# *Subsidizing Liquidity: The Impact of Make/Take Fees on Market Quality*[*]

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June 4, 2013

**Abstract**

Competition among stock exchanges has increased dramatically over the last decade. To attract trading volume, most exchanges introduced maker-taker fees, an incentive scheme that rewards liquidity suppliers and charges liquidity demanders. Using a change in fees on the Toronto Stock Exchange, we analyze how the breakdown of trading fees between liquidity demanders and suppliers affects market outcomes. Although posted liquidity improves, after accounting for the fees, trading costs are unaffected. Yet trading behavior changed, and liquidity suppliers benefitted through decreased adverse selection. Our findings thus provide a rationale for the entry of liquidity providing high-frequency trading algorithms in subsequent years.

*JEL Classification: G12, G14.*

*Keywords:* Liquidity rebates, market quality, trading, maker-taker pricing, retail trading

[*]Financial support from the SSHRC (grant number 410101750) is gratefully acknowledged. We thank Gustavo Bobonis, Jean-Edouard Colliard, Hans Degryse, Thierry Foucault, Joel Hasbrouck, Ohad Kadan, Ingrid Lo, Albert Menkveld, Roberto Pascual, Ioanid Rosu, Roger Silvers, Elvira Sojli, Mark van Achter, Jo van Biesebroeck, Martin Wagener, and Gunther Wuyts for insightful discussions and Tayo Akinbiyi, Andrew Bolyaschevets, Michael Brolley, James Cheung, Zuhaib Chungtai, Steve El-Hage, and Nathan Halmrast for valuable research assistance. We gratefully acknowledge many insightful comments from participants at the following conferences and seminars: Toronto, Leuven, Erasmus Rotterdam, VU Amsterdam, HEC Paris, the 2011 NYU Stern Microstructure Meeting, the Edwards Symposium, the 7th Central Bank Workshop on Market Microstructure, the 2011 CNMV Conference on Securities Markets, the 2012 AFA and the 2011 CEA. We also thank attendees of the 2011 TSX Trading Conference and of staff presentations at CIBC, TD Securities, RBC Capital Markets, ScotiaCapital, the Ontario Securities Commission, and Alpha Trading for valuable comments. TSX Inc. holds copyright to the data, all rights reserved. It is not to be reproduced or redistributed. TSX Inc. disclaims all representations and warranties with respect to this information, and shall not be liable to any person for any use of this information.

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The equity trading landscape has changed dramatically over the past two decades, bringing with it a host of new policy concerns. Technological innovation in the 1990s allowed the entry of fully electronic trading platforms, known in the United States as electronic communication networks (ECNs). Subsequent regulatory reforms[1] facilitated the competition among trading platforms, eliminated the privileges of incumbent exchanges, and ultimately forced the incumbents to abandon physical trading floors and become electronic limit order markets.

In a limit order market, a trader can either specify the desired price and quantity by posting a limit order or the trader can accept the terms of a previously posted limit order by submitting a market order. To compete for trading volume, during the last decade most equity trading platforms in North America introduced cash incentives for posting attractively priced limit orders. These cash payments are part of an incentive scheme known as *maker-taker pricing*. Understanding the impact of trading platforms' innovative offerings, such as maker-taker pricing, has become increasingly important in the new competitive environment. In the past, exchanges in North America were non-profit entities with a mandate to serve their members. Facing stiff competition, they converted to shareholder-owned corporations, raising concerns that their profit-motivated "incentive schemes may run counter to the integrity of pricing and investor protection."[2]

In this paper, we empirically analyze the impact of the maker-taker pricing model on market liquidity, trader behavior, and trading volume. The International Organization of Securities Commissions (IOSCO) defines maker-taker fees as "a pricing model whereby the maker of liquidity, or passive [limit] order, is paid a rebate and the taker of liquidity,

[1] Examples are: for the United States Reg. ATS in 1999 and Reg. NMS in 2007; for Canada the ATS Rules (NI 21-101, NI 23-101, and OSC Rule 23-501) in 2001; and for Europe MiFID in 2004.

[2] "Regulatory Role of Exchanges and International Implications of Demutualization" by Roel C. Campos, March 10, 2006, available at `http://www.sec.gov/news/speech/spch031006rcc.htm`.

or aggressive [market] order, is charged a fee."[3] Maker rebates aim to improve liquidity by rewarding its provision and to increase trading volume, yet theoretical studies have shown that they need not affect liquidity and that trading volume may, in fact, decline.

Angel, Harris, and Spatt (2011) argue that introducing a maker rebate that is financed by a taker fee should have no effect, because in competitive markets the prices would adjust by the amount of the rebate. Colliard and Foucault (2012) formalize Angel, Harris, and Spatt's intuition and prove, without relying on perfect competition, that in the absence of frictions, only changes in the *total fee* retained by the exchange affect liquidity and trading volume. Foucault, Kadan, and Kandel (2013), in contrast, show that trading volume may increase or decrease, depending on the model parameters, even in the absence of a change in the total fee, because a fixed tick size prevents prices from neutralizing the effect of the maker rebate.

In this paper, we use the introduction of a maker rebate on the Toronto Stock Exchange to identify whether and how the breakdown of the total exchange fee into the maker rebate and the taker fee affects market liquidity and trading volume. Prior to October 1, 2005, liquidity takers paid 2 basis points of the dollar value of their marketable orders, and liquidity makers incurred no fee or rebate. As of October 1, 2005, the TSX offered a maker rebate of 27.5 cents and a taker fee of 40 cents per 100 shares for a pilot group, which consisted of the TSX-listed securities that were cross-listed with NASDAQ and AMEX. For the remaining securities, the taker fee was 1.8 basis points of the dollar value of the trade, and makers continued to incur no fee or rebate.

The strength of our analysis lies in the structure of the TSX fee change and in the data that we have access to. First, the TSX introduced the new fee system only for a

[3]See "Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency", Consultation Report, July 2011, available at `http://www.iosco.org/library/pubdocs/pdf/IOSCOPD407.pdf`. The SEC (2010) offers a similar definition.

pre-defined subset of securities, permitting an analysis of the impact with a difference-in-differences approach that uses the unaffected securities as a control group. Second, the data is granular at the trader level, allowing us to identify changes in traders' market and limit order submission strategies. Third, the shift from per-dollar to per-share fees generated heterogeneity in the fee change depending on the price of the stock: the total fee declined for high-priced stocks and it increased for low-priced stocks. To address the impact of the maker-taker model, we focus on a subset of securities in the pilot group with prices such that the post-change total fee of 12.5 cents per 100 shares was close to the 1.8 basis point total fee of the unaffected group. Any change observed for this "fee-neutral" group can then be attributed to the breakdown of the total fee into the maker rebate and taker fee.

The null hypothesis, based on Colliard and Foucault (2012), is that liquidity measures that account for exchange fees would be unaffected for the fee-neutral group. Consistent with the null-hypothesis, the "cum-fee" trading costs, measured by the effective bid-ask spread plus (twice) the taker fee, did not change, even though the "raw" bid-ask spread, which does not include the taker fee, declined. While we find support for Colliard and Foucault's notion that prices adjust, we also observe that the "cum-fee" realized spreads increased. The latter measure is the portion of the cum-fee effective spread that proxies for liquidity providers' revenues, accounting for the maker rebate. The remaining portion of the cum-fee effective spread compensates the liquidity provider for adverse price movements after the trade and it is referred to as the price impact. We observe a decline in the price impact, and we attribute the increase in the cum-fee realized spreads to a decline in adverse selection (which does not feature in Colliard and Foucault (2012)).

Existing theoretical work on informed trading in limit order books provides some

intuition for the decline in adverse selection. For instance, in Kaniel and Liu (2006) and Rosu (2012), better-informed traders use market orders, while less-informed traders use limit orders. If, after the fee change, traders switch from limit to market orders, then the average information content of a market order, and thus the price impact, may decline. At first sight, our empirical results provide no economic justification for such a switch, because cum-fee effective spreads do not change. In practice, however, traders often do not pay maker-taker fees directly, and instead pay only a flat fee to their broker.[4] Such traders would base their limit vs. market order choice on "raw" rather than "cum-fee" quoted spreads. As quoted spreads decline, market orders become relatively cheaper for these traders and, ceteris paribus, these traders would indeed switch from limit to market orders. In Brolley and Malinova's (2012) theoretical model of informed limit order trading, this behavior is an equilibrium outcome.

One group of traders that commonly pays flat commissions are retail traders. Exploiting our trader-level data, we classify traders as retail when they use small orders frequently and have limited short-selling activity. Indeed, we find that for retail traders, the number of passive trades as a fraction of all trades and the number of passive limit orders as a fraction of all orders both decrease.

Retail traders are, arguably, the least sophisticated group of market participants. The observed change in their order submission strategies raises questions about additional redistributive effects of maker-taker fees from less to more sophisticated traders.[5]

[4]Brokers do not consistently pass on maker-taker fees to their customers, and they generally do not pass these fees to retail clients but charge them a flat commission ("$9.99 per trade"). See, e.g., TD Securities' comment letter to the OSC, at `http://www.osc.gov.on.ca/documents/en/Securities-Category2-Comments/com_20110117_23-405_pankod.pdf`.

