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

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Abstract

Facing increased competition, over the last decade many stock exchanges changed their trading fees to maker-taker pricing, an incentive scheme that rewards liquidity suppliers and charges liquidity demanders. Using a change in trading fees on the Toronto Stock Exchange, we study whether and why the breakdown of trading fees between liquidity demanders and suppliers matters. Posted quotes adjust after the change in the fee composition, but the transaction costs for liquidity demanders remain unaffected once fees are taken into account. Yet, as posted bid-ask spreads decline, traders, in particular retail, use aggressive orders more frequently, and adverse selection costs decrease.

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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 maker-taker pricing 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. 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 post-change 1.8 basis point total fee of the securities that did not switch to maker-taker pricing. Any change observed for this "fee-neutral" subset 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. Further, we find an increase in the fraction of market orders and a decline in the price impact of market orders. The price impact is defined as the signed change in the midpoint of the bid-ask spread subsequent to a trade and it measures the information that is revealed by the trade. A decline in the price impact reflects a decline in adverse selection costs (which do not feature in Colliard and Foucault (2012)).

At first sight, since cum fee effective spreads did not change, our empirical results provide no economic justification for the changes in adverse selection. In practice, however, traders often do not pay maker-taker fees directly, and instead pay only a flat fee

to their broker.[4] Ceteris paribus, 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 more of them would choose market over limit orders. In Brolley and Malinova (2012) this behavior is an equilibrium outcome, and the increased usage of market orders causes a decline in adverse selection. The decline stems from the monotonic order choices of informed traders: traders with stronger information use market orders, traders with weaker information use limit orders; see also Kaniel and Liu (2006) and Rosu (2012). Traders who switch from limit to market orders have weaker information than the original market order submitters, and thus the price impact of market orders declines.

One group of traders that commonly pays flat commissions is 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] 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

[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.)

for passive trades, we find no evidence that the introduction of the maker rebates led to redistributions in cum fee trading costs 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. Unique to our paper is that we focus on the breakdown of the total fee into the maker rebate and the taker fee, holding the total fee constant.

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 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. tests the empirical predictions on trading costs, volume, and adverse selection. Section V. studies the behavior of retail traders. Tables and figures are appended. The Internet Appendix contains further details on some measures 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 Prediction 1 (Benchmark)

1. *Holding the total exchange fee constant, as the maker rebate increases*
   (a) *the raw bid-ask spread decreases;*
   (b) *the cum fee bid-ask spread (spread plus (twice) the taker fee) is unaffected;*
   (c) *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 fraction of market orders of all 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 ask 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 effect of changes in 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, only a fraction of traders receive maker rebates for each executed limit order; as the

maker rebate increases, these traders improve their quotes and the raw bid-ask spread declines. For the remaining traders, the fee per trade is flat: it does not depend on the order type but instead equals the average exchange fee incurred by these traders as a group. Ceteris paribus, traders who pay the flat fee base their order choice on the raw, rather than the cum fee bid-ask spread, and submit relatively more market orders as the raw bid-ask spread declines. The authors find numerically that this behavior is also an equilibrium outcome in their setting, accounting for equilibrium changes in the flat fee.

The authors then predict that in presence of asymmetric information, the change in trader behavior causes market orders to become less informative. Their prediction is driven by the monotonic equilibrium behavior of traders in their model, whereby, similarly to Kaniel and Liu (2006) and Rosu (2012), traders with a sufficiently large informational advantage use market orders and those with weaker information use limit orders.[7]

To understand why the information content of market orders declines in such an equilibrium, consider an extreme outcome where (a) informed traders only submit market orders and (b) uninformed traders submit market and limit orders. In this example, traders who switch from limit to market orders are uninformed. Assuming that the informed traders do not increase their trading intensity, adverse selection costs for liquidity suppliers fall and, therefore, so do cum fee bid-ask spreads.

Empirical Prediction 2 (Maker-Taker Breakdown: Flat Commissions) *For a constant total fee, in the presence of flat commissions, as the maker rebate increases,*

1. *the raw bid-ask spread, the price impact of trades, and the cum fee bid-ask spread decrease for the traders paying flat commissions;*

[7]Privately informed traders face a trade-off between the better price offered by a limit order and the potential loss of their informational advantage if their limit order does not execute immediately. Those with the strongest informational advantage then choose market orders and pay the bid-ask spread, whereas those with a weaker advantage choose limit orders and (hope to) receive the spread.

2. *as the raw bid-ask spread declines, traders who pay flat commissions submit relatively more market orders than limit orders.*

When testing the above prediction, we seek to identify, in particular, whether traders who pay flat commissions change their order submission behavior in response to changes in the maker-taker breakdown. Our data does not contain information on the commission structures, and we perform this test by identifying a group of traders that commonly pays flat ("$9.99 per trade") commissions, namely, retail traders. One caveat is that retail traders are arguably less-informed than the average trader. As a consequence, while we can test whether these traders change their behavior consistently with Empirical Prediction 2.2, we cannot differentiate empirically whether changes in the price impact arise because limit order submitters are less-informed than market order submitters or because traders who play flat commissions are less-informed on average. Notably, Empirical Prediction 2.2 does not rely on the presence of asymmetric information.

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

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.[8]

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").[9] The highest priced buy limit order in the book sets the bid price, the lowest priced sell order sets the ask price. Transactions occur when a trader submits either a market order or a marketable limit order, e.g., a buy limit order that matches or exceeds the ask price. In what follows we will use the term "active order" for a market order or a marketable limit order, and we use "passive order" for the standing limit order that is hit by an active order.

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 "interlisted"), 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.

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

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

[9]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. This so-called "broker-preferencing" is, however, immaterial for our analysis.

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 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.

[Insert Figure 1 about here]

[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 $p \times 1/55 \times 1\% = \$.004$.

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 cross-listed 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 October 11 and November 21 due to errors in the raw data, as well as U.S. Thanksgiving and Black Friday. 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]

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 occur 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

[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 NASDAQ/AMEX related events during our sample period.

is identified as either buyer- or seller-initiated. Finally, the data contains all updates on the best bid and ask quotes as well as on 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 trade on the main exchange, and we 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 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 during the event window. Finally, we exclude Nortel as 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 during the event window. Companies that changed their cross-listing status during the sample period 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 refer to companies that are cross-listed with NASDAQ and AMEX as "cross-listed", and we refer to companies that are listed only on the TSX or that are cross-listed with NYSE as "non-crosslisted".

[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)).

C. *Matched Sample*

Since the TSX initially introduced maker-taker fees only for cross-listed securities, we use the remaining companies as a control group to ensure that our results are not driven by market-wide fluctuations. Specifically, for each "treated", cross-listed company we select a unique control company as follows. Using one-to-one matching without replacement, we match companies based on their 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 behavior.[16] Finally, Foucault, Kadan, and Kandel (2013) predict that the competition among traders affects the impact of changes in the maker-taker fees.

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

[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.

[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.

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.

[Insert Table I about here]

D. Subsample Selection: Fee-Neutral Securities

To test predictions on the impact of the breakdown of the total fee, we need to identify a group of securities for which the change in the total fee is small; we refer to this group as the fee-neutral securities. We measure the total fee for the cross-listed securities relative to the total fee of the control group. The total fee for non-crosslisted securities declined from 2 bps to 1.81 bps on October 1, 2005, and we use the post-event fee for the control group as the benchmark for fee changes to neutralize any effect that may stem from the change in the fees for the control group. Specifically, we define the change in the total fee for cross-listed securities as $(\$0.004 - \$0.00275)/\text{price} - 1.81\text{bps}$. Figure 2 plots the change in the total fee against the price of the underlying security.

We require the group of fee-neutral securities to have an average change in the total fee of zero and to contain the same number of stocks with (small) fee increases and decreases. The fee-neutral group contains 22 securities, with July 2005 closing prices between \$4.36 and \$12.05 (implying fee changes between -1.05 and $+.8$ bps relative to

the control group); the group of securities with a fee increase contains 23 securities, the group with a fee decrease contains 20 securities. Figure 2 identifies the securities by their respective groups. Table I provides summary statistics for the three groups.

[Insert Figure 2 about here]

E. Retail Traders

Empirical Prediction 2 is based on the premise that traders who pay flat commissions change their behavior. Our data does not provide information on the commission structure that traders face. To test the prediction, we focus on the group of retail traders because these traders commonly face flat commissions. Individuals who want to trade on the TSX have to submit their orders through a broker. Brokers typically have multiple trading desks, and they often funnel particular types of order flow, such as retail or institutions, through dedicated desks. Our data granularity is at the trading desk level, and we believe that we can identify retail trading desks by their trading characteristics.

Our premise is that retail traders frequently trade small quantities. To distinguish small size trades that are used by order-splitting algorithms from those of retail traders, we base our classification on trades for less than 100 shares, so-called odd-lot trades, because on the TSX large orders must not be split into odd-lots.[17] We classify a unique identifier as specializing in retail orders if for the aggregate trading activity over the sample period this identifier has a fraction of so-called odd-lot transactions above 1%

[17] O'Hara, Yao, and Ye (2011) analyze 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. Oddlots are used differently in Canada. TSX trading rules specifically prohibit the splitting of large orders into multiple odd-lots for trades for the same account (currently, TSX Trading Rules, Policy 4-802; formerly, Section 5.1 of the Equities Manual). Moreover, odd-lots 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.

of the total intraday transactions. Since odd-lot trades are also used by some sophisticated traders, for instance, in exchange-traded fund arbitrage strategies, we impose an additional filter. Namely, we exclude identifiers with short sale volume in excess of 10% of sales because, arguably, sophisticated traders are more likely to use short-sales than retail traders.

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. Table II reports summary statistics for the groups of retail and non-retail traders for the pre-sample month of July 2005. Retail traders trade 44% of their volume in cross-listed securities with limit orders, the remaining volume was traded with market orders. Of all the orders submitted by retail traders, 74% are limit orders, the remainder are market orders. Retail traders are likely less informed than other traders. A standard way to measure the informativeness of an order is the price impact, which is the signed change in the midpoint of the bid-ask spread subsequent to the trade; see, for instance, Huang and Stoll (1996). We use change from the time of the trade to five minutes after the trade. We observe that the market orders by retail traders in our sample have a lower price impact than market orders by non-retail traders (e.g., for fee-neutral securities the price impacts are 24 and 55 basis points respectively), suggesting that retail traders are indeed less-informed.

F. 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.

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 midpoint returns, 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.[18] For each measure, we estimate

$$\begin{aligned}\Delta DV_{it} &= \alpha_1 fee\ down_i + \alpha_2 fee\ neutral_i + event_t \times (\beta_1 fee\ down_i + \beta_2 fee\ neutral_i \\ &\quad + \beta_3 fee\ up_i) + \gamma \mathsf{VIX}_t + \delta X_i + \xi + \epsilon_{it}, \qquad (2)\end{aligned}$$

where ΔDV_{it} is the day t realization of the dependent variable for treatment group security i less the realization of the measure for the ith control group match; $event_t$ is a dummy variable that is 1 after October 1 2005 and 0 before; VIX_t is the closing value

[18] 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 stock fixed effects and no VIX. The estimation results are similiar.

of CBOE's volatility index for day t, X_i is a vector of the aforementioned security level control variables (it is omitted in the fixed effects specification), and ξ is the intercept. Dummy variables *fee down*$_i$, *fee neutral*$_i$, and *fee up*$_i$ are indicator variables for whether security i is, respectively, in the fee-decrease, fee-neutral or fee-increase sub-sample.

Furthermore, when we analyze the behaviour by trader group, we compute the dependent variables for the group of retail traders and for all other traders separately. We then interact the terms in (2) that relate to the event and three subsamples with different fee changes with indicator variables for whether the dependent variable pertains to retail traders or non-retail traders:

$$\begin{aligned}\Delta DV_{it} &= \alpha_0 rt_{it} + rt_{it} \times (\alpha_1 \textit{fee down}_i + \alpha_2 \textit{fee neutral}_i + \textit{event}_t \times (\beta_1 \textit{fee down}_i \\ &\quad + \beta_2 \textit{fee neutral}_i + \beta_3 \textit{fee up}_i)) + nrt_{it} \times \textit{event}_t \times (\beta_4 \textit{fee down}_i \\ &\quad + \beta_5 \textit{fee neutral}_i + \beta_6 \textit{fee up}_i) + \gamma \mathsf{VIX}_t + \delta X_i + \xi + \epsilon_{it}, \qquad (3)\end{aligned}$$

where in addition to the variables defined for (2), rt_{it} is a dummy variable that is 1 if the value of the dependent variable was for retail traders and 0 otherwise, and $nrt_{it} = 1 - rt_{it}$.

We conduct inference in all regressions using double-clustered Cameron, Gelbach, and Miller (2011) standard errors, which are robust to cross-sectional correlation and idiosyncratic time-series persistence,[19] with and without stock fixed effects. For brevity, for estimations of (2) we display only the estimated coefficients β_1, β_2, and β_3 on the interaction terms for the fee change groups, and for (3) we present $\beta_1, \ldots, \beta_6$. The tables further list results for tests of differences in these coefficients.

[19] 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. Maker-Taker Fees, Bid-Ask Spreads, and Volume

The goal of our analysis is to test mechanisms that can explain why the breakdown of the total exchange fee into a maker rebate and a taker fee may or may not matter. The first set of hypotheses, Empirical Prediction 1, predicts that only changes in the total fee have economically meaningful effects; we test in these hypotheses in Subsections A.-C. The second set of hypotheses, Empirical Prediction 2, is based on the idea that due to market frictions, some traders alter their behavior and cause changes in the information content of trades; we test for changes in the informativeness of trades in Subsection D.

A. Do posted quotes react to changes in maker-taker fees?

Empirical Prediction 1.1 states that the raw bid-ask spread declines as the maker rebate increases holding the total fee constant. We focus on the *effective spread*, which is twice the difference between the transaction price and the midpoint of the bid and offer quotes at the time of the transaction, expressed in basis points as a proportion of the prevailing quote midpoint. Specifically,

$$espread_{it} = 2q_{it}(p_{it} - m_{it})/m_{it}, \tag{4}$$

where p_{it} is the transaction price for security i at time t, m_{it} is the midpoint of the quote prevailing at the time of the trade, and q_{it} is an indicator variable, which equals 1 if the trade is buyer-initiated and -1 if the trade is seller-initiated.[20] Our data reports

[20] In the Internet Appendix, we include tests for changes in the *quoted spread*, which 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 results for the quoted spread are similar to those of the effective spread. We also presents tests for changes in the *dollar depth*, which is defined as the average dollar amount that can be traded at the bid and the offer. The table there reports an increase in depth (interpreted as an improvement in liquidity). Since we have no predictions for changes in depth, we exclude the table from the main text. Finally, we present the results on spreads measured

the prevailing quotes, and it also contains a marker that signs each trade as buyer or seller initiated. Pre-sample summary statistics for spreads are in Table I.

[Insert Figure 3 about here]

Results. The left panel in Figure 3 illustrates a decline for the effective spread after the event date for the fee-neutral securities. In the first column of Table III, we test Empirical Prediction 1.1.a on raw bid-ask spreads. For the fee-neutral securities, we find that the effective spread declines by 11 basis points after the introduction of the maker rebate. The decline in the effective spread for the group with the increased total fee is stronger than that for the group with the decreased total fee.

[Insert Table III about here]

Therefore, we find support for Empirical Prediction 1 which states that prices adjust as the maker rebate changes. Furthermore, the difference in the spread changes across groups of securities with fee increases and decreases is consistent with Colliard and Foucault (2012), who predict that the effective spread declines 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.[21]

B. Do changes in posted quotes neutralize maker-taker fees?

According to Empirical Prediction 1, holding the total fee constant, the bid-ask spread adjustment offsets the change in the maker-taker fees. To test this hypothesis, we define

in cents; the results are similar.

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

the *cum fee bid-ask spread* as the effective spread plus twice the taker fee, normalized by the prevailing midpoint. This measure reflects the cost to a liquidity taker for a round-trip transaction, accounting for the taker fees. Empirical Prediction 1 states that only changes in the total fee lead to adjustments in cum fee bid-ask spreads.

Results. The right panel in Figure 3 plots the average cum fee effective spread for the fee-neutral securities over the sample period and shows that there is no noticeable change after the introduction of the maker rebate. In column 2 of Table III we test Empirical Predictions 1.1.b and 1.2 on the effect of the fee breakdown and the total fee on the cum fee effective spread. We find that for the fee-neutral securities, the cum fee effective spread remains unaffected by the introduction of maker-taker fees. While the cum fee effective spread increase for the group of securities with the increased total fee is not statistically significant, and the change is significantly different from the change for the group of securities with the decreased total fee.

Our findings support Empirical Prediction 1, that prices adjust to effectively neutralize the maker-taker breakdown, holding the total fee constant. The 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. Trading volume and maker-taker fees

Empirical Prediction 1 states that volume, and, more generally, trading activities, are only affected by changes in the total fee. To test the prediction, we study the dollar 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 market and limit orders.[22]

[22] 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.,

Results. In Table IV we test Empirical Predictions 1.1.c, 1.1.d, and 1.3. We find that for the fee-neutral securities, dollar volume, the number of transactions, and the fraction of market orders increase after the introduction of maker-taker fees; 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.

[**Insert Table IV about here**]

Our results 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. There is weak evidence of a volume increase for the fee-neutral securities, which is broadly consistent with models that include market frictions. For instance, Foucault, Kadan, and Kandel (2013) predict that a change in the division of gains from trade between makers and takers affects traders' monitoring activities and consequently trading volume.[23] Furthermore, the increase in the fill rate is consistent with the underlying argument of Empirical Prediction 2, which is that traders who face flat commissions submit more market orders relative to limit orders as the raw bid-ask spread declines.

D. The information content of trades

Empirical Prediction 2.1 states that in the presence of asymmetric information, an increased usage of market orders relative to limit orders lowers the information content

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.

[23]Table XI 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.

of trades. To test for changes in the informativeness of trades, we analyze the price impact, defined as the signed change in the midpoint of the bid-ask spread subsequent to a trade. This measure reflects the portion of the transaction cost that is due to the presence of informed liquidity demanders. A decline in the price impact indicates a decline in adverse selection. We use the common benchmark of the midpoint five minutes after the transaction and define for a trade at time t in security i

$$\textit{price impact}_{it} = 2q_{it}(m_{i,t+5\text{ min}} - m_{it})/m_{it}. \tag{5}$$

Results. In column 3 of Table III we test Empirical Prediction 2.1. Our results show that for the fee-neutral securities the price impact declines by 11 basis points after the introduction of maker-taker fees.

A decline in the price impact reduces the adverse selection costs for liquidity providers. If liquidity provision is perfectly competitive, as is implicitly assumed in Empirical Prediction 2.1, then the reduced price impact should lead to lower cum fee effective spreads, which we do not find. If, however, liquidity provision is not perfectly competitive, then the reduced price impact can increase liquidity providers' rents.

To empirically confirm that these rents have indeed changed, we analyze the *realized* spread, defined as

$$\textit{rspread}_{it} = 2q_{it}(p_{it} - m_{i,t+5\text{ min}})/m_{it} \tag{6}$$

Together, the realized spread and the price impact form a mechanical decomposition of the effective spread:

$$\textit{espread}_{it} = \textit{rspread}_{it} + \textit{price impact}_{it}. \tag{7}$$

The realized spread is Economically, the realized spread reflects the portion of the transaction costs that is attributed to liquidity provider revenues. The decomposition of the effective spread can then be extended to measures that account for the maker-taker fees.

Specifically, the cum fee effective spread can be decomposed into the cum fee realized spread, defined as the realized spread plus twice the maker rebate, the price impact and the total fee:[24]

$$cum\ fee\ espread_{it} = cum\ fee\ rspread_{it} + price\ impact_{it} + 2 \times total\ fee/m_{it}. \quad (8)$$

For our fee-neutral group, the cum fee effective spread and the total fee are unchanged, and the price impact declines. Therefore, we expect cum fee realized spreads to increase. Column 5 in Table III confirms this relation. The increase in the cum fee realized spread suggests, in particular, that the benefit of the lower price impact was captured by the liquidity providers.

V. Maker-Taker Fees and Retail Trader Behavior

A. Retail Trader Choice of Market vs. Limit Orders

In Section IV. we establish broad support for Empirical Prediction 1. Additionally, we find that there are changes in the informativeness of the order flow, consistent with Empirical Prediction 2. In this section, we test whether there is evidence in support of the mechanism that underlies Empirical Prediction 2. Specifically, we analyze whether retail traders, who arguably pay flat commissions, change their behavior as a group.

Empirical Prediction 2 builds on the premise that there are traders who pay maker-taker fees only on average through flat commissions to their brokers. As the raw bid-ask spread declines, these traders find market orders relatively more attractive and will use them more often. To assess the changes in retail traders' usage of market and limit

[24]Details are in the Internet Appendix.

orders, we compute three measures: (1) the fraction of their submitted orders that are limit orders; (2) the fraction of their traded volume that stems from limit orders; and (3) the log dollar-volume that they trade with market orders.

Results. In Table V we test Empirical Prediction 2.2. We find that for the fee-neutral group of securities, retail traders submit fewer limit orders, as a fraction of all orders, they trade a smaller fraction of their trades with limit orders, and their trading dollar-volume from active, marketable orders increases after the introduction of the maker rebate. Our findings on the changes in order submission patterns are consistent with Empirical Prediction 2.2.

[Insert Table V about here]

B. Redistributive Effects

As retail traders use market orders more frequently, retail traders' ex-post transactions costs may change, leading to a redistribution of costs between retail traders and other traders. To assess whether there is a redistribution, we compute the *cum fee total cost*, defined as the volume-weighted difference of the cum fee effective spread paid (for active orders) and the cum fee realized spread received (for passive orders).[25]

Results. The fourth column of Table V shows that for the fee-neutral securities there is no statistically significant change in retail traders' cum fee total costs after the introduction of maker-taker fees, and there are no statistically significant differences between the changes in retail and non-retail traders' costs. Consequently, there is no evidence of a redistribution.

[25] Note that the cum fee total cost does not lend itself to assessing whether retail traders act optimally: as the measure is ex post, it does not account for the probability of a limit order execution.

The cum fee total cost accounts for the fees that accrue and thus assumes that the maker-taker fees are passed on to the retail traders. As retail traders use market orders more frequently, retail brokers have to pay higher aggregate fees and we would expect them to raise their flat commissions. In practice, since the 2005 fee change was a pilot program, it is possible that retail brokers did not change their pricing immediately. If brokers did not increase their commissions, then retail traders may have benefitted after the change, at the expense of their brokers.[26]

VI. 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 in the cum fee effective spread, which proxies for liquidity takers' trading costs, and that it leads to a lower fill rate for limit orders.

To analyze the effect of the breakdown of the total fee into the maker rebate and the taker 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 prices that people trade at improve so as to offset the increase in the maker rebate, consistent with Colliard and Foucault (2012) and Angel, Harris, and Spatt (2011). We further find evidence that the cum fee realized

[26] 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`).

spread, which proxies 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. Since flat commissions do not differentiate between trades that make or take liquidity, these traders' decisions are driven by posted spreads.

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.

The findings of this paper should interest regulators and policy makers 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.[27]

Our paper establishes an empirical benchmark on the impact of the maker-taker

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

pricing model that can be weighed against these unintended consequences. We find that holding the total fee constant, the breakdown of fees into maker-taker fees does not matter for liquidity, and that, in contrast, the total fee matters (as predicted by Colliard and Foucault (2012)). Furthermore, to interpret the effects of maker-taker pricing, it is important to understand how brokers adjust their pricing subsequent to changes in maker-taker fees. Regulators should thus focus their attention on the total fee charged by the trading venues, on broker commissions, and on the impact of maker-taker fees on these commissions.

References

Anand, Amber, Tim McCormick, and Laura Serban, 2012, Does the make-take structure dominate the traditional structure? Evidence from the options markets, Working paper Syracuse University http://ssrn.com/abstract=2074318.

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

Barclay, Michael J., Eugene Kandel, and Leslie M. Marx, 1998, The effects of transaction costs on stock prices and trading volume, *Journal of Financial Intermediation* 7, 130–150.

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

Battalio, Robert H., Andriy Shkilko, and Robert A. Van Ness, 2012, To pay or be paid? The impact of taker fees and order flow inducements on trading costs in U.S. options markets, Working paper University of Notre Dame http://ssrn.com/abstract=1954119.

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

Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller, 2011, Robust inference with multiway clustering, *Journal of Business & Economic Statistics* 29, 238–249.

Cardella, Laura, Jia Hao, and Ivalina Kalcheva, 2012, Competition in make-take fees in the U.S. equity market, Working paper Texas Tech University http://ssrn.com/abstract=2149302.

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

Davies, Ryan J., and Sang Soo Kim, 2009, Using matched samples to test for differences in trade execution costs, *Journal of Financial Markets* 12, 173 – 202.

Ellis, Katrina, Roni Michaely, and Maureen O'Hara, 2002, The making of a dealer market: From entry to equilibrium in the trading of Nasdaq stocks, *The Journal of Finance* 57, pp. 2289–2316.

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

Gry, Tara, 2005, Dual-class share structures and best practices in corporate governance, Staff Report PRB 05-25E Staff of the Parliamentary Information and Research Service (PIRS).

Hendershott, Terrence, and Pam Moulton, 2011, Automation, speed, and stock market quality: The NYSE's hybrid, *Journal of Financial Markets* 14, 568–604.

Huang, Roger D., and Hans R. Stoll, 1996, Dealer versus auction markets: A paired comparison of execution costs on {NASDAQ} and the {NYSE}, *Journal of Financial Economics* 41, 313 – 357.

Kandel, Eugene, and Leslie M. Marx, 1999, Payments for order flow on NASDAQ, *Journal of Finance* 49, 35–66.

Kaniel, R., and H. Liu, 2006, So what orders do informed traders use?, *Journal of Business* 79, 1867–1913.

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

O'Hara, Maureen, Chen Yao, and Mao Ye, 2011, What's not there: The odd-lot bias in TAQ data, Johnson School Research Paper Series 31-2011 Cornell University.

Parlour, Christine, and Uday Rajan, 2003, Payment for order flow, *Journal of Financial Economics* 68, 379–411.

Petersen, Mitchell A., 2009, Estimating standard errors in finance panel data sets: Comparing approaches, *Review of Financial Studies* 22, 435–480.

Rosu, Ioanid, 2012, Liquidity and information in order driven markets, