins of liquidity-based trading fees can be traced to the 1990s.[15] In 1997, Island, an electronic communications network (ECN), decided to pay a rebate to brokers who added liquidity and to charge a fee for brokers who took liquidity in order to compete with Nasdaq Stock Market. Island hoped to "jump-start the market" said Matthew Andersen, its chief executive (Spicer, 2009), and that is exactly what happened: Island's market share of reported Nasdaq trades increased from approximately 3% in 1997 to almost 13% in 1999 and became the number one daily market participant, ahead of all other market makers and ECNs, among many of the most active Nasdaq-listed stocks.[16] Every ECN and exchange soon followed and the rivalry in attracting order flow through liquidity-based trading fees reached its climax when Attain ECN charged non-subscribers a 150-cent per 100 shares access fee in 1998 (Harris, 2013). At the time, the SEC issued an interpretive letter that limited access fees to 30 cents per 100 shares, also known as 30 mils; in 2005, Rule 610(c) of Reg NMS formally capped the take access

[14]For example, the power of statistical tests will be low for analysis that focuses on specialized cases of the fees such as the most competitive fees, inverted fee structures, changes on only one side of the market, etc.

[15]These liquidity-based fees are different from the "SEC Fees." Under Section 31 of the Securities Exchange Act of 1934, self-regulatory organizations (SROs) – such as the Financial Industry Regulatory Authority (FINRA) and all of the national securities exchanges – must pay transaction fees to the SEC based on the volume of securities that are sold on their markets. These fees are designed to recover the costs incurred by the government, including the SEC, for supervising and regulating the securities markets and securities professionals. More information on these fees can be found at: `http://www.sec.gov/answers/sec31.htm`. The most recent level of the Section 31 Fees can be found at: `http://www.sec.gov/divisions/marketreg/mrfreqreq.shtml`.

[16]The historical growth of Island can be found at `http://www.hofstra.edu/pdf/biz_mlc_concannon1.pdf`, accessed August 31, 2016.

fees for equities to 30-cents per 100 shares (*Ibid.*). In the mid 2000s, liquidity-based trading fees gained widespread adoption as a standard pricing model across equity and options markets in the U.S. and Europe.[17]

Typically, liquidity providers pay negative fees (receive rebates) while liquidity takers are charged positive fees with the motivation of increasing the number of non-marketable orders. This fee structure increases liquidity and, in turn, attracts marketable orders. Consequently, the increased number of executed transactions generates revenue for the platform and increases its market share with respect to its competitors. However, if an exchange were to observe many nonmarketable orders but few transactions it can choose to invert the fee structure and provide a rebate to liquidity takers. For example, in 2010, BATS-Y advertised that they offered a rebate of $0.02 per 100 shares for traders removing liquidity.[18] That is, exchanges may elect to subsidize the make or the take to balance any discrepancies in participation rates between makers and takers of liquidity.[19]

Changes in make and take fees by registered exchanges are filed with the SEC. We search these filings and press announcements made by registered exchanges to hand-collect all fee

[17]These fees are closely related to the literature on payment for order flow, which generally refers to the practice of dealers or trading locales paying brokers for retail order flow (Easley, Kiefer, and O'Hara, 1996; Blume and Goldstein, 1997; Kandel and Marx, 1999; Battalio and Holden, 2001; Battalio, Shkilko, and Van Ness, 2015). Traditionally this payment is approximately 1 to 2 cents per share from the market maker to the retail broker for orders that the retail broker sends to the market maker. Payment for order flow is similar to negative take fees, which are payments to investors submitting market orders (see the discussion in footnote 13 in Colliard and Foucault, 2012).

[18]Nasdaq OMX BX, Direct Edge's EDGA, and CBSX exchanges have operated similar pricing structures.

[19]The trading fees are also closely related to the industrial organization literature on two-sided markets, defined by Rochet and Tirole (2006, p.645) as "markets in which one or several platforms enable interactions between end-users (buyers and sellers) and try to get the two sides 'on board' by appropriately charging each side. That is, platforms court each side while attempting to make, or at least not lose, money overall." A two-sided market is one in which the volume of transactions between the end users depends on the structure of the fees and not only on the overall level charged by the platform. The price structure (the distribution of the total fee between maker and takers) affects the economic outcome (volume, profits, efficiency, and/or welfare) (see p.657 in Rochet and Tirole, 2006).

changes for the period January 1, 2008 - December, 31, 2010.[20] It is important to observe that exchanges offer a menu of fees, which generally have two dimensions. First, individual securities are designated to tapes based on listing exchange (Tape A, Tape B, and Tape C) and each tape may have a unique set of fees that apply to those securities. Hence, on an exchange, fees for traded shares can vary across securities. Second, exchanges typically implement a "tier" pricing structure, based on volume and liquidity provision such that exchanges offer more attractive pricing to high-volume market participants (typically based on a minimum total executed volume per month) who also provide high levels of liquidity (typically based on a minimum limit order volume per month).[21] Traders who do not meet these thresholds are charged the less attractive basic-tier pricing. As a result, on an exchange, fees for traded shares can also vary across market participants. We note that over time, the volume-based tiers have become increasingly complex and segmented based on liquidity provision, removal, and overall volume.[22] Since 2010, unique tiers have emerged, including tiers specifically for market participants removing large amounts of liquidity and tiers specifically for participants submitting large blocks of displayed liquidity. Due to the complex nature of the fee menus, we collect data, and focus our analysis, on the most competitive pricing offered to market participants, i.e., the tier with the best possible pricing, and on the basic tier, i.e., the basic pricing available to all market participants that do not meet thresholds for the more favorable pricing.

[20]Regulation NMS, which is a structural change affecting order execution and fees, was implemented by the end of December, 2007. The regulation consists of four main parts, one of which is Rule 611, the Order Protection Rule (also known as the trade-through rule). This rule requires that exchanges route marketable orders to other exchanges that provide better prices; however, the rule does not take access fees or rebates into consideration in determining the best price. There are, however, exceptions to this rule – e.g., the Intermarket Sweep Orders (ISO), which allows the initiator of an order to designate the market that the order executes on. Chakravarty, Jain, Upson, and Wood (2012) show in a sample of 120 stocks that ISO orders represent 46% of trades and 41% of volume in the period from August 20, 2007 to May 30, 2008, representing 197 trading days. We do not believe that Rule 611 caused the make and take fees per se, although Regulation NMS "cleared regulatory impediments to electronic trading and thereby led to increased competition between market centers" (Angel, Harris, and Spatt, 2011, p. 4). This is not the focus of the current manuscript.

[21]During our sample period, exchanges used metrics such as ADV (average daily volume) and TCV (total consolidated volume), but they were inconsistently defined over time or across exchanges. For example, average daily volume might be calculated using the daily volume in only Tape A securities or the daily volume across all listed securities.

[22]See, for example, the Investor Tier on NYSE Arca, which is designed to "incentivize customers to maintain low cancellation rates and provide liquidity," http://www.sec.gov/rules/sro/nysearca/2011/34-64593.pdf.

2.1. Fee Change Events

We examine the make, fee, and total fees on every exchange for both the basic and competitive tiers across all three tapes on each trading day for a three-year period from January 1, 2008 to December 31, 2010.[23] During this period there are 108 exchange-tape fee change events uniformly distributed across different tapes and sides of the market.[24] There are 39 fee-change events on Tape A, 33 on Tape B, and 36 on Tape C. Of the total 108 events, 24 events have changes only in the make fee without an accompanying change in the take fee; 23 events have changes only in the take fee without a simultaneous change in the make fee; and 61 events have simultaneous changes in the make and take fees. In contrast, when we categorize the events by basic and competitive tiers, the fee change events are more concentrated on the competitive tier. Specifically, 67 events have changes only on the competitive tier without a simultaneous change on the basic tier; 99 events have simultaneous changes on both the competitive and basic tiers; and only 3 events have changes in the make fee without a simultaneous change in take fee. This result implies that the change of pricing structure targets traders that qualify for the highest-volume-based tier.

The distribution of fee changes for each tape over time is shown in Figure 1. For all tapes the highest number of changes occurs in March and April of 2009, with 10 fee changes across five exchanges and 10 fee changes across four exchanges, respectively. Categorized by exchange, in our sample, the fee change events occur most often on Nasdaq, NYSE Arca, and ISE, with 23 changes, 20 changes and 17 changes, respectively; these exchanges also span a large portion of the sample period compared with relatively younger platforms such as BATS or Direct Edge. The exchange that changes its fees the least is Amex with one fee change, followed by Nasdaq OMX PSX and Direct Edge X each with three changes.

[23]We examine make and take fees that apply to stocks with prices greater than $1.00. Stocks priced under $1.00 have a unique pricing structure, which varied greatly over our sample period

[24]We exclude one event for Tape B securities on the Nasdaq exchange on February 1, 2008 because it is an outlier event in which the total fee changed by 69 cents per 100 shares. The average fee change is an increase of $ 0.0136 per 100 shares.

2.2. Fee Variables and Volume

As discussed earlier in this section, due to the complex nature of the pricing menus, we focus on the competitive and basic tiers to examine boundaries for the effects of fees on exchanges volume. Moreover, we cannot identify the volume that was transacted at each pricing tier. While it is possible to observe total revenue from make and take fees in the annual filings of the stock exchange, take fees apply to transacted volume and make fees apply to orders posted in the limit order book, which makes it unfeasible to approximate the total transacted volume for each tier. Thus, we assume that either all volume is executed at the basic tier pricing or all volume is executed at the most competitive pricing tier. That is, we look at the two extreme cases: the relationship between volume and fees at the least and at the most favorable pricing for market participants, which are the lowest and highest possible boundaries on an exchange's revenue. All variable descriptions are in Appendix B. For each tape and exchange we measure the nominal fee (make and take) in dollars per 100 shares for the basic and competitive tiers as follows:

- *Nom_Make_Basic* and *Nom_Take_Basic* are the nominal make fee and the take fee, respectively, offered to traders who do not qualify for higher volume-based tiers. *Nom_Total_Basic* is the sum of *Nom_Make_Basic* and *Nom_Take_Basic*.

- *Nom_Make_Comp* and *Nom_Take_Comp* are the make fee and the take fee, respectively, offered to traders who qualify for the highest volume-based tier offered and thus capture the most favorable pricing available on an exchange. *Nom_Total_Comp* is the sum of *Nom_Make_Comp* and *Nom_Take_Comp*.[25]

When an exchange increases its fee, in nominal terms, the fees charged by other exchanges become relatively more attractive. Therefore, we consider the relative attractiveness of the nominal fees to examine the effect of fee changes that make a particular exchange relatively more or less attractive than its rivals. A natural approach would be to take the distance from the cross-sectional mean or median, but this approach does not capture the dispersion

[25]When there are no volume tiers, we record the fee that is offered to all market participants.

or clustering of exchanges' fees. We design a measure, relative-to-rivals fee, that captures the full distribution of its rivals' fees, i.e., the distance of an exchange's fees from each of its rivals' fees. At each point in time, the exchanges are ordered from the lowest to highest nominal fee – i.e., Fee_1, Fee_2, $\ldots Fee_n$, then the relative fee measure for exchange i relative to its rivals j is defined as:[26]

$$\text{Relative Fee Measure}_i = \sum_{j=1,j<i}^{i} |Fee_i - Fee_j| - \sum_{j=i,j>i}^{n} |Fee_i - Fee_j|. \quad (1)$$

We denote the relative-to-rivals fee measure with *Rel* – e.g., *Rel_Make_Basic*. The smaller the value of the measure, the more attractive an exchange's fees are relative to the rivals' fees. While the nominal fee measures gauge absolute magnitude, the relative-to-rival fee measures provide an evaluation of the relative magnitude of fee attractiveness compared to the menu of fees available on other exchanges. The summary statistics for the nominal and relative fees are reported in Panel A and B of Table 1.