[5]The popular press repeatedly criticized maker rebates for their alleged redistributive effects. See, for instance, the Globe and Mail (a major Canadian National newspaper) which asserted that "the money [to pay for the rebates] often comes out of the retail investors' pocket."(*Globe and Mail*, "Small investors pay the price for high-frequency trading", January 31, 2011, by Boyd Erman.)

Studying changes in traders' total costs, measured by the volume-weighted difference of paid cum-fee effective spreads for aggressive trades and received cum-fee realized spreads for passive trades, we find no evidence that the introduction of the maker rebates disadvantaged retail traders during our sample period.

Our paper contributes to the literature that studies transaction costs and exchange fees. Barclay, Kandel, and Marx (1998) empirically study the effect of changes in bid-ask spreads on volume and prices and find that higher transaction costs reduce trading volume. Lutat (2010) argues that the Swiss Stock Exchange's removal of a maker fee (without changing the taker fee) did not affect quoted spreads. Cardella, Hao, and Kalcheva (2012) study a number of make-take fee changes in the U.S. from 2008 to 2010. They find that an exchange's total fee relative to that of other exchanges affects the exchange's trading volume, and that a change in the taker fee has a stronger effect than a change in the maker fee. Differently to our work, they find no effect of the split of the total fee into maker rebates and taker fees on quoted spreads. It is our understanding, however, that in Lutat (2010) and Cardella, Hao, and Kalcheva (2012) changes in the maker-taker fees are accompanied by changes in the total fee.

Maker-taker fees relate to payments for order flow, see, e.g., Kandel and Marx (1999), Battalio and Holden (2001), or Parlour and Rajan (2003). These payments are typically made by market makers (not trading platforms), they are often contingent on a type of order flow (e.g., retail), and they thus differ economically from of maker-taker fees. Anand, McCormick, and Serban (2012) and Battalio, Shkilko, and Van Ness (2012) compare market quality under maker-taker pricing and payment for order-flow systems for U.S. options markets.[6]

[6] In U.S. options markets, payments for order flow are financed by market makers, but they are commonly administered by the option exchanges.

The rest of the paper is organized as follows. Section I discusses theoretical work that guides the analysis. Section II reviews trading on the TSX and the details of the fee change. Section III describes the data, the sample selection, and the regression methodology. Section IV summarizes our main findings on market quality and, in particular, on the costs of takers and revenues for makers. Section V describes our results on volume and fill rates. Section VI studies the behavior of retail traders. Tables and figures are appended. The Internet Appendix contains further details on some measures, the selection of the fee neutral securities, and results from additional regression specifications.

# I Theoretical Predictions

To the best of our knowledge, there are three theoretical studies that focus on the impact of maker-taker fees. Colliard and Foucault (2012) provide a theoretical benchmark in the absence of market frictions; Foucault, Kadan, and Kandel (2013) and Brolley and Malinova (2012) introduce market frictions.

Colliard and Foucault (2012) emphasize, in particular, the importance of distinguishing between a change in the breakdown of the total exchange fee into a maker rebate and a taker fee from the change in the total exchange fee, because only changes in the latter are economically meaningful. If an exchange introduces a maker rebate and finances it by an increased taker fee, without changing the total fee, ceteris paribus, placing a market order becomes relatively more expensive than trading with a limit order. When some traders switch from market to limit orders, each limit order's execution probability declines and traders will improve quotes to attract matches for their limit orders. Absent frictions, the benefit from maker rebates will be exactly offset by the narrowed bid-ask spread. Consequently, changes in the split of the total fee between makers and takers

should not affect trading behavior.

Focussing on the impact of changes in the total exchange fee, Colliard and Foucault (2012) show that these changes affect a trader's choice of an order type, and that an increase in the total fee can lead to an increase or a decrease in the trading volume, depending on the parameters. We thus use the following empirical predictions as the null hypothesis in our empirical analysis:

**Empirical Predictions 1 (Benchmark)**

1. *Holding the total exchange fee constant,*
   (a) *the raw quoted and effective spreads decrease;*
   (b) *the cum-fee effective spread (spread plus (twice) the taker fee) is unaffected;*
   (c) *the price impact is unaffected;*
   (d) *volume is unaffected.*
2. *An increase (decrease) in the total exchange fee leads to an increase (decrease) in the cum-fee effective spread.*
3. *Changes in the total exchange fee affect volume and the ratio of market to limit orders.*

Foucault, Kadan, and Kandel (2013) show that the split of the total fee between makers and takers becomes economically meaningful when the minimum tick size restricts adjustments of the bid and offer prices. Exchanges can then increase the trading rate by using maker-taker fees to balance the activities of liquidity makers and takers. Foucault, Kadan, and Kandel (2013) further predict that makers' and takers' activities reinforce each other, highlighting a liquidity externality. This prediction is supported empirically in Skjeltorp, Sojli, and Tham (2013), and it is not the focus of our study.

Brolley and Malinova (2012) argue that the breakdown of the total fee into a maker rebate and a taker fee is not neutral if some traders only pay them on average, e.g.,

through a flat commission to their brokers. In their model (similarly to Kaniel and Liu (2006) and Rosu (2012)) better-informed traders use market orders, less-informed ones use limit orders. As the raw spread declines, a trader who pays a flat commission ("$9.99 per trade") would find a market order relatively more attractive. Since traders who switch from limit to market orders are less-informed than original market order submitters, the price impact of a market order declines.

**Empirical Predictions 2 (Maker-Taker Breakdown: Flat Commissions)**

*For a constant total fee, in presence of flat commissions, as the maker rebate increases,*

1. *the price impact of trades, the raw quoted spread, and the cum-fee effective spread decrease;*
2. *volume increases;*
3. *traders who pay flat commissions submit relatively more market orders than limit orders.*

Flat commissions are common practice for retail traders. We thus expect that retail traders in particular will submit more market orders relative to limit orders as raw quoted spreads decline.

In practice, when a trading platform changes its fees, the change often affects both the total fee and the breakdown into the maker and taker fees. A key feature of the TSX experiment is the heterogeneity of changes in the total fee across securities. This heterogeneity allows us to identify a group of securities for which the change in the total fee is minimal and to isolate the effect of the change in the total fee from that of the change in the maker-taker breakdown.

# II The Toronto Stock Exchange and its Trading Fees

## A Trading on the TSX

For our sample period in 2005, the Toronto Stock Exchange (TSX) was the sixth largest exchange world-wide in terms of market capitalization of traded securities and twelfth largest in dollar trading volume.[7]

The TSX operates as an electronic limit order book that generally follows the so-called price-time priority: orders are sorted first by their price ("price priority") and then, in case of equality, by the time of the order arrival (earlier orders have "time priority").[8] Transactions occur when the price of a buy limit order matches or exceeds the price of a sell limit order. In what follows we will use the term "active order" for the marketable portion of an order, and we use "passive order" for the standing limit order that is hit by an active order.

## B Details of the Change in Trading Fees

The TSX phased in maker rebates on two discrete dates, introducing them on October 1, 2005 for the TSX companies that were cross-listed on NASDAQ or AMEX (the TSX uses the term "inter-listed"), and on July 1, 2006 for all remaining companies. Fees for stocks that were cross-listed on the NYSE were the same as for the TSX-only companies. We focus on the 2005 change of fees.[9]

[7] Source: *World Federation of Exchanges*.

[8] The TSX also allows broker priority in the sense that a passive order submitted by the same broker as the incoming active order has priority over earlier submitted orders at the same price. Broker preferencing is, however, immaterial for our analysis.

[9] We restrict attention to the 2005 change for two reasons: first, in 2006 there was a substantial change in the total exchange fee simultaneously with the switch to a maker-taker fee structure. Second, a difference-in-differences analysis in 2006 has less statistical power because the treatment group, non-crosslisted securities, is much larger than the control group, cross-listed securities.

At the time of its introduction, the 2005 fee change was planned as a one year trial. The TSX did not formally provide reasons for the particular choice of the new fee structure, nor did they explain their choice of the trial group. It is our opinion that the TSX wanted to match the maker-taker pricing that had been introduced on NASDAQ earlier in 2005, in order to remain competitive in the trading of cross-listed securities. While the affected group is not randomly selected, it is, arguably, an exogenous group.

Prior to October 1, 2005, all TSX securities were subject to so-called value-based pricing, under which the active side of each transaction incurred a fee of 2 basis points (1/50 of 1%) of the dollar value of the trade, and the passive side incurred no fee or rebate. On October 1, TSX-listed securities that were also cross-listed with NASDAQ and AMEX switched to so-called volume-based pricing. For each traded share the active side had to pay \$.004 and the passive side obtained a rebate on its exchange fees of \$.00275. All other securities remained at the prevailing regime, but the fees were slightly reduced — after October 1, active orders incurred a fee of approximately 1.8 basis points (1/55 of 1%) of the dollar value of the trade and passive orders remained free.[10]

Exchange fees under value based pricing depend on the price of the underlying stock, under volume based pricing they do not. Compared to the value based pricing model, securities that trade below \$6.875 incur a higher total fee under the the new volume based pricing model.[11] Figure 1 illustrates the different fees as functions of the stock price. The figure further illustrates that the change in the total fee across different securities is monotone in the security price. We exploit the differential change in fees to isolate the

[10] The SEC capped taker fees in the U.S. in August 2005 to be no larger than \$.003 per share. To this date there is no regulated fee cap in Canada, but by now fees have declined. Adjusted by the exchange rate (≈1.2 Canadian dollars per 1 U.S. dollar in 2005), the taker fee in Canada was slightly larger than the SEC cap.

[11] Total fees coincide for the price $p = \$6.875$, which solves $p \times 1/55 \times 1\% = (\$.004 - \$.00275)$. Active fees coincide for the price $p = \$22$, which solves $p \times 1/55 \times 1\% = \$.004$.

impact of the change in the total exchange fee from the impact of the change in the breakdown of this total fee into a maker rebate and a taker fee. We acknowledge, however, that the switch from value based to volume based pricing may lead to behavioral changes for which we have no theoretical predictions. From the institutional perspective, we expect that the brokers understood both billing systems because most Canadian brokers deal both in the U.S. and in Canada, and the U.S. already had volume-based pricing.

# III Data, Sample Selection, and Methodology

## A Data Sources

Our analysis is based on a proprietary trader-level dataset, provided to us by the Toronto Stock Exchange (TSX). Data on market capitalization, monthly volume, splits, and crosslisting status is obtained from the monthly TSX e-Reviews publications. Data on the CBOE's volatility index VIX is from the CBOE database within WRDS.

We analyze the effect of the fee structure change during a 4 month window (2 months before and 2 months after the introduction of maker-taker pricing), from August 1, 2005 to November 30, 2005. This event window includes the first month plus the month following the first monthly trading fee bill. We exclude U.S. Thanksgiving and Black Friday, and October 11 and November 21 due to errors in the raw data. On August 29, 2005, about one month before our event date, Reg NMS Rule 301(b)(5) of Regulation ATS [2] under the Exchange Act (the "Fair Access Rule") became effective. When we reduce the sample period to one month before and after the event, our results remain qualitatively unaffected.[12]

[12] We found no other events for NASDAQ, based on a search of `www.federalregister.gov`; Cardella, Hao, and Kalcheva (2012) kindly shared their data on exchange fee changes, and there were no NAS-

Our data includes all information on order submissions and trades, including price, volume, and a unique identifier for the trader that submitted the order. We restrict attention to transactions that occurred in the limit order book during regular trading hours and we exclude, for instance, opening trades, dealer crosses, and trades that occur outside normal trading hours. For each limit order book transaction the data specifies the active (liquidity demanding) and passive (liquidity supplying) party, thus each trade is identified as either buyer- or seller-initiated. Finally, the data contains all updates on the best bid and ask quotes as well as the depth at the best quotes.

## B Sample Selection

Out of the 3,000+ symbols that trade on the TSX, we focus on common stocks that trades on the main exchange, and allow companies with dual class shares.[13] We require that the companies had non-zero volume in July 2005, according to the TSX e-Review, and were continuously listed between July 2005 and November 2005. We exclude securities that during the event window from August to November had stock splits, that were under review for suspension, that had substitutional listings, that had days with an average midpoint below $1, and that had less than 10 transactions per day on more than 5% of the trading days. Finally, we exclude Nortel because it was involved in a high profile accounting scandal at the time of our sample period (along with Worldcom and Enron).

We determine a company's cross-listed status from the TSX e-Reviews, where we require that a company is cross-listed with NASDAQ or AMEX from August to November 2005. Companies that changed their cross-listing status during the sample period

DAQ/AMEX related events during our sample period.

[13] In the Canadian market, as of August 2005, an estimated 20-25% of companies listed on the TSX made use of some form of dual class structure or special voting rights, whereas in the United States, only about 2% of companies issue restricted voting shares (see Gry (2005)).

or for which the cross-listing status was ambiguous are omitted from the sample.

We are then left with 65 NASDAQ and AMEX cross-listed companies and 180 TSX only and NYSE cross-listed companies. In what follows, we will refer to companies that are cross-listed with NASDAQ and AMEX as "cross-listed", and we will refer to companies that are listed only on the TSX or that are cross-listed with NYSE as "non-crosslisted".

## C Matched Sample

We construct the matched sample as follows. Using one-to-one matching without replacement, we determine a unique non-crosslisted match for each of the cross-listed securities based on closing price, market capitalization, and the level of competition for liquidity provision, as measured by the Herfindahl Index.[14]

Davies and Kim (2009) argue that one-to-one matching without replacement based on closing price and market capitalization is the most appropriate method to test for differences in trade execution costs. We additionally include a measure of competition as a matching criterium, for three reasons. First, our treatment group, the cross-listed securities, is not a random sample, and liquidity provision in the average cross-listed stock is systematically more competitive than in the average TSX-only stock, even controlling for market capitalization.[15] Second, the focus of this study is not only on trade execution costs but also other variables that are affected by competition, such as trader

[14] We compute the Herfindahl Index based on the brokers' shares of passive volume; the details are in the Internet Appendix. Weston (2000), Ellis, Michaely, and O'Hara (2002) and Schultz (2003) use the Herfindahl Index of market concentration to assess competition for market making in dealer markets; their indices are based on NASDAQ dealers' shares of volume.

[15] Taking matches only from the group of NYSE cross-listed stocks would generate very poor matches since NYSE cross-listed companies are much larger and trading in these stocks is much more competitive than NASDAQ/AMEX cross-listed companies. Our matched sample does contain some stocks that are cross-listed with NYSE, but only those that are comparable.

behavior.[16] Finally, we aim to identify the impact of the introduction of maker rebates, and Foucault, Kadan, and Kandel (2013) predict that the impact is affected by the competition among traders.

We randomize the order of matching by sorting the stocks in the treatment group (i.e. the cross-listed securities) alphabetically by ticker symbol. The match for each treatment group security $i$ is then defined to be a control group security $j$ that minimizes the following matching error:

$$matcherror_{ij} := \left|\frac{p_i - p_j}{p_i + p_j}\right| + \left|\frac{MC_i - MC_j}{MC_i + MC_j}\right| + \left|\frac{HHI_i - HHI_j}{HHI_i + HHI_j}\right|, \tag{1}$$

where $p_i$, $MC_i$, and $HHI_i$ denote security $i$'s July 2005 closing price, market capitalization as of the end of July 2005, and the average July 2005 value of the Herfindahl Index at the broker level, respectively. The list of cross-listed companies and their matches is in the Internet Appendix; summary statistics for both groups are in Table I.

## D Panel Regression Methodology

We employ a methodology that is similar to that in Hendershott and Moulton (2011). For each security in our sample and for each match, we compute a number of daily liquidity and market activity measures. Our panel regression analysis employs a difference in differences approach and thus controls for market-wide fluctuations. As dependent variables in our regression we use the day $t$ realization of the measure for cross-listed security $i$ less the realization of the measure for security $i$'s non-crosslisted match.

As Colliard and Foucault (2012) emphasize, one must differentiate between changes

[16] When matching only on price and market capitalization, the results for most liquidity measures, including spreads (the variable of interest in Davies and Kim (2009)), are similar.

in the total fee and changes in the breakdown between maker and taker fees. We split the securities into three sub-samples with respect to the change in the total fee, relative to the post change total fee of 1.81 basis points for the control group. The goal was to identify a group of securities for which average change in the total fee is zero and which contains the same number of stocks with (small) fee increases and decreases. This group contains 22 securities, with July 2005 closing prices between \$4.36 and \$12.05. We refer to it as the *fee neutral* group of securities. An observed change for this group can be attributed to the breakup of the total fee into the maker rebate and the taker fee because the total fee for the group does not change relative to the control group.

We present our results for two regression specifications. In the first, we employ the following stock level controls: the July 2005 share turnover (volume over shares outstanding), the July 2005 standard deviation of daily mid-price returns, and, relating to the matching variables, the log of the July 2005 closing price, the log market capitalization (based on the July 2005 closing price), and the average July 2005 Herfindahl-index for liquidity provision. We include the market capitalization and price as controls to capture heterogeneity across matched pairs that arises because the fee change differs by price. Furthermore, we include the daily realization of the CBOE volatility index VIX to control for market-wide volatility that affects trading variables across time and that is not captured by the difference-in-differences approach. In particular, cross-listed securities may react more to U.S. market movements and the VIX, which is U.S. based, helps to control for these possible differences. The second specification employs stock fixed effects and the volatility index VIX.[17] For each measure, we run the following regression

[17] In the Internet Appendix, we provide the results from two additional specifications: the first uses no stock level controls, no fixed effects, and no VIX; the second uses firm fixed effects and no VIX. The estimation results are similiar.

$$
\begin{aligned}
\textit{dependent variable}_{it} \;=\; & \beta_0 + \beta_1 \textit{fee change}_t \times \textit{fee decrease group}_i \\
& + \beta_2 \textit{fee change}_t \times \textit{fee neutral group}_i \\
& + \beta_3 \textit{fee change}_t \times \textit{fee increase group}_i \\
& + \beta_4 \textit{fee decrease group}_i + \beta_5 \textit{fee neutral group}_i \\
& + \beta_6 \mathsf{VIX}_t + \sum\nolimits_{j=1}^{5} \beta_{6+j} \textit{control variable}_{ij} + \epsilon_{it},
\end{aligned} \tag{2}
$$

where *dependent variable*$_{it}$ is the day $t$ realization of the measure for treatment group security $i$ less the realization of the measure for the $i$th control group match; *fee change*$_t$ is a dummy variable that is 1 after October 1 2005 and 0 before; $\mathsf{VIX}_t$ is the closing value of CBOE's volatility index for day $t$, and *control variable*$_{ij}$ are the above mentioned security level control variables, where applicable. Dummy variables *fee decrease group*$_i$, *fee neutral group*$_i$, and *fee increase group*$_i$ indicate the sub-sample group with respect to the total fee change that security $i$ belongs to.

We conduct inference in all regressions in this paper using double-clustered Cameron, Gelbach, and Miller (2011) standard errors, which are robust to cross-sectional correlation and idiosyncratic time-series persistence,[18] with and without stock fixed effects. For brevity we display only the estimated coefficients $\beta_1$, $\beta_2$, and $\beta_3$ on the interaction terms for the fee change groups. The tables further list results for tests of differences in these coefficients.

[18] Cameron, Gelbach, and Miller (2011) and Thompson (2011) developed the double-clustering approach simultaneously. We follow the former and employ their programming technique. See also Petersen (2009) for a detailed discussion of (double-) clustering techniques.

# IV Market Quality

## A Trading Costs Excluding Exchange Fees

We first study the impact of the maker-taker fees on standard liquidity measures. We measure quoted liquidity using daily time weighted quoted spreads and depth, and we capture the conditions that traders decided to act upon by analyzing the effective spread. We express the spread measures in basis points as a proportion of the prevailing quote midpoint. The *quoted spread* is the difference between the lowest price at which someone is willing to sell, or the best offer price, and the highest price at which someone is willing to buy, or the best bid price. The *effective spread* is twice the difference between the transaction price and the midpoint of the bid and offer quotes at the time of the transaction, specifically,

$$espread_{ti} = 2q_{ti}(p_{ti} - m_{ti})/m_{ti}, \tag{3}$$

where $p_{ti}$ is the transaction price, $m_{ti}$ is the midpoint of the quote prevailing at the time of the trade, and $q_{ti}$ is an indicator variable, which equals 1 if the trade is buyer-initiated and $-1$ if the trade is seller-initiated. Our data reports the prevailing quotes, and it also contains a marker that signs each trade as buyer or seller initiated.

The *dollar depth* is defined as the average dollar amount that can be traded at the bid and the offer. We use logarithms of the depth to ensure a more symmetric distribution since several Canadian companies, particularly, non-crosslisted ones, historically have very large depth. High liquidity refers to large depth and small spreads.[19] Pre-sample summary statistics for spread and depth are in Table I.

**Results.** Figure 2 shows a marked decline in the quoted spread after the event

[19] In the Internet Appendix, we present the results on spreads measured in cents and depth measured in shares; the results are similar.

date and an increase in the dollar depth for the fee-neutral securities. The left panel in Figure 3 illustrates a similar decline for the effective spread. The panel regression results for the change in the quoted spread and depth in dollars are in Table III; results for the effective spread are in the first column of Table IV.

**Empirical Observation 1** *For the fee-neutral securities, quoted and effective spreads decline by 16 and 10 basis points, respectively, quoted depth increases, by around 13%. The declines in the quoted and effective spreads for the group with the increased total fee are stronger than that for the group with the decreased total fee.*

The result on the quoted and effective spreads for the fee-neutral securities is consistent with the theoretical predictions that prices adjust to accommodate the increased taker fee. The difference in the spread changes across groups of securities is consistent with Colliard and Foucault (2012), who predict that the quoted and effective spread decline as the taker fee increases. Figure 1 illustrates that for our TSX experiment, changes in the total fee are monotonically related to changes in the taker fee, because both these fees increased stronger for the lower priced securities. Securities with the increased total exchange fee also experienced the highest increase in the taker fee, whereas the group of securities with the decreased total exchange fee experienced the smallest increase in the taker fee (and a decline for all securities with prices above $22).[20]

## B Cum-Fee Trading Costs

We follow Colliard and Foucault (2012) and define the *cum-fee effective spread* as the effective spread plus twice the taker fee, normalized by the prevailing midpoint. This

[20] Table XI in the Internet Appendix provides regression results for subsamples of securities, split by changes in the taker fee.

measure reflects the cost to a liquidity taker for a round-trip transaction, accounting for the taker fees. Figure 3 and the panel regression coefficients from column 2 in Table IV illustrate the following observation.

**Empirical Observation 2** *For the fee-neutral securities, the cum-fee effective spread remains unaffected. The cum-fee effective spreads increase for the group of securities with the increased total fee, and this change is significantly different from the (insignificant) change for the group of securities with the decreased total fee.*

Our findings on the cum-fee effective spread support the null-hypothesis (Empirical Predictions 1) that prices adjust to effectively neutralize the maker-taker breakdown. Results on the changes in the cum-fee effective spread across different groups of securities support Colliard and Foucault (2012)'s predictions on the impact of the total exchange fee.

## C Price Impact and Liquidity Providers' Revenues

The effective spread can be decomposed as the sum of the *price impact* and the *realized spread*. The price impact measures the change in the midpoint five minutes after the transaction:

$$price\ impact_{ti} = 2q_{ti}(m_{t+5\ \mathrm{min},i} - m_{ti})/m_{ti}. \tag{4}$$

The price impact reflects the portion of the transaction costs that is due to the presence of informed liquidity demanders. A decline in the price impact indicates a decline in adverse selection and an improvement in liquidity. The realized spread reflects the portion of the transaction costs that is attributed to liquidity provider revenues. The five-minute realized spread assumes that liquidity providers are able to close their positions at the

midpoint five minutes after the trade, and it is defined as:

$$rspread_{ti} = 2q_{ti}(p_{ti} - m_{t+5\ \mathrm{min},i})/m_{ti}, \tag{5}$$

We further define the *cum-fee realized spread*, which accounts for the exchange fees, as the realized spread plus twice the maker rebate. Panel regression results in columns 3-5 of Table IV yield the following observations.

**Empirical Observation 3** *For the fee-neutral securities, the price impact decreases by 11 basis points, the realized spread is unaffected, and the cum-fee realized spread increases by 9 basis points. There are no statistically significant differences in the price impact changes across different groups of securities.*

The change in the price impact and the cum-fee realized spread indicate that, although prices adjust with changes in the maker-taker breakdown, the effect of the breakdown is not neutral. Instead, our finding on the price impact suggests that the introduction of the maker rebate led to a decline in adverse selection, consistent with Brolley and Malinova (2012).

They further predict a decline in the cum-fee effective spread, which we do not find. The predicted decline in their paper stems, however, from the perfect competition in liquidity provision in their model: if liquidity providers earn zero profits, then any benefit from a decline in adverse selection is fully captured by the liquidity demanders. The increase in the cum-fee realized spread in our study suggests that the benefit of the lower adverse selection was instead captured by the liquidity providers.

# V Trading Volume and Fill Rates

To test theoretical predictions on trading activities, we study the dollar trading volume, the number of transactions, and the fill rate for limit orders, which we measure by the number of market orders as a fraction of the sum of all orders (market and limit).[21] Table I displays some pre-sample summary statistics for volume. Panel regression results in Table V yield the following observations.

**Empirical Observation 4** *For the fee-neutral securities, share volume, dollar volume, the number of transactions, and the fraction of market orders increase; the change in volume is only significant at the 10% level. The change in the fill rate is inversely related to the change in the total exchange fee, and there are no statistically significant differences in the trading volume changes across different groups of securities.*

Our results on the change in trading volume and the fill rate for the fee-neutral securities are consistent with Brolley and Malinova (2012), who predict that as quoted spreads decline, traders who face flat broker commissions submit more market and fewer limit orders. The increase in trading volume is also consistent with Foucault, Kadan, and Kandel (2013), who predict that a change in the division of gains from trade between makers and takers affects traders' monitoring activities and consequently trading volume.[22] Finally, our findings on the impact of the total exchange fee are consistent with Colliard and Foucault (2012) who predict that changes in the total fee causally affect makers' limit order pricing strategies and the probabilities of limit order executions.

[21] Our data provides information on orders that contain marketable portions. If only a portion of an incoming order is executed immediately, and the remainder is placed in the limit order book, e.g., because there is not enough depth, the marketable portion adds to the market order count and the "booked" portion adds to the limit order count. A modified limit order adds to the limit order count.

[22] Table X in the Internet Appendix provides evidence that traders change their quoting behavior, consistent with Foucault, Kadan, and Kandel (2013)'s predictions that traders' monitoring activities are affected by changes in the maker-taker breakdown of the total fee.

# VI Behavior and Trading Costs of Retail Investors

In the remainder of the paper, we focus on the group of retail traders. We are interested in retail traders for two reasons.

First, these traders likely pay exchange fees through a flat commission to their brokers. If flat commissions contribute to the non-neutrality of the split of the total fee into maker rebate and taker fee, then we would expect that the ratio of market to limit orders increases for these traders. Second, retail traders are arguably the least sophisticated group in the market, and it is important to understand whether maker-taker fees have redistributive effects among traders with different degrees of sophistication. Our results on changes in the fill rate support theoretical predictions that maker-taker fees affect traders' order submission strategies. If, as a result of these changes, retail traders indeed trade more with marketable orders and thus pay the bid-ask spread cost more frequently, then their total trading costs may increase.

**Classification.** Our data contains unique identifiers for parties that submit orders and trades to the TSX. Brokers typically funnel particular types of order flow through dedicated unique identifiers. For instance, they may send their retail flow through one identifier, use another for their proprietary desk, have one for their institutional flow, and have designated identifiers for the clients that they allow to access the market directly (so-called direct market access (DMA) clients). Our data does not explicitly identify the source of the order flow, and we classify trader identifiers by their trading characteristics.

Specifically, we assert that *retail* flow would contain a relatively high fraction of small transactions, and we use odd-lot trades, which are trades for less than 100 shares, in our classification. Differently to the U.S., in Canada odd-lot orders are always active and incur taker fees, they are filled by the registered trader (a designated market maker),

and they do not interact with the limit order book. There is thus no benefit (real or perceived) in submitting odd-lot orders instead of round-lot (in multiples of 100 shares) orders, and odd-lots cannot be used in order splitting strategies.[23]

Odd-lots may, however, be used by sophisticated traders, for instance, for ETF arbitrage strategies. We conjecture that such traders also likely use short sales in their strategies, whereas retail clients may not be able able to short stock easily. We thus additionally require that traders classified as retail have only limited short-sale activity.

Formally, a unique identifier is classified as trading on behalf of a retail client if for the aggregate trading activity over the sample period this identifier (*i*) has a fraction of odd-lot transactions above 1% of the total intra-day transactions (we also used a 5% threshold, with similar results), (*ii*) is a client account (as opposed to, say, inventory or equity specialist), and (*iii*) has short sale volume as a share of its total sale volume below 10%.

We perform our analysis based on all unique identifiers that appear in our data for the August-November sample period. Of these 2,833 traders, we classify 337 as retail traders; the remaining traders are classified as non-retail.

We aim to analyze the redistributive effects of the maker-taker fees, allowing for the possibility that traders change their strategies. We thus compute, for each trader group (retail and non-retail) per day per stock, the *total trading costs* by adding the cum-fee effective spread each time the trader is on the active side and subtracting the cum-fee realized spread each time a trader is on the passive side. For consistency with the rest of our analysis, we exclude odd-lot trades when computing trading costs. We

[23]See O'Hara, Yao, and Ye (2011) for an analysis of odd-lot trades in the U.S.. They discuss, in particular, that on U.S. trading venues odd-lots can be used to "ping" for fully hidden orders and that odd-lot trades are not reported on the consolidated tape. TSX trading rules specifically prohibit splitting large orders into multiple odd-lots on trades for the same account (currently, TSX Trading Rules, Policy 4-802; formerly, Section 5.1 of the Equities Manual).

volume-weight this measure to compute the average cost per share traded for each group. Analogously to equations (2), we estimate

$$\begin{aligned} \textit{dependent variable}_{it} &= \beta_0 + \sum\nolimits_{j=1}^{3} \beta_j \times \textit{fee change}_t \times \textit{retail}_i \times \textit{fee change group}_i \\ &\quad + \sum\nolimits_{j=4}^{6} \beta_j \times \textit{fee change}_t \times \textit{non-retail}_i \times \textit{fee change group}_i \\ &\quad + \sum\nolimits_{j=7}^{9} \beta_j \times \textit{group dummies}_i + \beta_{10} \times \mathsf{VIX}_t \\ &\quad + \sum\nolimits_{j=1}^{5} \beta_{10+j} \times \textit{control variable}_{ij} + \epsilon_{it}, \end{aligned} \tag{6}$$

where $\textit{fee change}_t$ is the fee change dummy, $\textit{retail}_i$ is a dummy that is 1 if the dependent variable pertains to retail traders, and $\textit{non-retail}_i$ is 1 if the dependent variable does not pertain to retail traders, and $\textit{fee change group}_i$ is an abbreviation for the three dummies for the fee-increase, fee-decrease and fee-neutral groups. We include the volatility index VIX and the same $\textit{control variables}_{ij}$ as in (2). The main coefficient of interest is $\beta_2$, the coefficient on $\textit{fee change}_t \times \textit{retail}_i \times \textit{fee neutral group}_i$. Table II contains pre-sample summary statistics for our variables of interest, split by cross-listed and non-crosslisted securities as well as by retail and non-retail traders. Table VI illustrates the following:

**Empirical Observation 5** *For the fee-neutral group of securities, retail traders trade a smaller fraction* ($-2.3\%$) *of their trades with limit orders, they submit fewer limit orders , as a fraction of all orders* ($-2.4\%$)*, and their trading dollar-volume from active, marketable orders increases after the introduction of the maker rebates. There is no statistically significant change in retail traders' total trading costs and there are no statistically significant differences between the changes in retail and non-retail traders' total costs.*

Our findings on the changes in order submission patterns are consistent with the predictions of Brolley and Malinova (2012). The results on the total costs suggest that retail

traders trade on the passive side sufficiently frequently to benefit from the increased realized spreads, even though they increased their more cost-intensive active volume. Our measure of the total trading costs assumes that traders, as a group, pay the maker-taker fees incurred on their trades, either directly to the exchange or through a commission to their brokers. Since for retail traders the active volume has increased and the fraction of passive, limit order volume has declined, the total exchange fees incurred by brokers on retail trades for the fee-neutral group of securities have increased with the introduction of the maker rebates. If brokers did not increase their commissions, then retail traders may have benefitted after the change, at the expense of their brokers.[24]

# VII Conclusion

We empirically study maker-taker pricing, the most prevalent, yet controversial exchange fee schedule in today's equity markets. We use the introduction of maker rebates for passive limit orders on the Toronto Stock Exchange (TSX) to identify the effect from changes in the total fee retained by the exchange and the effect of splitting the total fee into a maker rebate and a taker fee. Our results on the impact of the total fee support the theoretical predictions of Colliard and Foucault (2012): we find that an increase in the total exchange fee leads to an increase the cum-fee effective spreads, which proxy for liquidity takers' trading costs, and that it leads to a lower fill rate for limit orders. To analyze the maker-taker breakdown of the total fee, we focus on the group of securities for which the change in the total fee was close to zero. For this group of securities, the

[24] Anecdotal evidence indicates that brokers do not fully pass the maker-taker fees to their clients, suggesting that maker rebates may "ultimately [be] funded by retail brokers" (see, David Panko's letter to the OSC, Jan 17, 2011 `http://www.osc.gov.on.ca/documents/en/Securities-Category2-Comments/com_20110117_23-405_pankod.pdf`).

prices that people trade at improve so as to exactly offset an increase in the taker fee, consistent with Colliard and Foucault (2012) and angel:2010. We further find evidence that the cum-fee realized spreads, which proxy for liquidity makers' revenues, as well as trading volume and the fill rate for limit orders all increased, and that the price impact of marketable orders decreased.

We attribute the decline in adverse selection that is associated with the reduced price impact to the behavior of traders who pay maker-taker fees only through a flat commission to their brokers. These traders would base their trading decisions on posted spreads, rather than cum-fee spreads. Such behavior is an equilibrium outcome in Brolley and Malinova (2012), and we find further evidence for the behavioral changes that they predict in their paper: retail traders who, arguably, pay flat commissions, trade with market orders more frequently as the split between maker rebates and taker fees increases.

In our study, the benefit from reduced adverse selection was captured by the liquidity makers. When interpreting our results, it is important to understand that high frequency trading on the TSX, while in existence, was still in its infancy in 2005. The increase in the (positive) cum-fee realized spreads indicates that, during our sample period, the shift to maker rebates increased the profitability of liquidity provision. Our findings thus lend support to arguments that maker rebates have incentivized the entry of algorithmic, high frequency traders that specialize in liquidity provision. Over time, as high frequency trading developed and liquidity provision became more competitive, the revenues of liquidity makers likely decreased, and it is possible that the distribution of gains from trade between makers and takers has since changed.

The findings of this paper should interest regulators and policy makers in particular because the maker-taker pricing model had, allegedly, unintended negative consequences.

The SEC believes that maker rebates facilitated the development of high frequency trading and has questioned whether "rebates [are] unfair to long-term investors because they necessarily will be paid primarily to [high frequency] proprietary firms engaging in passive market making strategies."(SEC (2010)). Angel, Harris, and Spatt (2011) argue that the maker-taker model has "aggravated agency problems among brokers and their clients," because a typical broker does not forward exchange fees to their clients on a trade-by-trade basis and may have a conflict of interest with their clients regarding the choice of a trading venue. One industry report by Woodbine Associates estimates the associated costs to investors to be $5 billion annually.[25] Our paper establishes an empirical benchmark on the impact of maker rebates that can be weighed against these unintended consequences. Our findings suggest, in particular, that a regulation of the brokers' handling of maker-taker fees should weigh the agency costs against the possible benefits of flat commissions.

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[25]See Senator Schumer's letter to the SEC, May 10, 2012, available at `http://www.schumer.senate.gov/Newsroom/record.cfm?id=336748`.

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## Table I
## Pre-sample Summary Statistics of Cross-listed Companies and their Matches

The table lists selected summary statistics for variables that we use in our regressions for the NASDAQ/AMEX-cross-listed companies and their matches for the pre-sample month of July 2005. Unless otherwise specified, the numbers are average per day per company. Intraday volume refers to transactions that occur in the open market during regular trading hours (9:30-16:00), excluding odd-lot trades, special terms orders and dealer crosses.

| | | | NASDAQ/AMEX cross-listed | Non-crosslisted |
|---|---|---|---|---|
| Total intraday July 2005 share volume | (millions) | Mean | 3.017 | 4.036 |
| | | StD | (4.404) | (9.635) |
| | | Median | 1.436 | 1.888 |
| Total intraday July 2005 dollar volume | (millions) | | $ 39.948 | $ 41.927 |
| | | | $ (95.813) | $ (123.737) |
| | | | $ 10.410 | $ 13.509 |
| Total July 2005 transactions | (thousands) | | 4.784 | 3.533 |
| | | | (6.547) | (5.338) |
| | | | 2.554 | 2.011 |
| Closing price end July 2005 (in $) | | | $ 12.67 | $ 12.81 |
| | | | $ (18.06) | $ (17.84) |
| | | | $ 6.62 | $ 6.63 |
| Market capitalization end July 2005 | (billions) | | $ 1.47 | $ 1.66 |
| | | | $ (4.79) | $ (6.36) |
| | | | $ 0.51 | $ 0.46 |
| Time weighted quoted spread (in bps) | | | 62.97 | 82.24 |
| | | | (47.00) | (46.77) |
| | | | 51.42 | 80.97 |
| Time weighted quoted spread (in cents) | | | 4.33 | 5.96 |
| | | | (4.22) | (5.03) |
| | | | 3.28 | 4.02 |
| Time weighted dollar depth (in $) | (thousands) | | $ 16.19 | $ 21.92 |
| | | | $ (13.71) | $ (16.90) |
| | | | $ 12.56 | $ 17.16 |
| Herfindahl Index broker level | | | 0.22 | 0.23 |
| | | | (0.06) | (0.06) |
| | | | 0.20 | 0.23 |
| Number of brokers | | | 13.7 | 13.1 |
| | | | (5.3) | (5.5) |
| | | | 13.0 | 12.2 |

## Table II
## Pre-sample Summary Statistics by Trader Group

The table lists selected summary statistics for the by-trader variables that we use in our regression, split by retail vs. non-retail traders and by NASDAQ/AMEX-cross-listed companies and their matches. The statistics are for the pre-sample month of July 2005. The numbers are the average per day per security across the respective groups of retail and non-retail traders.

| | Type of trader | Unit | NASDAQ/AMEX cross-listed | Non-crosslisted |
|---|---|---|---|---|
| net costs | Retail | bps | 18.9 | 21.8 |
| | | | (26.2) | (23.7) |
| | | | 14.8 | 16.7 |
| | Non-Retail | | 8.2 | 5.9 |
| | | | (14.6) | (19.6) |
| | | | 6.1 | 5.0 |
| % passive | Retail | percent | 44.0 | 35.7 |
| | | | (16.5) | (12.2) |
| | | | 43.7 | 35.6 |
| | Non-Retail | | 51.9 | 60.5 |
| | | | (7.5) | (10.4) |
| | | | 51.5 | 59.0 |
| % limit orders | Retail | percent | 73.8 | 66.7 |
| | | | (11.8) | (12.5) |
| | | | 74.9 | 68.5 |
| | Non-Retail | | 96.1 | 83.3 |
| | | | (4.2) | (10.3) |
| | | | 97.4 | 84.8 |

## Table III
## Quoted Liquidity

The table examines the effect of the fee change on daily time-weighted quoted bid-ask spreads in basis points and the log of the time-weighted quoted depth in dollars. The dependent variables are the difference of the daily realization for each of the 65 NASDAQ/AMEX cross-listed stocks and its non-crosslisted match for the sample period from August 1, 2005 to November 30, 2005. The estimation is based on the following regression specification:

$$\begin{aligned} \textit{dependent variable}_{it} \;=\; & \beta_0 + \beta_1 \textit{event}_t \times \textit{fee decrease group}_i + \beta_2 \textit{event}_t \times \textit{fee neutral group}_i \\ & + \beta_3 \textit{event}_t \times \textit{fee increase group}_i + \beta_4 \textit{fee decrease group}_i + \beta_5 \textit{fee neutral group}_i \\ & + \beta_6 \mathsf{VIX}_t + \sum\nolimits_{j=1}^{5} \beta_{6+j} \textit{control variable}_{ij} + \epsilon_{it}, \end{aligned}$$

where $\textit{event}_t$ is 1 for dates after October 1, 2005 and 0 before; $\textit{fee decrease group}_i$, $\textit{fee decrease group}_i$, and $\textit{fee decrease group}_i$ are dummies that are 1 when security $i$ is in the respective group with respect to the total fee change; and $\mathsf{VIX}_t$ is the daily realization of the CBOE volatility index VIX. We estimate the specification with and without fixed effects; in the latter case, we use July 2005 log(market capitalization) and log(price), and average July 2005 broker-level HHI, dollar turnover, and return volatility as control variables. Standard errors are in parentheses and they are clustered by security and date. Coefficients for control variables are not reported for brevity. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level. We test for equality of coefficients; "Yes" indicates that we reject the hypothesis of equality.

| Dependent Variable | time weighted quoted spread | | *log* time-weighted dollar depth | |
|---|---|---|---|---|
| Stock fixed effects | No | Yes | No | Yes |
| event$_t$ × fee decrease$_i$ | -5.14** | -5.14* | 0.10 | 0.10 |
| | (2.61) | (2.80) | (0.07) | (0.08) |
| event$_t$ × fee neutral$_i$ | -16.15*** | -16.15** | 0.16*** | 0.16*** |
| | (6.26) | (6.49) | (0.05) | (0.06) |
| event$_t$ × fee increase$_i$ | -19.80** | -19.80** | 0.07 | 0.07 |
| | (8.01) | (8.21) | (0.09) | (0.09) |
| Observations | 5,200 | 5,200 | 5,200 | 5,200 |
| Adjusted R-squared | 0.048 | 0.440 | 0.154 | 0.446 |
| decrease ≠ increase | Yes* | Yes* | | |
| decrease ≠ fee neutral | | | | |
| increase ≠ fee neutral | | | | |

## Table IV
## Effective Trading Costs and Liquidity Provision Benefits

The table examines the effect of the change of trading fees on the effective spread, the effective spread plus twice the taker fee, the realized spread, the realized spread plus twice the maker rebate, and the price impact, all measured in basis points of the prevailing midpoint, and they are calculated per day per security as volume-weighted averages. The presented results are based on the estimation of equation (2) (also displayed in Table III). $event_t$ is 1 for dates after October 1, 2005 and 0 before; *fee decrease group*$_i$, *fee decrease group*$_i$, and *fee decrease group*$_i$ are dummies that are 1 when security $i$ is in the respective group with respect to the total fee change; and $\mathsf{VIX}_t$ is the daily realization of the CBOE volatility index VIX. We estimate the specification with and without fixed effects; in the latter case, we use July 2005 log(market capitalization) and log(price), and average July 2005 broker-level HHI, dollar turnover, and return volatility as control variables. Standard errors are in parentheses and they are clustered by security and date. Coefficients for control variables are not reported for brevity. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level. We test for equality of coefficients; "Yes" indicates that we reject the hypothesis of equality.

| Dependent Variable | effective spread | | effective spread plus 2×taker fee | | 5-minute realized spread | | realized spread plus 2×maker rebate | | 5-minute price impact | |
|---|---|---|---|---|---|---|---|---|---|---|
| Stock fixed effects | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes |
| $\text{event}_t \times \text{fee decrease}_i$ | -1.76 | -1.77 | -1.79 | -1.80 | -0.09 | -0.09 | 2.40 | 2.40 | -1.68 | -1.68 |
| | (2.10) | (2.27) | (2.14) | (2.32) | (1.80) | (1.90) | (1.88) | (1.97) | (1.67) | (1.71) |
| $\text{event}_t \times \text{fee neutral}_i$ | -11.03** | -11.04** | -1.45 | -1.46 | 0.10 | 0.10 | 9.19*** | 9.19*** | -11.14** | -11.14** |
| | (5.17) | (5.34) | (5.57) | (5.74) | (3.11) | (3.14) | (3.40) | (3.42) | (4.86) | (4.94) |
| $\text{event}_t \times \text{fee increase}_i$ | -18.95*** | -19.03*** | 13.30 | 13.21 | -9.90** | -9.92** | 14.76*** | 14.74*** | -9.05* | -9.11* |
| | (7.08) | (7.27) | (8.15) | (8.31) | (4.50) | (4.64) | (5.41) | (5.54) | (5.19) | (5.27) |
| Observations | 5,199 | 5,199 | 5,199 | 5,199 | 5,199 | 5,199 | 5,199 | 5,199 | 5,199 | 5,199 |
| Adjusted R-squared | 0.041 | 0.324 | 0.012 | 0.308 | 0.018 | 0.103 | 0.013 | 0.104 | 0.013 | 0.101 |
| decrease $\neq$ increase | Yes** | Yes** | Yes* | Yes* | Yes** | Yes** | Yes** | Yes** | | |
| decrease $\neq$ fee neutral | Yes* | | | | | | Yes* | Yes* | Yes* | Yes* |
| increase $\neq$ fee neutral | | | | | Yes* | Yes* | | | | |

## Table V
## Volume, Transactions and Fill Rates

The table examines the effect of the change of trading fees on the log of the daily dollar volume, the daily number of transactions, and the daily fill rate, computed as the fraction of market orders of all orders. The presented results are based on the estimation of equation (2) (also displayed in Table III). $event_t$ is 1 for dates after October 1, 2005 and 0 before; *fee decrease group*$_i$, *fee decrease group*$_i$, and *fee decrease group*$_i$ are dummies that are 1 when security $i$ is in the respective group with respect to the total fee change; and $\mathsf{VIX}_t$ is the daily realization of the CBOE volatility index VIX. We estimate the specification with and without fixed effects; in the latter case, we use July 2005 log(market capitalization) and log(price), and average July 2005 broker-level HHI, dollar turnover, and return volatility as control variables. Standard errors are in parentheses and they are clustered by security and date. Coefficients for control variables are not reported for brevity. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level. We test for equality of coefficients; "Yes" indicates that we reject the hypothesis of equality.

| Dependent Variable | *log* dollar volume | | transactions | | fill rate | |
|---|---|---|---|---|---|---|
| Stock fixed effects | No | Yes | No | Yes | No | Yes |
| event$_t$ × fee decrease$_i$ | 0.05 | 0.05 | 43.15 | 43.15 | 2.58*** | 2.58*** |
| | (0.10) | (0.11) | (38.03) | (43.35) | (0.84) | (0.87) |
| event$_t$ × fee neutral$_i$ | 0.32* | 0.32* | 55.87* | 55.87* | 1.37** | 1.37** |
| | (0.18) | (0.18) | (29.76) | (30.26) | (0.64) | (0.67) |
| event$_t$ × fee increase$_i$ | 0.26* | 0.26 | 83.15* | 83.15* | -2.08** | -2.08** |
| | (0.15) | (0.16) | (47.40) | (50.03) | (0.90) | (0.94) |
| Observations | 5,199 | 5,199 | 5,200 | 5,200 | 5,200 | 5,200 |
| Adjusted R-squared | 0.089 | 0.510 | 0.048 | 0.499 | 0.174 | 0.464 |
| decrease ≠ increase | | | | | Yes*** | Yes*** |
| decrease ≠ fee neutral | | | | | | |
| increase ≠ fee neutral | | | | | Yes*** | Yes*** |

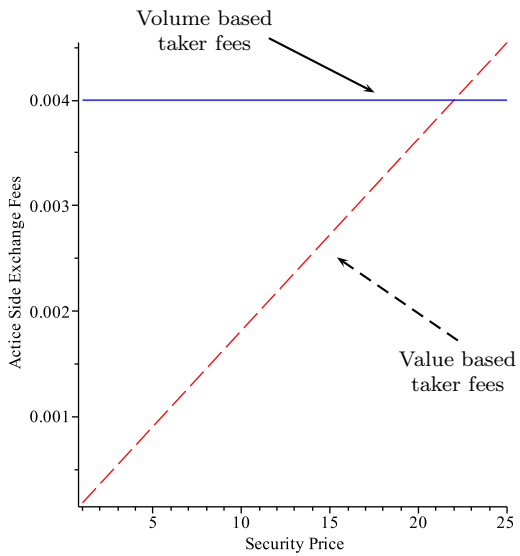
## Table VI
## Retail Trader Behavior

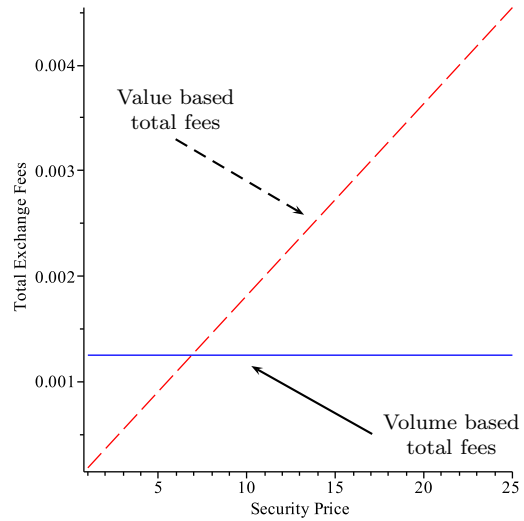
The table examines the effect of the change of trading fees on retail trader behaviour. There are four dependent variables, computed for each group of traders, per day per stock: net costs, % passive, % limit orders, and log (aggressive dollar volume). Net costs are computed as the difference of the cum fee effective spreads paid and the cum fee realized spreads received for all traded shares, divided by the group's total volume; % passive is the percent of volume that the respective group trades with passive limit orders; % limit orders is the percent of limit orders (as the fraction of all orders submitted by the group); and log (aggressive dollar volume) is the logarithm of the total dollar volume traded by the group with marketable orders.
The presented results are based on the estimation of equation (2). The dummy $event_t$ is 1 for dates after October 1, 2005 and 0 before; *fee decrease group*$_i$, *fee decrease group*$_i$, and *fee decrease group*$_i$ are dummies that are 1 when security $i$ is in the respective group with respect to the total fee change; *retail*$_i$ is a dummy that is 1 if the computed dependent variable is for the group of retail traders and 0 otherwise; the reverse for *non-retail*$_i$. We estimate the specification with and without fixed effects; in the latter case, we use July 2005 log(market capitalization) and log(price), and average July 2005 broker-level HHI, dollar turnover, and return volatility as control variables. All regressions further include the daily realization of the CBOE volatility index VIX. Standard errors are in parentheses and they are clustered by security and date. Coefficients for control variables are not reported for brevity. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level. We test for equality of coefficients for retail and non-retail traders; "Yes" indicates that we reject the hypothesis of equality.

| Dependent Variable | net costs | | % passive | | % limit orders | | *log* aggressive dollar volume | |
|---|---|---|---|---|---|---|---|---|
| Firm fixed effects | No | Yes | No | Yes | No | Yes | No | Yes |
| event$_t$ × fee decrease$_i$ × retail$_i$ | -1.60 | -1.61 | -0.42 | -0.41 | -2.52** | -2.52* | -0.03 | -0.03 |
| | (1.21) | (1.22) | (0.57) | (0.67) | (1.25) | (1.34) | (0.08) | (0.10) |
| event$_t$ × fee decrease$_i$ × non-retail$_i$ | -1.09 | -1.45** | 1.53** | 0.76* | -3.29*** | -1.51*** | 0.02 | 0.01 |
| | (0.98) | (0.73) | (0.78) | (0.45) | (1.01) | (0.57) | (0.18) | (0.13) |
| event$_t$ × fee neutral$_i$ × retail$_i$ | -4.02 | -4.01 | -2.33*** | -2.33** | -2.44** | -2.44** | 0.31** | 0.30* |
| | (2.57) | (2.59) | (0.89) | (0.92) | (0.97) | (1.03) | (0.16) | (0.16) |
| event$_t$ × fee neutral$_i$ × non-retail$_i$ | -1.42 | -0.62 | 0.37 | 0.92 | 0.58 | -0.98 | 0.12 | 0.37* |
| | (1.68) | (1.13) | (1.06) | (0.61) | (1.02) | (0.80) | (0.27) | (0.21) |
| event$_t$ × fee increase$_i$ × retail$_i$ | 1.33 | 1.33 | -2.36** | -2.36** | -0.86 | -0.86 | 0.32** | 0.32** |
| | (2.81) | (2.83) | (1.00) | (1.05) | (0.85) | (0.88) | (0.13) | (0.14) |
| event$_t$ × fee increase$_i$ × non-retail$_i$ | 1.16 | 0.68 | 0.23 | 0.38 | 2.38* | 2.33** | 0.53** | 0.30 |
| | (1.92) | (2.06) | (1.00) | (0.71) | (1.25) | (1.05) | (0.26) | (0.19) |
| Observations | 10,391 | 10,391 | 10,391 | 10,391 | 10,399 | 10,399 | 10,367 | 10,367 |
| Adjusted R-squared | 0.012 | 0.082 | 0.177 | 0.287 | 0.130 | 0.36 | 0.096 | 0.499 |
| Fee decrease: retail $\neq$ non-retail | | | | | | | | |
| Fee neutral: retail $\neq$ non-retail | | | Yes* | Yes** | Yes** | | | |
| Fee increase: retail $\neq$ non-retail | | | Yes* | Yes* | Yes** | Yes** | | |

**Figure 1**
**Per Share Exchange Fees.**

The left panel plots the taker fees for a marketable order of one share under volume and value based pricing systems of exchange fees as functions of the security's price; the right panel plots the total exchanges fees (taker fee minus maker rebate) under the two systems.



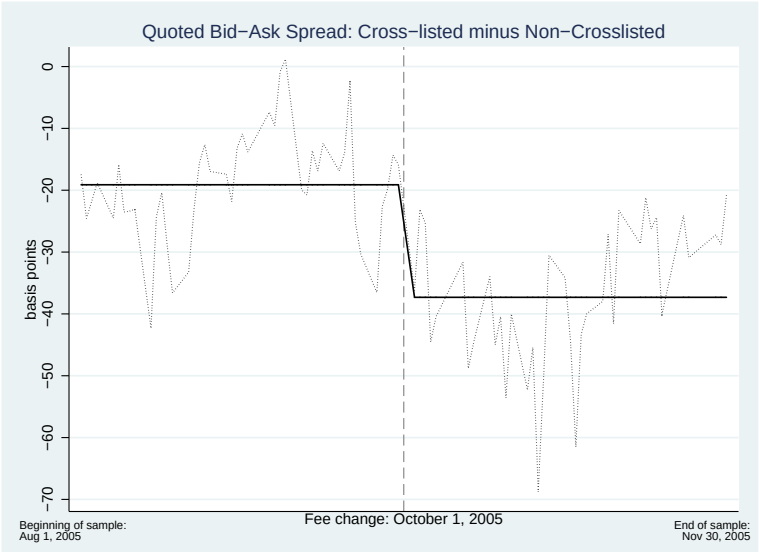



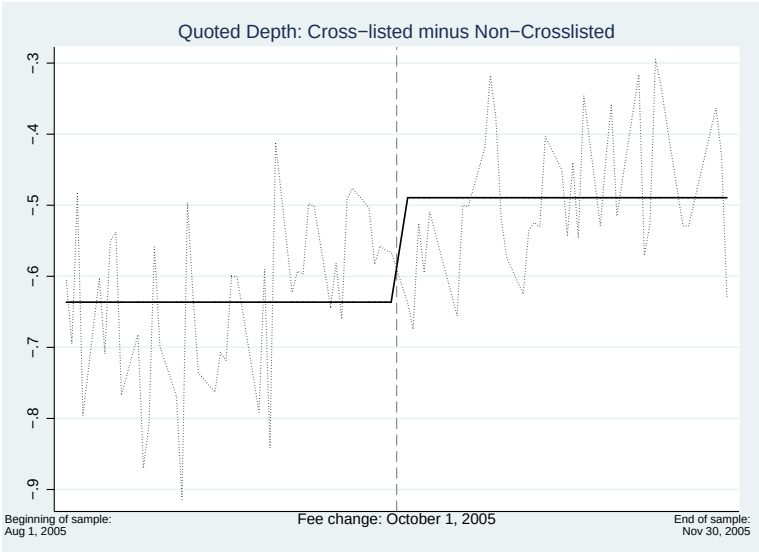

$$\text{Value based taker fee} = \text{price} \times \tfrac{1}{55} \times 1\%$$
$$\text{Volume based taker fee} = \$0.004$$

$$\text{Value based total fee} = \text{taker} - \text{maker} = \text{price} \times \left(\tfrac{1}{55} \times 1\% - 0\right)$$
$$\text{Volume based total fee} = \text{taker} - \text{maker} = \$0.004 - \$0.0275$$

## Figure 2
## Quoted Liquidity: Bid-Ask Spreads and Depth

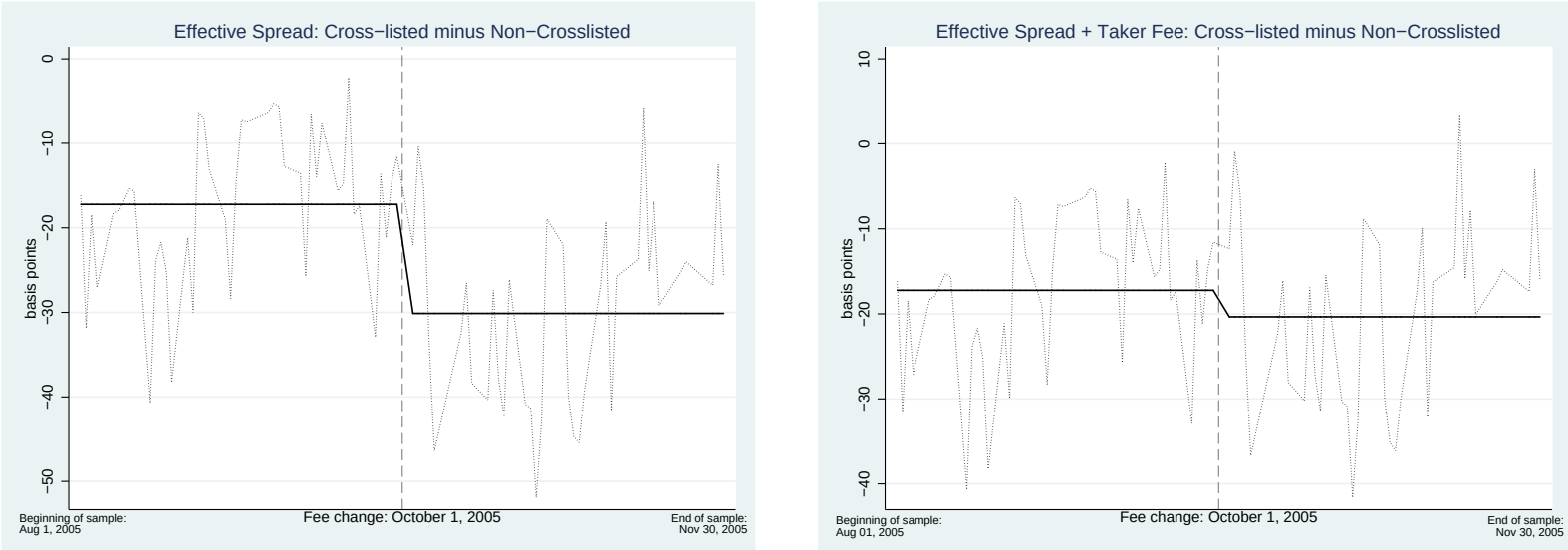
We plot the differences of the time-weighted quoted spreads (left panel) and time-weighted log-dollar depth (right panel) for NASDAQ/AMEX cross-listed securities and their matches. The plots are for the securities in the fee-neutral group, that is, for the group of stocks for which the total exchange fee after October 1, 2005, was close to the 1.8 basis point total fee of the unaffected group. Spreads are measured in basis points of the prevailing midpoint, depth is measured as the logarithm of the average dollar amount available for trading at the best bid and offer prices. The solid, horizontal lines are pre- and post event averages, the thin, dotted lines are the daily averages. The sample period is from August 1 until November 30, 2005.

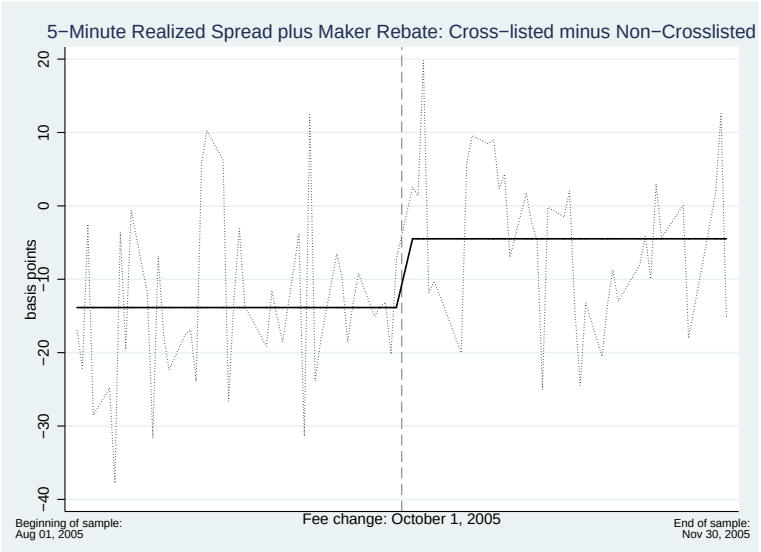
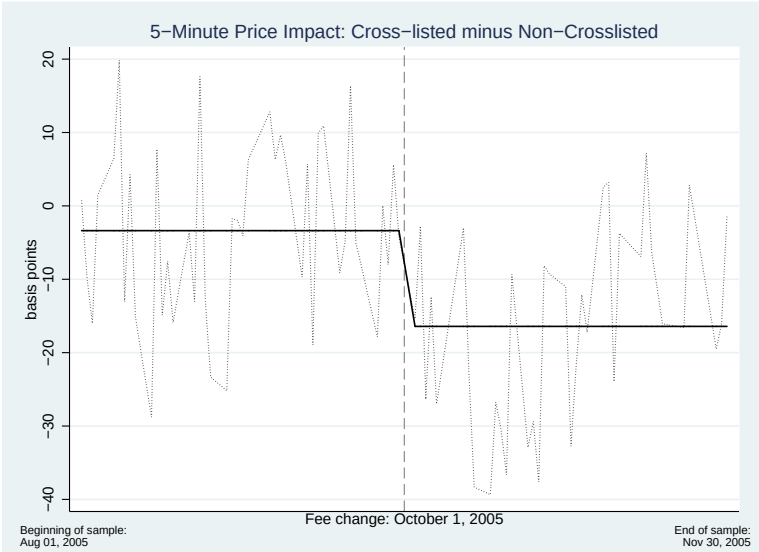


## Figure 3
## Effective Spreads without and with Taker Fees

We plot the differences of the volume-weighted effective spreads without (left panel) and with (right panel) taker fees for NASDAQ/AMEX cross-listed securities and their matches. The plots are for the securities in the fee-neutral group, that is, for the group of stocks for which the total exchange fee after October 1, 2005, was close to the 1.8 basis point total fee of the unaffected group. All measures are in basis points of the prevailing midpoint. The solid, horizontal lines are pre- and post event averages, the thin, dotted lines are the daily averages. The sample period is from August 1 until November 30, 2005.



## Figure 4
## Realized Spreads plus Maker Rebate and Price Impact

We plot the differences of the volume-weighted 5-minute realized spreads plus twice the maker rebate (left panel) and the 5-minute price impacts (right panel) for NASDAQ/AMEX cross-listed securities and their matches. The plots are for the securities in the fee-neutral group, that is, for the group of stocks for which the total exchange fee after October 1, 2005, was close to the 1.8 basis point total fee of the unaffected group. All measures are in basis points of the prevailing midpoint. The solid, horizontal lines are pre- and post event averages, the thin, dotted lines are the daily averages. The sample period is from August 1 until November 30, 2005.