Panel A of Table 1 shows the fees exhibit sufficient variation across the sample period. On average, on the make side, high-volume-high-liquidity market participants receive higher rebates than other market participants: \$0.2288 vs. \$0.1992 per 100 shares. On the take side, high-volume-high-liquidity market participants pay lower fees than other market participants:

[26]The following numerical example illustrates the construction of the relative-to-rivals fee. Suppose there are four exchanges: E, F, G, and H. Each exchange has a total fee per 100 shares: 0.01, 0.02, 0.03, 0.04, respectively (the mean level of total fee for the basic tier reported in Table 1 is 0.033). Consider the relative-to-rivals fee for exchange F calculated as the sum of the distance to exchange E, the negative distance to exchange G, and the negative distance to exchange H. Thus, (0.02-0.01)-(0.03-0.02)-(0.04-0.02)= -0.02. In this sense, if the total fee on exchange, E, G, or H changes, the relative-to-rivals fee on exchange F will adjust to reflect this change. For example, if exchange H were to increase its fee, to 0.05, the relative-to-rivals fee on exchange F would decrease to -0.03 to reflect that exchange F's fee is now more attractive. Similarly, if exchange H decreased its fee to 0.03, the relative-to-rivals fee on exchange F would now be -0.01 to reflect its relative attractiveness has decreased.

$0.24008 vs. $0.2490 per 100 shares.[27] With higher make rebates and lower take fees on the competitive tier for high-volume-high-liquidity market participants, exchanges have lower total fees on the competitive pricing level ($0.0112 per 100 shares) than the basic pricing level ($0.0498 per 100 shares). In fact, the median values reveal that a exchange-tape typically earns no revenue directly from these fees at the competitive pricing menu since the median total fee on the competitive tier is zero. The median of the total fee on the basic tier is four cents per 100 shares. Despite the appearance that in some cases make and take fees produce no direct revenue to the exchange, exchanges potentially earn significant revenue from the sale of trade and quote data, magnifying the importance of trading volume, which depends, in part, upon the pricing structure of liquidity-based trading fees.[28]

Panel B of Table 1 reports the relative-to-rivals fees, which captures the exact position of an exchange's fees relative to the fees charged by its rivals. By construction, these variables are zero on average across exchanges. The median values show fee clustering. For example, the medians for the relative make fee variables, *Rel_Make_Basic* and *Rel_Make_Comp*, are negative (-0.2600 and -0.2350, respectively), which indicates some exchanges offer much larger make fees or alternatively offer smaller rebates than most other exchange for some tapes. The medians for the relative take fee variables, *Rel_Take_Basic* and *Rel_Take_Comp*, are positive (0.2200 and 0.1900, respectively), demonstrating a few exchanges offer much lower take fees than other exchanges for some tapes.

For our analysis we also need a measure for trading volume. Because fees are applied per share and the same fee is applied to all securities in a tape, we aggregate individual securities' volume in shares to the exchange-tape level. Hence,we measure volume in billions of shares traded on

[27]The median value for the take fee on the basic tier shown in the second column is 30 cents per 100 shares, which is the SEC's maximum allowable take fee. The median take fee on the competitive tier is 28 cents per 100 shares, which is two cents less than the imposed cap on the take fee. While not reported in the table, our sample shows that from 2008 through 2010, the highest total fee charged on both the competitive tier and basic tier was 0.30 per 100 shares. We identify this fee structure as Nasdaq OMX PSX in September 2008. The lowest total fee on both the competitive and basic tier was -0.06 per 100 shares, which was Nasdaq OMX BX in March and April, 2009.

[28]The Securities Information Processors (SIPs) collect fees from subscribers for trade and quote tape data received from trading centers and reporting facilities. After deducting the cost of operating each tape, the profits are allocated among the SIP Participants on a quarterly basis. (http://www.sec.gov/rules/sro/chx/2013/34-70546.pdf)

an exchange in a tape. We collect data from NYSE's Trade and Quote (TAQ) database and the Center for Research in Security Prices (CRSP) Daily database. Appendix A discusses the Consolidated Trades (CT) files from TAQ with regards to what the data encompasses, data management, and how to merge with CRSP. We start with 32,801,938 daily security-level observations across exchanges for our sample period, which are then aggregated to 18,362 daily exchange-tape observations for trading volume. Panel C of Table 1 shows that across all exchange-tape observations in our sample there are, on average, 0.1818 billion shares traded in a tape on an exchange. Aggregating the volume in a tape across exchanges, the average daily tape volume is 2.3375 billion shares ranging from 0.230 billion shares to 9.803 billions shares (unreported in the table). Further, aggregating the volume of all securities on each exchange across tapes reveals the average volume on a given day on an exchange is 0.4961 billion shares; over the three-year sample period the total volume across all exchanges is 3,337.64 billion, and thus, average volume on an exchange is 238.40 billion (unreported in the table).

2.3. Money Transfer between Makers, Takers, and Exchanges

Even though exchanges have diversified revenue sources, trading fees are an important source of revenue.[29] For example, in 2010 Nasdaq reported that transaction revenue was $1.600 billion, while transaction rebates paid to participants was $1.094 billion, which generated a net fee revenue of $0.506 billion.[30] To put this in perspective, Nasdaq's net income across all revenue sources in 2010 was $0.395 billion.

Using our hand-collected data, we can obtain the amount of money transfer due to the fees among exchanges, makers, and takers. Although we cannot separate the shares traded on the basic and the competitive tier, assuming the basic (competitive) fee is applied to all transacted shares provides us with the upper (lower) bound of money transfer to the exchange, or the most (least) an exchange can earn. Combining the share volume data with our hand-collected

[29]Exchanges have gone through "demutualization," where a nonprofit member-owned mutual organization is transformed into a for-profit shareholder corporation, and if publicly traded, like Nasdaq, must file a 10K Report (Macey and O'Hara, 2005).

[30]These amounts were taken for the year end December 31, 2010 found in the Nasdaq 10K Report, p.57, and include only revenue and rebates directly from U.S. cash equity trading and do not include other sources of revenue, for example, from market data generation.

fee data, we show in Table 2 that, on average, across securities in all three tapes, an exchange can receive a maximum of \$1.171 million per day from takers and rebate \$0.710 million to makers, retaining a net profit of \$0.460 million (Panel A, Column (1)). An exchange can make a minimum of \$0.132 million per day (Panel B, Column (1)). The money that all exchanges retain in aggregate for the whole sample period ranges from approximately \$890 million (Panel B, Column (3)) to \$3,095 million (Panel A, Column (3)), which is approximately 12% to 40% of the aggregate amount paid by takers.

3. Hypotheses, Methodology, and Results

3.1. Total Fee

Baseline Regression Model and Predictions

Theory suggests that all else equal a platform's trading volume could be negatively or positively related to the total fee (i.e., the sum of the make and take fees) it charges (Colliard and Foucault, 2012; Brolley and Malinova, 2012). One would generally expect the demand for trading to decrease with an increase in the price of trading, i.e., an increase in the exchange's total fee (Foucault, et al., 2013; Colliard and Foucault, 2012; Constantinides, 1986).[31] However, an increase in the total fee can be associated with an increase in trading volume due to heterogeneous patience levels across investors (Colliard and Foucault, 2012). With an increase in the total fee, patient investors submit more aggressive quotes, increasing the likelihood of a transaction. Given the two opposing views on the relation between volume and total fee, whether an increase in the total fee reduces or decreases volume on an exchange is an open question. Thus, our first testable prediction, states that exchange volume decreases in the the total fee (**P1**).[32] In our tests, we regress trading volume, estimated for each exchange and each

[31] A detailed discussion about the demand for trading could be found on p.3402 in Colliard and Foucault (2012).

[32] Exploring the relationship between trading volume and the total fee charged by the exchange is not inconsistent with the view of markets as being two-sided. As shown in Alexandrov and Spulber (2013), a two-sided market can be characterized as a one-sided market in which the intermediary is concerned with the difference between the demand and supply of the two sides of the market.

tape, on the total fee:

$$Volume_{i,k,t} = \alpha \times Total\ Fee_{i,k,t} + \beta \times Tape\_Vol_{i,k,t} + Constant + \varepsilon_{i,k,t}, \quad (2)$$

where subscripts i, k, and t denote exchange, tape, and day, respectively. We use daily data at the exchange level for each tape. All variable descriptions are provided in Appendix B. In the above equation $Total\ Fee$ is one of our four measures of total fee, *Nom_Total_Basic*, *Nom_Total_Comp*, *Rel_Total_Basic*, or *Rel_Total_Comp*. The dependent variable, $Volume$, is the detrended daily volume in billions of shares traded on an exchange in a given tape. We detrend volume because our sample includes a sharp uptrend in trading activity (Chordia, Roll, and Subrahmanyam, 2011).[33] To control for changes in overall tape volume that are unrelated to fees, we include the detrended total volume in a tape measured in billions of shares across all exchanges each day, *Tape_Vol*. We expect α, the coefficient on the total fee, to be negative and significant.

In all regression specifications we difference-out the exchange-tape fixed effects by using changes in variables.[34] Using the first-difference transformation is preferred to fixed effects in our case because the number of cross-sectional units is relatively small (we have 14 exchanges and each reports fees for three tapes, which yields at the most 42 cross-sectional units); the number of time periods is relatively large (we have three years of daily data).[35] All regression specifications also include date fixed effects to control for time variation in the first-difference of the dependent variable.

[33]We avoid imposing a linear trend by taking the first difference (see Lo and Wang, 2000, p.294).

[34]In this way, we eliminate both the constant unobserved effect over time and the autocorrelation in the error terms. Given that our regression analysis is performed in changes of the variables, which potentially, partially mitigates some endogeneity concerns that might arise when the analysis is conducted in levels, we essentially test how market outcomes change on the fee change event. A separate robustness section describes two other approaches used to establish the validity of our results.

[35]For relevant material for this discussion see Wooldridge (2002), Chapter 10, pp.248-297.

Results

The results of the baseline regression model in Eq.(2) are reported in Table 3.[36] We first focus on the case when the total fee is measured in nominal terms. Results are shown in Columns (1) and (2) of Table 3. The coefficient associated with the control variable *Tape_Vol* is positive and significant in both Columns (1) and (2), which shows that as the volume across all exchanges increases, the volume on a exchange-tape also increases, on average. In Column (1), the nominal total fee is for the basic tier. The coefficient on *Nom_Total_Basic* is negative (-0.235) and statistically significant (p-value of 0.012). In Column (2), the nominal total fee is on the competitive tier. The coefficient on *Nom_Total_Comp* is also negative and statistically significant (-0.223 with a p-value of 0.039). The observed negative association between volume and the total fee indicates that the daily volume on an exchange in a tape of securities increases when the total fee decreases, consistent with **P1**. We do not find support for the conjecture that due to heterogeneous patience across investors, an increase in total fee can be associated with an increase in trading volume.

The reported association between an exchange's volume and the total fee is economically meaningful. The average total fee change across all events is \$0.0136 per 100 shares. Our results in Column (1) show that an increase in the basic total fee of one cent per 100 shares decreases daily volume by 0.00235 billion shares on an exchange for a given tape of securities. The average daily traded number of shares for a tape of securities on an exchange is 0.1818 billion and the average basic total fee is \$0.0498 per 100 shares (see Table 1). Thus, the average daily revenue for an exchange is 181,800,000*(0.0498/100) =\$90,536.40 per tape. By increasing the basic total fee from \$0.0498 to \$0.0598 per 100 shares, the daily revenue increases to (\$0.0598/100)*(181,800,000-2,350,000) = \$107,311.10, an increase of \$16,774.70 in a day. The higher fees that an exchange receives offsets the reduction in trading volume. Therefore, revenue increases as the fee increases. An increase of one cent per 100 shares (20.08% of the mean) leads to a 18.52% increase in the total revenue for a given tape of securities per day on an

[36]The results are robust to log transformation of trading volume.

exchange.[37]

Now we focus our attention on the case when the total fee is measured in relative-to-rivals-fees terms, which allows us to examine the effect of fee changes on volume that makes exchanges' pricing relatively more or less attractive than rivals' pricing. Our relative-to-rivals fee measures capture the relative attractiveness of the fees compared to fees charged by other exchanges, specifically the distance (proximity of fees across exchanges), not just the absolute level of the fee. Columns (3) and (4) of Table 3 report the results for the relative fees for the basic-tier and for the competitive-tier, respectively. The point estimates are -0.033 (p-value of 0.006) and -0.024 (p-value of 0.061). Thus, if an exchange lowers its fee, compared to the fees charged by rival exchanges (i.e., increasing the distance from rivals' fees and thus the attractiveness of its fees), it will increase the exchange's own volume. For instance, in the extreme case when an exchange offers the lowest nominal total fee, further reducing that fee can incentivize some market participants to utilize that exchange, thereby increasing volume.

Taken together, the regression results reported in Table 3 show (i) that an increase in the total fee leads to a decrease in volume and has, on average, a positive effect on an exchange's revenue and (ii) that not only the nominal level of the fees matter, but the relative attractiveness compared to rival exchanges fees is also important.

3.2. Make and Take Fees and Trading Volume

Baseline Regression Model and Predictions

While the association between volume and total fee is important to our understanding of the effect of fees on equity trading, we continue by exploring whether an exchange's volume and revenue is dependent upon how the fee is split between makers and takers. If, indeed, volume on an exchange is more sensitive to changes in make fee or take fee, then an exchange could potentially influence trading volume and ultimately its expected profit, by changing the

[37] A 1-cent increase per 100 shares in the total fee increases an exchange's revenue by 34.87% when evaluated at the 25th percentile of total fee and volume and by only 12.22% when evaluated at the 75th percentile of total fee and volume. Therefore, our results indicate that at relatively high fees, increases in the net fee will result in relatively smaller increases in revenue because of the large corresponding loss in volume for the exchange; this suggests that if fees are too high, the gains from trade are potentially decreased from fee increases and/or the effects of increased competition.

allocation of the total fee between the make and take sides, while holding the total fee unchanged (Rochet and Tirole, 2003, 2006; Foucault, et al., 2013).

Theoretical models predict that trading volume is decreasing in both make and take fees (Constantinides, 1986, Foucault, et al., 2013). If trading is endogenous as in Constantinides (1986), investors alleviate the cost of the fees by reducing trading activity because the utility costs of not trading are small.[38] Under this framework, makers can be better off by refraining from posting nonmarketable orders when the make fee increases and takers can be better off by refraining from posting market orders when the take fee increases; both can lead to an overall reduction in the number of executed transactions. In Foucault et al. (2013) changes in the aggregate monitoring intensities, which are impacted by make and take fees, translate into changes in the same direction for the trading volume (see Corollary 1 in Foucault et al., 2013) because participants trade-off the benefit from a higher likelihood of being first to detect an opportunity with the cost of monitoring. For example, a decrease in the makers' monitoring benefit (from an increase in the make fee) reduces their individual monitoring levels, other things being equal. The marginal benefit of monitoring for takers is then smaller because they are less likely to find a good price when they inspect the market. Consequently, takers monitor the market less intensively, even though their own monitoring cost has not changed, which implies less trading volume because traders are less active in the market as the fees increase. Thus, our second testable prediction is that, on average, the volume is decreasing in make and take fees (**P2**).

Theory suggests that both the make and the take fee are negatively related to trading volume, but whether the sensitivities of the exchange's trading volume to a change in the make fee versus the take fee are the same remains an empirical question. Our third testable prediction is whether the split of the total fee between makers and takers has an effect on exchange volume. (**P3**). We empirically test **P2** and **P3** by employing our baseline regression model in Eq.2 but now

[38]Constantinides (1986) presents an equilibrium model with risky and riskless assets. The investor intends to maintain a constant ratio of the two assets, which requires continuous, costly rebalancing. Thus, a no-trade zone arises around the optimal ratio. The no-trade zone will be wider the greater the cost of trading.

our independent variables of interest are the make and take fees:

$$Volume_{i,k,t} = \alpha_1 \times Make\ Fee_{i,k,t} + \alpha_2 \times Take\ Fee_{i,k,t} + \beta \times Tape\_Vol_{i,k,t} + Constant + \varepsilon_{i,k,t}, \quad (3)$$

where subscripts i, k, and t denote exchange, tape, and day, respectively. $Make\ Fee$ and $Take\ Fee$ are the corresponding fees in nominal or relative (basic or competitive) terms. According to **P2** we expect to find that α_1 and α_2 are negative and significant.

To study the difference in sensitivities, we test whether the difference between the coefficient associated with the make fee and the coefficient associated with the take fee is different from zero, i.e., $\alpha_2 - \alpha_1 = 0$. If the difference between these two coefficient is zero, we can infer that on average a unit change in the make fee has the same effect on exchange trading volume as a unit change in the take fee. In this case, the inference is that an exchange cannot affect its trading volume by changing the allocation of the total fee between the two sides of the market. What matters for exchange trading volume is the sum of the make fee and take fee – the total fee. However, if the difference between the coefficient associated with the make fee variable and the coefficient associated with the take fee variable is significant, the inference is that an exchange can affect its trading volume by changing the allocation between the make fee and the take fee, keeping the total fee constant, consistent with **P3**.

Results

The regression results, when we consider the make and take fees in nominal terms, are reported in Columns (1) and (2) of Table 4. Column (1) reports results for the make and take fees at the basic-tier pricing schedule. The coefficient on *Nom_Make_Basic* is -0.177 and the coefficient on *Nom_Take_Basic* is -0.389, both are statistically significant, consistent with **P2**. Specifically, the inverse associations between exchange trading volume and make and takes fees are consistent with theoretical predictions (Constantinides, 1986; Foucault et al., 2013). The difference between the two coefficients is 0.212 with a p-value of 0.023, consistent with **P3**. This difference indicates that the sensitivity of trading volume to changes in the take fee is, on

average, twice as large as the equivalent change in the make fee.[39] Hence, our results suggest that an exchange can affect trading volume on its platform by changing the allocation of the total fee to the take and make sides of the market.

Column (2) of Table 4 shows the results for make and take fees on the most competitive pricing tier offered by each exchange. The coefficient on *Nom_Make_Comp* and *Nom_Take_Comp* are both negative, -0.144 and -0.392, respectively, although the coefficient on *Nom_Make_Comp* is not significant. The difference between the coefficients is positive and significant (0.249 with a p-value of 0.007). Thus, for the competitive-tier pricing level, as well as for the basic-tier pricing level, a change in the take fee is associated with a greater change in trading volume than an equivalent change in the make fee for an exchange-tape.

The aforementioned relation between volume and take and make fees is not only statistically significant but also economically meaningful. We illustrate the economic significance by focusing on the coefficients reported in Column (1) of Table 4.[40] An increase in the take fee by one cent per 100 shares on a given day, holding the make fee constant, decreases the daily trading volume by 3.89 million, which leads to a 17.51% increase in exchange revenue.[41] However, an increase in the make fee by one cent per 100 shares on a given day, holding the take fee constant, decreases the daily trading volume by only 1.770 million shares, which leads to an increase in exchange

[39]Using our regression results in Column (1) we see that when the make fee decreases by \$0.01 per 100 shares, volume increases by 0.00177 billion shares, a 0.97% increase in exchange trading volume estimated as ((0.1818+0.00177)/0.1818). When the take fee decreases by \$0.01 per 100 shares, volume increases by 0.00389 billion shares, which is a 2.1% increase in exchange trading volume ((0.1818+0.00389)/0.1818).

[40]We also find economic significance if we look at the regression coefficients associated with fee changes in the competitive pricing tier.

[41]The average daily exchange-tape trading volume is 181,800,000 shares and the average make and take fees in dollars per 100 shares is \$-0.1992 and \$0.2490 (Table 1). Estimated at the average trading volume and the average make and take fees the daily revenue for an exchange is \$90,536.40 (estimated as 181,800,000*(\$0.2490-\$0.1992)/100). The coefficient associated with the change in take fees is -0.389 (Table 4, Column (1)) and therefore the 1-cent take fee increase per 100 shares, from \$0.2490 to \$0.2590, decreases trading volume by 3,890,000 shares. The revenue to an exchange from a certain tape if the take fee is increased by one cent per 100 shares is estimated as (181,800,000-3,890,000)*(\$0.259-\$0.1992)/100)=\$106,390.18 and thus the percentage increase in the revenue is (\$106,390.18-\$90,536.40)/ \$90,536.40=17.51%.

revenue of 18.91%.[42] These results suggest that in the event that an exchange increases its total fee, the exchange will generate 1.40% more revenue by increasing its make fee compared to an equivalent increase in its take fee. The aforementioned relation between volume and take and make fees is not only statistically significant but also economically meaningful. We illustrate the economic significance by focusing on the coefficients reported in Column (1) of Table 4.[43] An increase in the take fee by one cent per 100 shares on a given day, holding the make fee constant, decreases the daily trading volume by 3.89 million, which leads to a 17.51% increase in exchange revenue.[44] However, an increase in the make fee by one cent per 100 shares on a given day, holding the take fee constant, decreases the daily trading volume by only 1.770 million shares, which leads to an increase in exchange revenue of 18.91%.[45] These results suggest that in the event that an exchange increases its total fee, the exchange will generate 1.40% more revenue by increasing its make fee compared to an equivalent increase in its take fee.

Above we examine a change in the take fee when the make fee is held constant and vice versa; in both cases, however, the total fee also changes. Now we keep the total fee unchanged and specifically focus on the economic impact of changing only the allocation of the total fee between the make and take sides on revenue. We study the impact of allocation by netting out

[42]The coefficient associated with a change in the make fee, reported in Table 4, Column (1), is -0.177. Thus, at the average make fee, a one cent increase per 100 shares, from -$0.1992 to -$0.1892 (smaller rebate), decreases trading volume by 1,770,000 shares. At the average daily volume, make and take fees, if the make fee is increased by one cent per 100 shares, revenue is increased to $107,657.94 estimated as (181,800,000-1,770,000)*(0.2490-0.1892)/100, and, thus, the percentage increase in exchange's daily revenue is ($107,657.94-$90,536.40)/$90,536.40)=18.91%.

[43]We also find economic significance if we look at the regression coefficients associated with fee changes in the competitive pricing tier.

[44]The average daily exchange-tape trading volume is 181,800,000 shares and the average make and take fees in dollars per 100 shares is $-0.1992 and $0.2490 (Table 1). Estimated at the average trading volume and the average make and take fees the daily revenue for an exchange is $90,536.40 (estimated as 181,800,000*($0.2490-$0.1992)/100). The coefficient associated with the change in take fees is -0.389 (Table 4, Column (1)) and therefore the 1-cent take fee increase per 100 shares, from $0.2490 to $0.2590, decreases trading volume by 3,890,000 shares. The revenue to an exchange from a certain tape if the take fee is increased by one cent per 100 shares is estimated as (181,800,000-3,890,000)*($0.259-$0.1992)/100)=$106,390.18 and thus the percentage increase in the revenue is ($106,390.18-$90,536.40)/ $90,536.40=17.51%.

[45]The coefficient associated with a change in the make fee, reported in Table 4, Column (1), is -0.177. Thus, at the average make fee, a one cent increase per 100 shares, from -$0.1992 to -$0.1892 (smaller rebate), decreases trading volume by 1,770,000 shares. At the average daily volume, make and take fees, if the make fee is increased by one cent per 100 shares, revenue is increased to $107,657.94 estimated as (181,800,000-1,770,000)*(0.2490-0.1892)/100, and, thus, the percentage increase in exchange's daily revenue is ($107,657.94-$90,536.40)/$90,536.40)=18.91%.

any effect due to a change in the amount of total fee. We consider the case where an exchange simultaneously considers (i) a one cent decrease in the take fee with a one cent increase in the make fee, and contrast this with (ii) a one cent increase in the take fee with a one cent decrease in the make fee. In the first scenario, the trading volume increases by 2.12 million shares (Table 4, Column (1)); consequently, an exchange's daily revenue increases by 1.167%.[46] However, in the second scenario, the trading volume decreases by 2.12 million shares (Table 4, Column (1)), which leads to a decrease of 1.155% in an exchange's revenue on a given day.[47] This analysis indicates that keeping the total fee unchanged, an exchange's revenue increases when the take fee is decreased and the make fee is increased by the same absolute amount; however, an exchange's revenue decreases if the take fee is increased and the make fee is decreased. Therefore, an exchange's trading volume and revenue are not affected solely by the total fee but also by the allocation of this fee to both sides of the market.

We now focus on the effect of relative-to-rivals' fee on volume. The results are reported in Table 4, Columns (3) and (4). The coefficients on all fee measures in both columns are negative and significant. Namely, the difference in coefficients between the relative make and take fees in both columns are positive and significant indicating that in a relative sense, a decrease in the take fee increases exchange's trading volume more than an equivalent decrease in the make fee.

In sum, we find evidence that an increase in the make and take fees, in nominal and in

[46]A 1-cent per 100 shares increase in the make fee decreases volume by 0.00177 billion shares while a one cent decrease in the take fee increases volume by 0.00389 billion shares leading to an overall volume increase of 0.00212 billion shares, which is the difference in the coefficients as reported in Table 4, Column (1). At the average daily volume of 0.1818 billion shares, these fee changes result in an increase in volume to 0.1839 billion shares. The revenue at the average fees and average volume is 90,536.40 (181,800,000*(0.2490-0.1992)/100), while the resulting revenue after the fee changes is $91,592.16 (183,920,000(0.2390-0.1892)/100), which is an increase in revenue. This scenario leads to an increase of 1.167% in the revenue (estimated as (91,592.16 -90,536.40)/ 90,536.40.)

[47]A 1-cent per 100 shares decrease in the make fee per 100 shares increases volume by 0.00177 billion shares while the 1-cent increase in the take fee decreases volume by 0.00389 billion shares leading to an overall decrease in volume of 0.00212 billion shares, which is the difference in the coefficients reported in Column (1), Table 4. The revenue at the average fees and average volume is 90,536.40 (181,800,000*(0.2490-0.1992)/100). Following a decrease in the make fee and increase in the take fee of 1 cent per 100 shares, volume decreases by 0.00212 billion shares and the resulting revenue after the fee changes is $89,490.60 (179,700,000*(0.2590-0.2092)/100), a decrease in revenue. This scenario leads to a decrease of 1.155% in the total revenue (estimated as (89,490.60 -90,536.40)/90,536.40).

relative terms, reduces exchange volume. Moreover, an exchange can affect its volume and, consequently, its revenue by keeping the total fee unchanged and changing the allocation of the total fee between makers and takers. These results not only have implications for exchanges but also for market participants has a whole. Because each transacted share benefits both the maker and the taker together, trading volume on an exchange captures the overall benefit of market participants. Hence changes in trading fees, or the allocation of trading fees, that impact an exchange volume indirectly impact the overall welfare of market participants.

3.3. Fees and Trading Volume – Binding Quotations

So far, the results show that an increase in the total fee decreases the trading volume on an exchange and that an increase in the take fee decreases trading volume relatively more than an increase in the make fee. In this subsection we explore whether the documented relations between trading volume and fees are more pronounced when the tick size is a binding constraint on the bid-ask spread, i.e., when the quoted bid-ask spread is relatively small.

Theory suggests that in the presence of frictions such as a nonzero tick size, traders may be unable to change their quotes in response to changes in the fees (Colliard and Foucault, 2012; Foucault et al., 2013; Chao, Yao, and Ye, 2015). Quotes must be expressed as multiples of a minimum monetary unit (the tick size), which is one cent in the U.S., and for this reason traders cannot fully neutralize the make and takes fees in the prices. That is, we expect to find that fees are negatively related to trading volume particularly when the tick-size is binding, i.e., when the quoted bid-ask spread is small.

To study whether the effect of the fees on an exchange's trading volume is, in part, determined by whether the tick size is a binding constraint on the bid-ask spread we proceed in the following way: First, we aggregate the transacted shares depending on whether they are transacted below (tick size is presumably a binding constraint on the bid-ask spread) or above (tick size is presumably not binding) the median of the daily individual securities' time-weighted average quoted bid-ask spread in dollars per share on each exchange. On each day, on each tape, and each exchange we construct two exchange-tape trading volume variables. Then we again employ

the regression models in Eq.(2) and (3).

We start by calculating the daily time-weighted average best bid and offer (BBO) quoted bid-ask spread in dollars per share for each security on every exchange.[48] Next, we identify the median each day across all time-weighted individual-security quoted spreads within each tape on an exchange as our measure of the typical quoted spread for a tape at an exchange.[49] We then stratify the securities into two groups each day within a tape on an exchange: (i) small-bid-ask-quoted-spread group – those securities below the median dollar exchange-tape BBO, and (ii) large-bid-ask-quoted-spread group – those securities above the median. We construct exchange-tape level volume variables separately for these two groupings, *Vol_Below* and *Vol_Above*. *Vol_Below* is the detrended volume in billions of shares by aggregating daily share volume of securities with relatively low dollar quoted BBO; *Vol_Above* is the detrended volume in billions of shares by aggregating daily share volume of securities with relative high BBO.[50]

The results for the below-median-securities-BBO subsample (the tick size is a binding constraint on the bid-ask spread) are reported in Table 5 and are consistent with the hypotheses that liquidity-based trading fees matter most for an exchange's trading activity when the tick size is a binding constraint on the bid-ask spread. The results reported in Table 5 show that when the total fee increases, volume at relatively low-quoted spreads decreases. Moreover, the allocation of the total fee to the make and the take sides significantly impacts the amount of volume when the tick size is binding. The reported coefficients in Table 5 are in line with the reported findings in prior tables when all share volume is aggregated for each exchange-tape regardless of BBO size.

We contrast these results to those of relatively large spreads, i.e., the tick-size is less binding.

[48] Appendix A explains that the Consolidated Quotes (CQ) Files in the TAQ Files report quote updates from all registered exchanges, and this updated quote will be the best bid and offer (BBO) prevailing at the market center.

[49] The distribution of the time-weighted individual-security quoted spreads is positively skewed, and in this case, the median better represents the typical spread compared to the average at the exchange-tape level. We require that we have at least two individual securities observations in a day in exchange-tape.

[50] We split in two the $Volume$ variable so the number of observations in Table 5 is the same as in the previous tables: 17,470.

None of the coefficients associated with the fee variables are significant, which indicates that volume at relatively large spreads is not significantly impacted by changes in trading fees, consistent with the hypothesis that allocation matters most when the tick-size is a binding constrained on the bid-ask spread. These results are available upon request.

In conclusion, this section provides support for the hypothesis based on the theoretical model by Foucault et al. (2013). Because quotes must be expressed as multiples of a minimum monetary unit, the tick size, traders cannot fully neutralize the fees and thus the allocation of the total fee to the two sides of the market matters for an exchange's trading volume. We find that when the tick size is a binding constraint on the bid-ask spread, i.e., when the quoted bid-ask spread is relatively small, an exchange can effectively change the amount of the executed trading volume on its platform by changing the allocation between the make and take sides, keeping the total fee constant.

4. Alternative Regression Specifications

In this section, we consider two alternative regression specifications to analyze the effect of liquidity-based trading fees, which provide robustness to the results derived in the previous section. The evidence so far is based on regression specifications that use first-differencing transformation of our variables. As explained earlier this approach is preferred to fixed effects when the cross-sectional units are relatively large compared to to the number of time periods. On one hand, first-differencing the variables eliminates the constant unobserved effect over time and the autocorrelation in the error terms. First-differencing also allows us to test how an exchange's characteristics change on the fee change event, potentially avoiding endogeneity issues that might arise doing analysis in levels. On the other hand, first-differencing creates zeros in the data because fees do not change every day. We deal with this issue in two ways. First, we add a dummy variable, which is an indicator variable that takes the value of one for an exchange-tape on days when a fee change occurs and is zero otherwise. Second, we perform s subsample analysis using only the subsample of those daily observations when changes in the fees occurred, i.e., observations with non-zero values for fee change variables. Table 6 reports

the results when fees are masured in nominal terms and the evidence is that results hold in both cases.

Specifically, Columns (1) and (2) of Table 6 report results that include an indicator variable for days when fee changes occur. The coefficient associated with this variable is not significant in all columns. However, the relationship between volume and fees is still negative and significant and the relationship between spreads and fees remains insignificant. Results in Panel B, also support our inference that the allocation of fees is important for volume. Columns (3) and (4) of Table 6 report results for a subsample of days when the fee changes actually occur. We have 58 observations in the regressions where the independent variable of interest is the basic-nominal-fee variables and 84 observations in the regressions where the independent variable of interest is the competitive-nominal-fee variables. The coefficients associated with the total fee variables in Panel A are negative and statistically significant. The point estimates on *Nom_Total_Basic* and *Nom_Total_Comp* are -0.238 (p-value of 0.038) and -0.222 (p-value of 0.086) and statistically significant at 5% and 10%, respectively. In Panel B the coefficients associated with *Nom_Take_Basic* and *Nom_Take_Comp* are negative and highly statistically significant (p values of 0.006 and 0.004) while the coefficients associated with *Nom_Make_Basic* and *Nom_Make_Comp* are also negative as predicted by theory, but insignificant. More important, these differences in coefficients confirm our previous findings that an increase in the take fee decreases trading volume relatively more than an increase in the make fee. The exact differences between the parameters for make-fee and take-fee variables are reported in Panel C, they are 0.212 (p-value of 0.069) and 0.292 (p-value of 0.008).

The results reported in Table 6 substantiate our main finding that as the total fee increases the trading volume on an exchange goes down and that an exchange can influence the level of trading activity by changes to the allocation of the total fee to the make side and the take side.

5. Conclusion

Liquidity-based fees have been adopted by all registered U.S. equities exchanges as a mechanism for exchanges to seek balance the relative supply and demand of liquidity. Because

fees are widely used, it is important to "...account for the welfare of all parties (makers, takers, and trading platforms' profits)" (Foucault, 2012). The effect of these fees on the U.S. equity exchange industry is largely undocumented and not well understood from the exchange's perspective. This study fills this gap by providing empirical evidence on the overall effect of the make-and-take fee pricing model on exchanges' volume and ultimately their revenue. We examine the relations between fees, volume, and revenue for the period January 1, 2008 through December 31, 2010, across all U.S. registered exchanges using hand-collected data of the make fee, take fee, and total fee (the sum of the make and take fees).

Our exchange-tape level regression analyses provides evidence that an increase in the total fee decreases an exchange's volume. We also find that an increase in the take fee decreases the trading volume on an exchange more than an equivalent increase in the make fee. Hence the take fee may be relatively more important in evaluating the welfare implications of market participants. We also show that evaluated at the average, an increase in the total fee leads to an increase in an exchange's revenue and that the increase in revenue is greater if the total fee is increased through higher fees charged to the make side. Furthermore, if an exchange keeps the amount of the total fee constant and changes only the allocation of the total fee to the two sides of the market we show a change in allocation that favors the make or the take side leads to opposing effects on exchange's volume and revenue. These results further buttress the notion that exchanges must court both sides of the market, make and take, while trying to increase revenue.

We also provide evidence that the results are driven primarily by securities for which the tick-size is a binding constraint on the bid-ask spread, i.e., when the quoted bid-ask spread is small (Colliard and Foucault, 2012; Foucault et al., 2013; Chao et al. 2015).

Finally, exchange trading volume depends not only on its level of fees but also on the fees charged by all other exchanges. The evidence provided about the relation between fees and volume also holds when we measure fees by taking into account the attractiveness of fees relative to those charged on other exchanges.

Our exchange-level evidence is not irreconcilable with a hypothesis that the effect of the

trading fees on trading volume is dependent upon security-level characteristics (e.g., high-volume and/or low-price stocks vs. low-volume and/or high-price stocks); type of a market participant (a retail investor, a mutual fund, or a high-frequency trading firm); or a trading strategy in a particular security. Security-level analyses and how fees affect different types of market participants and trading strategies are interesting areas of future research.[51]

While trading fees generate revenue for the exchanges, there are hidden costs associated with these fees (Angel, Harris, and Spatt, 2011, 2013; Harris, 2013). Some of the main considerations that arise with the adoption of make and take fees and rebate structures include: (1) an agency problem between brokers and their clients when the clients do not receive the liquidity rebates or when business models prevent brokers from passing on the take fees; (2) a transparency problem since quoted spreads are different from the more economically meaningful net-of-fee spreads; and (3) an incentive to route market orders for execution to venues that do not charge access fees like dealers who internalize their client order flows, dealers who pay brokers to preference their customers' orders, and various dark pools that match buyers and sellers (Ibid.). A detailed discussion and possible solutions to these issues can be found in Angel et al. (2011, 2013) and Harris (2013).[52]

How the fees affect market participants and the role of regulators are topics beyond the scope of this paper but of great importance. For example, high-frequency trading firms have designed strategies directed at capitalizing on make-and-take fee structures across markets.[53] The effects of these activities on the market as a whole and on long-term investors is still

[51]The optimal make-and-take fee structure can depend on security-level characteristics (Foucault et al., 2013). Further analysis is needed to address the impact of these fees for different types of securities depending on their characteristics.

[52]SEC Commissioner Luis Aguilar

addresses the issues associated with the liquidity-based fees from the perspective of the asset management industry in a 2014 speech (Aguilar, Luis A., April 2, 2014, "Taking an informed approach to issues facing the mutual fund industry," Speech by the Commissioner, Washington, DC. Retrieved from `http://www.sec.gov/News/Speech/Detail/Speech/1370541390232#_edn56`. SEC officials are considering a trial program to eliminate for a period the fees in a select number of stocks to show how trading in those securities compares with similar stocks that keep the payment system. The pilot program might also include a test of so-called trade-at rule (Patterson, S. and Ackerman, A.(April 14, 2014)"Regulators Weigh Curbs on Trading Fees" The Wall Street Journal `http://www.wsj.com/articles/SB10001424052702303887804579501881218287694`

[53]"What's behind high-frequency trading" by Scott Patterson and Geoffrey Rogow, *Wall Street Journal*; "Who's afraid of high-frequency trading?" by Jonathan Spicer and Herbert Lash, *Reuters*; "Serving all, not just the elite few" by Sal Arnuk and Joseph Saluzzi, *The New York Times*.

under debate.[54] Given our findings that these fees affect trading volume on an exchange, we believe that exploring the avenues through which fees affect trading strategies, behavior, and profitability is an interesting and relevant topic for future research.

[54]Regulators are particularly interested in the topic of the maker-taker pricing model. For example, the Securities and Exchange Commission has requested comment with regard to the impact of these make and take pricing models within the marketplace. In a recent filing, they ask, "Are liquidity rebates unfair to long-term investors because they necessarily will be paid primarily to proprietary firms engaging in passive market making strategies? Or do they generally benefit long-term investors by promoting narrower spreads and more immediately accessible liquidity? Do liquidity rebates reward proprietary firms for any particular types of trading that do not benefit long-term investors or market quality?" (SEC 34-61358)

Appendix A: Data Management Details

The Consolidated Tape Association (CTA)[55] oversees the dissemination of real-time trade and quote information. Market centers send their trades and quotes to Consolidated Tape System (CTS) and to Consolidated Quotation System (CQS).[56] Market centers are required, as authorizing Self-Regulatory Organizations (SROs) per the CTA Plan, to report their trade activity within 90 seconds of execution time to CTS; otherwise the trade report must be designated as a late report. The current participants of the CTA as of March 18, 2010, include the American Stock Exchange, Boston Stock Exchange, Chicago Board Options Exchange, Chicago Stock Exchange, Financial Industry Regulatory Authority, International Securities Exchange, Nasdaq Stock Market, National Stock Exchange, New York Stock Exchange, NYSE Arca, and Philadelphia Stock Exchange.

The TAQ (Trades and Quotes) database is the primary source of historical trade and quote data for U.S. equities coming from the CQS and CTS. Academicians usually have access to TAQ through Wharton Research Data Services (WRDS).[57] TAQ on WRDS have two components: the Consolidated Quotes Files and the Consolidated Trades Files. We will talk about each one in turn.

Consolidated Quotes Files on TAQ

The Consolidated Quotes Files report quotations, more specifically, a quote update (a quote is valid until a new quote comes in), from more than 10 market centers as of January 2010. If a market center would like to cancel its quote, typically it will post an extremely small bid (e.g., \$0.01) or an extremely large offer (e.g., \$201,000) (the so-called stub quote). For most market centers, this updated quote will be the best bid and offer (BBO) prevailing at the market center. The only exception is quotes coming from Nasdaq and the ADFs. From the BBO reported from all market centers, we could establish the prevailing National Best Bid and Offer (NBBO) at any point of time.

[55] http://www.nyxdata.com/cta

[56] http://sec.gov/divisions/marketreg/marketinfo/appendixq.pdf

[57] http://wrds.wharton.upenn.edu/

The variable EX in TAQ contains data for the exchange on which the quote occurred. More specifically, EX = A for Amex,[58] EX = B for Boston, EX = C for NSX (National Stock Exchange, formerly the Cincinnati Stock Exchange[59]), EX = D for NASD ADF and NASD, EX = N for NYSE, EX = P for Arca,[60] EX = T for Nasdaq,[61] EX = X for Philadelphia, EX = I for ISE,[62] EX = M for Chicago, EX = W for CBOE, EX = Z for BATS. The Consolidated Quotes File contains information about the bid price and the size of it, the offer price and the size of it, quote condition and that Nasdaq market marker for each NASD Quote (variable "MMID" in TAQ[63]), and the symbol of the security.

There are some specifics about the way Nasdaq reports its quotes in the CQ files in TAQ, during the process of becoming a regular market participant as a stock exchange. There are three important dates on TAQ CQ files: November 25, 2002, May 15, 2006, and February 12, 2007. Further, we take into account whether a security is (1) NYSE listed, AMEX listed, and Arca listed or (2) Nasdaq listed. Thus, we have the following case scenarios:

- The security is NYSE listed, AMEX listed, and Arca listed and the period is
  - *Case A. Before Friday, May 12, 2006*: Nasdaq quotes have EX = T identifier on TAQ with the MMIDs reported, i.e., individual dealer quotes. There are no quotes with EX = D identifier.

[58]NYSE Euronext acquired American Stock exchange on October 1, 2008. More details about the history of American Stock Exchange could be found at `http://www.nyse.com/pdfs/AmexTimeline.pdf` and about NYSE Euronext at `http://www.nyse.com/pdfs/NYSEEuronextTimeline-web.pdf`.

[59]The Cincinnati Stock Exchange moved to Chicago in 1995 and changed its name to National Stock Exchange in 2003.

[60]The Pacific Stock Exchange used to be a floor-based market, but it merged with Archipelago (an ECN) and later NYSE and Archipelago merged to form NYSE Group Inc. More details could be found at: `http://www.nyse.com/pdfs/nysegrouptimeline.pdf` and `http://www.nyse.com/pdfs/NYSEEuronextTimeline-web.pdf`.

[61]EX = Q only in the CT files. See next section.

[62]As of December 23, 2008, Direct Edge Holdings (Direct Edge), the parent company of Direct Edge ECN, and the International Securities Exchange (ISE) completed the transaction through which the ISE Stock Exchange has become a wholly owned subsidiary of Direct Edge Holdings. Upon completion of the transaction, ISE also gained a significant equity stake in Direct Edge.

[63]The market maker identification (MMID) data field provides an additional classification layer among Nasdaq dealers and ECNs. For example, TRIM denotes Trimark, a Nasdaq dealer, while BRUT denotes the BRUT ECN. The National Securities Clearing Corporation provides a listing of Nasdaq market makers and their MMIDs in the Member Directory at `www.nscc.com` and `http://www.dtcc.com/customer/directories/nscc.php`. (see footnote 13, p. 90 from GAO report).

- *Case B. Monday, May 15, 2006 - Friday, February 9, 2007*: Nasdaq quotes have EX = D identifier on TAQ with MMIDs reported. There are no quotes with EX = T identifier.
- *Case C. After Monday, February 12, 2007*: Nasdaq quotes have EX = T identifier with no MMIDs reported or the "CAES" MMID reported,[64] i.e., Nasdaq reported quotes are treated as standard market participant. ADF quotes have EX = D identifier with MMIDs reported.[65]

- The security is Nasdaq listed and the period is
  - *Case D. Before Friday, November 22, 2002*: Nasdaq quotes have EX = T identifier on TAQ with no MMIDs reported – i.e., best Nasdaq dealer quotes for Nasdaq stocks. There are no quotes with EX = D identifier. In the cases when MMIDs are not reported, we could consider that this is the Nasdaq BBO quote for Nasdaq-listed securities.
  - *Case E. After Monday, November 25, 2002*: Nasdaq quotes are identified with EX = T while NASD ADF quotes are identified with EX = D. MMIDs are not reported

[64]CAES (Computer Assisted Execution System) is an NASD interdealer automated execution system for listed 19c-3 securities. CAES is the NASD link to ITS (Intermarket Trading System). If an NASD dealer wishes to make markets in listed securities, he or she must register as an ITS/CAES market maker for those securities. CAES is a Nasdaq system that allows its members to quote NYSE-listed stocks. For details, go to `http://www.sec.gov/rules/sro/nd9975o.htm` and `http://www.sec.gov/rules/sro/nd9953/frucher1.htm`. "NAQS" stands for NASD Alternative Quotation System. "NAQS" replaced "CAES" as of May 15, 2006.

[65]The TAQ manual notes that "As of Monday, May 15, 2006, through Friday, March 2, 2007, Nasdaq quotes in NYSE-listed, AMEX-listed and Arca listed stocks will appear on TAQ with an exchange code of D only." We download CQ data for GM, which is a NYSE-listed stock for the period May 1, 2006, through March 15, 2007. We observe that on Friday, May 12, 2006, the Nasdaq quotes are identified with EX = T and the MMIDs are reported including MMID = CAES and that there are no quotes with EX = D identifier. We also observe that on Monday, May 15, 2006 the Nasdaq quotes are identified with EX = D and the MMIDs are reported and that there are no quotes with EX = T identifier. This is consistent with the TAQ Manual. However, as of Monday, February 12, 2007 (not Friday, March 2, 2007, as noted in TAQ Manual), Nasdaq quotes of NYSE-, Amex-, and Arca-listed securities have an exchange code of T (the MMIDs are not reported consistent with the fact that this is the time when Nasdaq quotes are treated as a regular market participant), while ADF quotes have a code of D with MMIDs reported. We contacted WRDS and they agreed that the data are not consistent with the TAQ Manual at this point.

for both cases[66].

Consolidated Trades Files on TAQ

The Consolidated Trades files report transactions with the time[67] they got recorded, the symbol of the security (variable *Symbol*), number of shares traded (variable *Size*), actual trade price per share (variable *Price*), the market center on which the trade occurred (variable *EX*)[68], correction indicator (variable *CORR*), sale condition (variable *COND*) and combined "G" Rule 127, and stopped stock trade indicator (variable *G127*). We eliminate from the sample trades with a correction code greater than 1 – i.e., corr in (0,1) following Bessembinder (1999) and Kyle, Obizhaeva, and Tuzun (2010).

We use only trades for which TAQ's CORR field is equal to zero or one and for which the COND field is either blank or equal to *, @, E, F, I, J, or K. We only include trades with positive prices or quantities. We eliminate trades with prices more than (less than) 150% (50%) of the previous trade price if the prior price is more than $2 per share. We do not delete observations for which price is less or equal to $2.

As of May 15, 2006, Monday through March 2, 2007, Friday Nasdaq trades in NYSE-listed, AMEX-listed, and Pacific- (Arca-) listed stocks will appear on TAQ with an exchange code of D only. As of March 5, 2007, Monday, Nasdaq trades of NYSE-, Amex-, and Arca-listed stocks will have an exchange code of T, while ADF and TRF trades will have a code of D. T will no

[66]EX = D was added for NASD on Friday, May 31, 2002 according to the CQS Revision #19. We downloaded CQ data from TAQ for MSFT, which is a Nasdaq-listed stock for the period May 1, 2002 through Dec 31, 2002. We observe that on Friday, November 22, 2002, we have quotes with EX = T (no MMIDs reported and no quote with EX = D). We observe that on Monday, November 25, 2002, we have both quotes with EX = T and quotes with EX = D. MMIDs are not reported for both cases. Thus, TAQ reflects the CQS change on Monday, November 25, 2002.

[67]Variable *TTIM* is trade time and reflects the time at which the trade entered CTS. The TAQ Manual says "Beginning in June 1995, the trade time for NYSE and AMEX issues is the Consolidated Trade System (CTS) time stamp. Beginning in March 1997, the trade time for Nasdaq issues is the NTDS time stamp. Previously, the time shown for all trades was the time the message was received by IGS, which is approximately 3 seconds later than the CTS time stamp."

[68]More specifically, EX = A for AMEX, EX = N for NYSE, EX = B Boston, EX = P for Arca, EX = C for NSX, EX = T/Q Nasdaq, EX = D for NASD ADF and TRF, EX = X for Philadelphia, EX = I for ISE, EX = M for Chicago, EX = W for CBOE, EX = Z for BATS, and EX = 1 for Nasdaq prints in Nasdaq stocks Aug/Sep 2006 only. For some observations, EX = 8 and there is no information for it in the TAQ Manual. We find, however, that for the period 2005 through 2008 less than 1% of the trades have exchange code equal to 8, so we exclude this data.)

longer appear for trades in Nasdaq stocks as of June 28, 2006 (T will not appear until Nasdaq becomes an exchange.). These trades will have an exchange identifier of "Q". When Nasdaq became an exchange, Nasdaq executions are represented with a "Q," while "D" will include Trade Reporting Facility(TRF) prints and ADF trades.

As of May 15, 2006, through March 2, 2007, Nasdaq trades and quotes in NYSE-listed, AMEX-listed, and Arca-listed (formerly Pacific Stock Exchange) stocks will appear on TAQ with an exchange code of D only. As of March 5, 2007, Nasdaq trades of NYSE-, Amex-, and Arca-listed stocks will have an exchange code of T, while ADF and TRF trades will have a code of D. T will no longer appear for trades in Nasdaq stocks as of June 28, 2006. These trades will have an exchange identifier of Q.

As of May 15, 2006, Nasdaq trades and quotes in NYSE-listed, AMEX-listed, and Arca-listed stocks will appear on TAQ with an exchange code of D only. T will not appear again when Nasdaq became an exchange.

Merging TAQ and CRSP

The CRSP "NCUSIP" variable has correct historical values (unlike "CUSIP," which is a header variable that contains current data only), and the first eight characters of the TAQ Master File variable "CUSIP" can be used to match with CRSP's NCUSIP. Thus we (1) get SYMBOL-CUSIP links from TAQ master files, (2) get PERMNO-NCUSIP- ticker links from CRSP, and (3) merge above two by using the common variable of CUSIP. Comerton-Forde, Hendershott, Jones, Moulton, and Seasholes (2010) note that the symbol in TAQ and ticker in CRSP match only 90% of the time in their CUSIP matched sample, suggesting that using the TAQ master file to obtain CUSIPs is constructive.

Appendix B: Description of Variables Used in the Regressions

Variables	
Nom_Make_Basic	The make fee (fee for providing liquidity) in dollars per 100 shares charged to traders that do not qualify for volume-based tiers for securities within a tape on each exchange.
Nom_Take_Basic	The take fee (fee for removing liquidity) in dollars per 100 shares charged to traders that do not qualify for volume-based tiers for securities within a tape on each exchange.
Nom_Total_Basic	The net fee, the sum of *Nom_Make_Basic* and *Nom_Take_Basic*, in dollars per 100 shares for securities within a tape on each exchange.
Nom_Make_Comp	The make fee (fee for providing liquidity) in dollars per 100 shares charged to traders that qualify for the most favorable pricing for securities within a tape on each exchange.
Nom_Take_Comp	The take fee (fee for removing liquidity) in dollars per 100 shares charged to traders that qualify for the most favorable pricing for securities within a tape on each exchange.
Nom_Total_Comp	The net fee, the sum of *Nom_Make_Comp* and *Nom_Take_Comp*, in dollars per 100 shares for securities within a tape on each exchange.
Rel_Make_Basic	The distance of an exchange's *Nom_Make_Basic* for a tape of securities relative to the make fees charged for the basic tier on other exchanges.
Rel_Take_Basic	The distance of an exchange's *Nom_take_Basic* for a tape of securities relative to the make fees charged for the basic tier on other exchanges.
Rel_Total_Basic	The distance of an exchange's *Nom_Total_Basic* for a tape of securities relative to the total fees charged for the basic tier on other exchanges.
Rel_Make_Comp	The distance of an exchange's *Nom_Make_Comp* for a tape of securities relative to the make fees charged for the competitive tier on other exchanges.
Rel_Take_Comp	The distance of an exchange's *Nom_take_Comp* for a tape of securities relative to the take fees charged for the competitive tier on other exchanges.
Rel_Total_Comp	The distance of an exchange's *Nom_Total_Comp* for a tape of securities relative to the total fees charged for the competitive tier on other exchanges.
$Volume$	the daily sum of volume in billions of shares on an exchange taken across all securities within a tape of securities each day. This variable is detrended in regression specifications.
Tape_Vol	daily volume in billions of shares for a tape of securities summed across all exchanges. This variable is detrended in regression specifications.
Volume_Below	The daily sum of volume in billions of shares on an exchange taken only across those securities within each tape with a daily quoted spread less than the median daily quoted spread, where the median is calculated daily on each exchange across all securities in each tape.
Volume_Above	The daily sum of volume in billions of shares on an exchange taken only across those securities within each tape with a daily quoted spread greater than the median daily quoted spread, where the median is calculated daily on each exchange across all securities in each tape.

References

Alexandrov, Alexei, and Daniel F. Spulber, 2013, Transactions in two-sided markets, Working Paper.

Anand, Amber, Jian Hua, and Tim McCormick, 2016, Make-take structure and market quality: Evidence from the U.S. options markets, Management Science, forthcoming.

Angel, James J., Lawrence E. Harris, and Chester S. Spatt, 2011, Equity trading in the 21st century, Quarterly Journal of Finance 1, 1–53.

Angel, James J., Lawrence E. Harris, and Chester S. Spatt, 2013, Equity trading in the 21st century: An update, Working paper.

Battalio, Robert, Shane A. Corwin, and Robert H. Jennings, 2016, Can brokers have it all? On the relationship between make take fees and limit order execution quality, The Journal of Finance, forthcoming.

Battalio, Robert, and Craig W. Holden, 2001, A simple model of payment for order flow, internalization, and total trading cost, Journal of Financial Markets 4, 33–71.

Battalio, Robert, Andriy Shkilko, and Robert Van Ness, 2015, To pay or to be paid? The impact of taker fees and order flow inducements on trading costs in the U.S. options markets, Journal of Financial and Quantitative Analysis, forthcoming.

Bessembinder, Hendrik, 1999, Trade execution costs on Nasdaq and the NYSE: A post-reform comparison, Journal of Financial and Quantitative Analysis 34, 387–407.

Blume, Marshall E., and Michael A. Goldstein, 1997, Quotes, order flow, and price discovery, The Journal of Finance 52, 221–244.

Brolley, Michael, and Katya Malinova, 2012, Informed trading and maker-taker fees in a low-latency limit order market, Working Paper.

Chakravarty, Sugato, Pankaj Jain, James Upson, and Robert Wood, 2012, Clean sweep: Informed trading through intermarket sweep orders, The Journal of Financial and Quantitative Analysis 47, 415–435.

Chao, Yong, Chen Yao, and Mao Ye, 2015, Tick size constraints, two-sided markets, and competition between stock exchanges, Working paper.

Chordia, Tarun, Richard Roll, and Avanidhar Subrahmanyam, 2011, Recent trends in trading activity and market quality, Journal of Financial Economics 101, 243–263.

Colliard, Jean-Edouard, and Thierry Foucault, 2012, Trading fees and efficiency in limit order markets, Review of Financial Studies 25, 3389–3421.

Comerton-Forde, Carole, Terrence, Hendershott, Charles M. Jones, Pamela C. Moulton, and Mark S. Seasholes, 2010, Time variation in liquidity: The role of market maker inventories and revenues, The Journal of Finance 65, 295–331.

Constantinides, George M., 1986, Capital market equilibrium with transaction costs, Journal of Political Economy 94, 842–62.

Copeland, Thomas E., and Dan Galai, 1983, Information effects on the bid-ask spread, The Journal of Finance 38, 1457–1469.

Demsetz, Harold, 1968, The cost of transacting, The Quarterly Journal of Economics 82, 33–53.

Easley, David, Nicholas M. Kiefer, and Maureen O'Hara, 1996, Cream-skimming or profit-sharing? The curious role of purchased order flow, The Journal of Finance 51, 811–833.

Foucault, Thierry, 2012, Pricing liquidity in electronic markets, in Foresight: The Future of Computer Trading in Financial Markets. Final Project Report, The Government Office for Science, Driver Review, 18).

Foucault, Thierry, Ohad Kadan, and Eugene Kandel, 2013, Liquidity cycles and make/take fees in electronic markets, The Journal of Finance 68, 299–341.

Harris, Larry, 2013, Maker-taker pricing effects on market quotations, Working paper.

Holden, Craig W., and Stacey Jacobsen, 2014, Liquidity measurement problems in fast, competitive markets: Expensive and cheap solutions, The Journal of Finance 69, 1747–1785.

Kandel, Eugene, and Leslie M. Marx, 1999, Payments for order flow on Nasdaq, The Journal of Finance 54, 35–66.

Kyle, Albert S., Anna A. Obizhaeva, and Tugkan Tuzun, 2010, Trading game invariance in the TAQ dataset, Working Paper.

Lo, Andrew W., and Jiang Wang, 2000, Trading volume: definitions, data analysis, and implications of portfolio theory, Review of Financial Studies 13, 257–300.

Lutat, Marco, 2010, The effect of maker-taker pricing on market liquidity in electronic trading systems Empirical evidence from European equity trading, Working paper.

Macey, Jonathan R., and Maureen O'Hara, 2005, From markets to venues: Securities regulation in an evolving world, Stanford Law Review 58, 563–599.

Malinova, Katya, and Andreas Park, 2015, Subsidizing liquidity: The impact of make/take fees on market quality, The Journal of Finance 70, 509-536.

Nagel, John C., 2010, Comment Letter. Retrieved from: `http://www.sec.gov/comments/s7-09-10/s70910-19.pdf`.

Panayides, Marios, Barbara Rindi, and Ingrid M. Werner, 2016, Trading fees and intermarket competition, Working paper.

Rochet, Jean-Charles, and Jean Tirole, 2003, Platform competition in two-sided markets, Journal of the European Economic Association 1, 990–1029.

Rochet, Jean-Charles, and Jean Tirole, 2006, Two-sided markets: A progress report, RAND Journal of Economics 37, 645–667.

Skjeltorp, Johannes A., Elvira Sojli, and Wing Wah Tham, 2016, Identifying cross-sided liquidity externalities, Management Science, forthcoming.

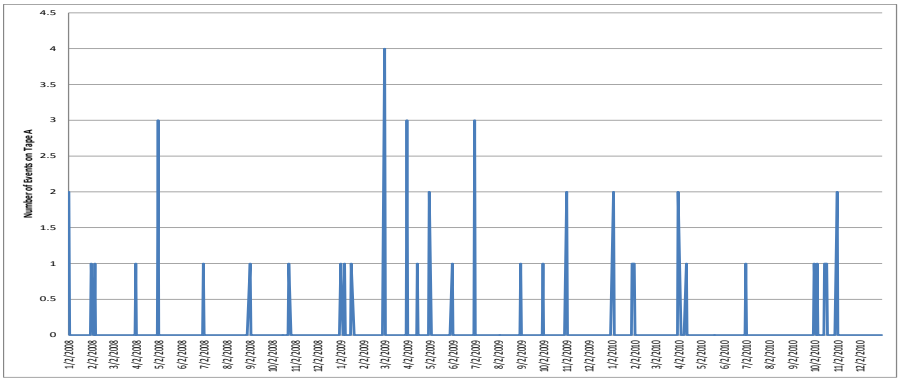
Spicer, Jonathan, 2009, Lure of rebates drives US trading despite selloff, Reuters April 24.

Stoll, Hans R., 1989, Inferring the components of the bid-ask spread: Theory and empirical tests, The Journal of Finance 44, 115–134.

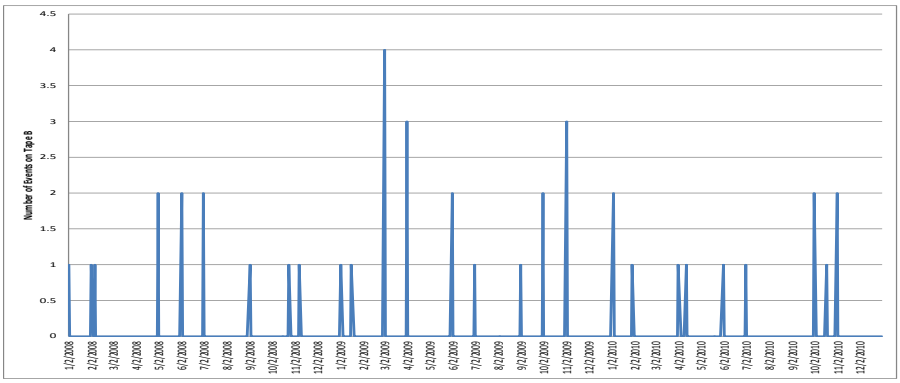
Wooldridge, Jeffrey M., 2002, Econometric analysis of cross section and panel data, The MIT Press, Cambridge, Massachusetts.

Yao, Chen and Mao Ye, 2014, Tick size constraints, market structure, and liquidity, Working Paper.

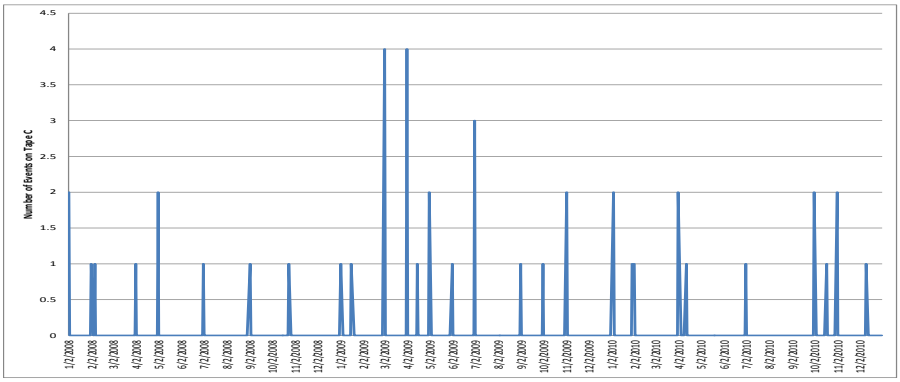
Figure 1. Frequency of Make-Take Fee Change Events, January 1, 2008 – December 31, 2010.



(a) Tape A – Securities listed on the NYSE exchange



(b) Tape B – Securities listed on the NYSE-Arca-, Amex-, and regional exchanges



(c) Tape C – Securities listed on Nasdaq

Table 1. Summary Statistics.

This table reports mean, median, and standard deviation for the fee measures and trading volume for 18,362 daily exchange-tape observations from January 1, 2008 – December 31, 2010. During the sample period the number of registered exchanges varies from 10 to 14. Exchanges have different fee menus for each of the three Tapes of securities, where Tape A includes securities listed on the NYSE exchange; Tape B on the NYSE-Arca-, Amex-, and regional exchanges; and Tape C on Nasdaq. *Nom_Make_Basic* and *Nom_Take_Basic* are the nominal make fee and the nominal take fee, respectively, offered to traders that do not qualify for higher volume-based tiers. *Nom_Total_Basic* is the sum of *Nom_Make_Basic* and *Nom_Take_Basic*. *Nom_Make_Comp* and *Nom_Take_Comp* are the nominal make fee and the nominal take fee, respectively, offered to traders that qualify for the high volume-based tier. *Nom_Total_Comp* is the sum of *Nom_Make_Comp* and *Nom_Take_Comp*. *Rel* stands for "relative-to-rivals" and is estimated as per Eq.(1). All nominal fee measures are in dollars per 100 shares. *Exchange Volume in a Tape* is the daily trading volume on an exchange across all securities that belong to a certain tape in billions of shares. *Tape Volume* is the daily trading volume in a tape aggregated across all exchanges in billions of shares. Detailed variable definitions are provided in Appendix B.

Variable	Mean	Median	St.Dev.
Panel A: Nominal Make, Take, and Total Fees in Dollars per 100 shares			
Nom_Make_Basic	-0.1992	-0.2500	0.1078
Nom_Take_Basic	0.2490	0.3000	0.1022
Nom_Total_Basic	0.0498	0.0400	0.0768
Nom_Make_Comp	-0.2288	-0.2700	0.1137
Nom_Take_Comp	0.2400	0.2800	0.0993
Nom_Total_Comp	0.0112	0.0000	0.0647
Panel B: Relative Make, Take, and Total Fees			
Rel_Make_Basic	0.0000	-0.2600	0.9243
Rel_Take_Basic	0.0000	0.2200	0.9097
Rel_Total_Basic	0.0000	-0.1000	0.6746
Rel_Make_Comp	0.0000	-0.2350	0.9997
Rel_Take_Comp	0.0000	0.1900	0.8861
Rel_Total_Comp	0.0000	-0.0450	0.6106
Panel C: Trading Volume in Billions of Shares			
Exchange Volume in a Tape	0.1818	0.0283	0.2970
Tape Volume	2.3375	1.3742	1.6863

Table 2. Money Transfer Among Exchanges, Makers and Takers.

This table reports upper and lower boundaries of money transfer in millions of dollars among exchanges, makers, and takers for the period January 1, 2008 – December 31, 2010. Panel A reports the upper boundary of money transfer, while Panel B reports the lower boundary of money transfer. Specifically, we multiply the nominal make fee per share, the nominal take fee per share, and the nominal total fee per share for the basic tier by the number of shares traded each day for each exchange-tape – i.e., we assume that all shares are transacted at the basic tier pricing level, which provides us with the upper boundary on money transfer among parties. Similarly, we multiply the nominal make fee per share, the nominal take fee per share, and the nominal total fee per share for the competitive tier by the number of shares traded each day for each exchange-tape – i.e., we assume that all shares are transacted at the competitive tier pricing level, which provides us with the lower boundary on money transfer among parties. We aggregate the data across tapes within each exchange. The observations are exchange-day observations in millions of dollars. The number of the exchange-day observations is 6,727. Column (1) reports the average across all exchange-day observations. For each exchange we aggregate across days and report the average across exchanges in Column (2). The sum across exchanges and all days is reported in Column (3).

	Average Money Transfer in an Exchange on a Day	Average Money Transfer in an Exchange	Total Money Transfer Across Exchanges and Days
	(1)	(2)	(3)
Panel A: Upper Boundary — All Shares Transacted at the Basic Tier			
Takers paid	1.171	562.505	7,875.074
Makers paid	-0.710	-341.410	-4,779.742
Exchanges earned	0.460	221.095	3,095.332
Panel B: Lower Boundary — All Shares Transacted at the Competitive Tier			
Takers paid	1.124	540.389	7,565.454
Makers paid	-0.992	-476.849	-6,675.882
Exchanges earned	0.132	63.541	889.571

Table 3. Total Fees.

This table reports results of four specifications of the baseline regression model in Eq.(2). The exchange-tape observations are in daily frequency and the sample period is January 1, 2008 – December 31, 2010. The dependent variable in all columns is *Volume*, the detrended volume in billions of shares on an exchange-tape. The independent variables of interest are the measures of total fees. *Nom_Make_Basic* and *Nom_Take_Basic* are the nominal make fee and the nominal take fee, respectively, offered to traders that do not qualify for higher volume-based tiers. *Nom_Total_Basic* is the sum of *Nom_Make_Basic* and *Nom_Take_Basic*. *Nom_Make_Comp* and *Nom_Take_Comp* are the nominal make fee and the nominal take fee, respectively, offered to traders that qualify for the high volume-based tier. *Nom_Total_Comp* is the sum of *Nom_Make_Comp* and *Nom_Take_Comp*. *Rel* stands for "relative-to-rivals" and is estimated as per Eq.(1). All nominal fee measures are in dollars per 100 shares. *Tape_Vol* is the detrended daily volume of a tape aggregated across exchanges in billions of shares. Detailed variable definitions are provided in Appendix B. All variables are in changes and specifications include date fixed effects. The p-values are shown in parentheses.

	(1)	(2)	(3)	(4)
Nom_Total_Basic	-0.235			
	(0.012)			
Nom_Total_Comp		-0.223		
		(0.039)		
Rel_Total_Basic			-0.033	
			(0.006)	
Rel_Total_Comp				-0.024
				(0.061)
Tape_Vol	0.081	0.081	0.081	0.081
	(0.000)	(0.000)	(0.000)	(0.000)
N	17,470	17,470	17,470	17,470
R^2	0.4124	0.4123	0.4124	0.4123

Table 4. Make and Take Fees.

This table reports results of four specifications of the baseline regression model in Eq.(3). The exchange-tape observations are in daily frequency and the sample period is January 1, 2008 – December 31, 2010. The dependent variable in all columns is *Volume*, the detrended volume in billions of shares on an exchange in a tape. The independent variables of interest are the measures of make and take fees. The table also reports estimates of the difference between the parameters of the corresponding make fee and take fee. *Nom_Make_Basic* and *Nom_Take_Basic* are the nominal make fee and the nominal take fee, respectively, offered to traders that do not qualify for higher volume-based tiers. *Nom_Total_Basic* is the sum of *Nom_Make_Basic* and *Nom_Take_Basic*. *Nom_Make_Comp* and *Nom_Take_Comp* are the nominal make fee and the nominal take fee, respectively, offered to traders that qualify for the high volume-based tier. *Nom_Total_Comp* is the sum of *Nom_Make_Comp* and *Nom_Take_Comp*. *Rel* stands for "relative-to-rivals" and is estimated as per Eq.(1). All nominal fee measures are in dollars per 100 shares. *Tape_Vol* is the detrended daily volume of a tape aggregated across exchanges in billions of shares. Detailed variable definitions are provided in Appendix B. All variables are in changes and specifications include date fixed effects. The p-values are shown in parentheses.

	(1)	(2)	(3)	(4)
Nom_Make_Basic	-0.177			
	(0.066)			
Nom_Take_Basic	-0.389			
	(0.001)			
Nom_Make_Comp		-0.144		
		(0.198)		
Nom_Take_Comp		-0.392		
		(0.002)		
Rel_Make_Basic			-0.028	
			(0.020)	
Rel_Take_Basic			-0.049	
			(0.000)	
Rel_Make_Comp				-0.019
				(0.159)
Rel_Take_Comp				-0.042
				(0.004)
Tape_Vol	0.081	0.081	0.081	0.081
	(0.000)	(0.000)	(0.000)	(0.000)
N	17,470	17,470	17,470	17,470
R^2	0.4125	0.4125	0.4126	0.4125
Nom_Make_Basic-Nom_Take_Basic	0.212		0.021	
	(0.023)		(0.017)	
Nom_Make_Comp-Nom_Take_Comp		0.249		0.023
		(0.007)		(0.007)

Table 5. Fees and Volume – Binding Quotations.

This table replicates Table 3 and Table 4 but instead of considering all trades across all securities and aggregating them to exchange-tape observations, we aggregate only those transactions that are below the median of the daily individual securities' time-weighted average quoted bid-ask spread in dollars per share on each exchange. Thus, the dependent variable in all regressions is *Vol_Below*, which is the detrended volume in billions of shares, where we consider only shares transacted below the median of the daily individual securities' time-weighted average quoted bid-ask spread in dollars per share on each exchange. The exchange-tape observations are in daily frequency and the sample period is January 1, 2008 – December 31, 2010. The independent variable of interest in Panel A is the total fee and in Panel B is the make fee and the take fee. Panel C reports estimates of the difference between the parameters of the corresponding make fee and take fee in Panel B. *Nom_Make_Basic* and *Nom_Take_Basic* are the nominal make fee and the nominal take fee, respectively, offered to traders that do not qualify for higher volume-based tiers. *Nom_Total_Basic* is the sum of *Nom_Make_Basic* and *Nom_Take_Basic*. *Nom_Make_Comp* and *Nom_Take_Comp* are the nominal make fee and the nominal take fee, respectively, offered to traders that qualify for the high volume-based tier. *Nom_Total_Comp* is the sum of *Nom_Make_Comp* and *Nom_Take_Comp*. *Rel* stands for "relative-to-rivals" and is estimated as per Eq.(1). All nominal fee measures are in dollars per 100 shares. *Tape_Vol* is the detrended daily volume of a tape aggregated across exchanges in billions of shares. Detailed variable definitions are provided in Appendix B. All variables are in changes and specifications include date fixed effects. The p-values are shown in parentheses.

	(1)	(2)	(3)	(4)
Panel A: Total Fee				
Nom_Total_Basic	-0.226			
	(0.010)			
Nom_Total_Comp		-0.224		
		(0.026)		
Rel_Total_Basic			-0.028	
			(0.011)	
Rel_Total_Comp				-0.020
				(0.097)
Tape_Vol	0.074	0.074	0.074	0.074
	(0.000)	(0.000)	(0.000)	(0.000)
N	17470	17470	17470	17470
R^2	0.4069	0.4068	0.4068	0.4068
Panel B: Make Fee and Take Fee				
Nom_Make_Basic	-0.174			
	(0.055)			
Nom_Take_Basic	-0.368			
	(0.001)			
Nom_Make_Comp		-0.149		
		(0.153)		
Nom_Take_Comp		-0.384		
		(0.001)		
Rel_Make_Basic			-0.024	
			(0.033)	
Rel_Take_Basic			-0.044	
			(0.001)	
Rel_Make_Comp				-0.015
				(0.235)
Rel_Take_Comp				-0.038
				(0.006)
Tape_Vol	0.074	0.074	0.074	0.074
	(0.000)	(0.000)	(0.000)	(0.000)
N	17470	17470	17470	17470
R^2	0.4071	0.4071	0.4071	0.4070
Panel C: Differences between the Parameters for Make Fee and Take Fee				
Nom_Make_Basic-Nom_Take_Basic	0.194		0.019	
	(0.025)		(0.015)	
Nom_Make_Comp-Nom_Take_Comp		0.234		0.022
		(0.006)		(0.005)

Table 6. Robustness.

The first two columns of this table replicate Columns (1) and (2) of Tables 3 and 4 with the exception that now we add a dummy variable for event days. The last two columns of this table replicate Columns (1) and (2) of Tables 3 and 4 with the exception that now we keep only observations with non-zero values for the nominal fee change variables. The dependent variable in all columns is *Volume*, the detrended volume in billions of shares on an exchange-tape. The independent variable of interest in Panel A is the total fee and in Panel B is the make fee and the take fee. Panel C reports estimates of the difference between the parameters of the corresponding make fee and take fee in Panel B. *Event_Dummy* is an indicator variable that takes the value of one on days when a fee change occurs and is zero otherwise. *Nom_Make_Basic* and *Nom_Take_Basic* are the nominal make fee and the nominal take fee, respectively, offered to traders that do not qualify for higher volume-based tiers. *Nom_Total_Basic* is the sum of *Nom_Make_Basic* and *Nom_Take_Basic*. *Nom_Make_Comp* and *Nom_Take_Comp* are the nominal make fee and the nominal take fee, respectively, offered to traders that qualify for the high volume-based tier. *Nom_Total_Comp* is the sum of *Nom_Make_Comp* and *Nom_Take_Comp*. All nominal fee measures are in dollars per 100 shares. *Tape_Vol* is the detrended daily volume of a tape aggregated across exchanges in billions of shares. All variables are in changes and explained in Appendix B. The p-values are shown in parentheses.

	(1)	(2)	(3)	(4)
Panel A: Total Fee				
Nom_Total_Basic	-0.247		-0.238	
	(0.008)		(0.038)	
Event_Dummy_Basic	0.015			
	(0.225)			
Nom_Total_Comp		-0.221		-0.222
		(0.040)		(0.086)
Event_Dummy_Comp		-0.005		
		(0.641)		
Tape_Vol	0.081	0.081	0.083	0.084
	(0.000)	(0.000)	(0.000)	(0.000)
N	17470	17470	58	84
R^2	0.4124	0.4123	0.3315	0.3183
Panel B: Make Fee and Take Fee				
Nom_Make_Basic	-0.188		-0.172	
	(0.056)		(0.141)	
Nom_Take_Basic	-0.383		-0.385	
	(0.001)		(0.006)	
Event_Dummy_Basic	0.007			
	(0.584)			
Nom_Make_Comp		-0.130		-0.135
		(0.246)		(0.292)
Nom_Take_Comp		-0.407		-0.428
		(0.001)		(0.004)
Event_Dummy_Comp		-0.013		
		(0.238)		
Tape_Vol	0.081	0.081	0.090	0.089
	(0.000)	(0.000)	(0.000)	(0.000)
N	17470	17470	58	84
R^2	0.4125	0.4126	0.3715	0.3758
Panel C: Differences between the Parameters for Make Fee and Take Fee				
Nom_Make_Basic-Nom_Take_Basic	0.195		0.212	
	(0.045)		(0.069)	
Nom_Make_Comp-Nom_Take_Comp		0.276		0.292
		(0.004)		(0.008)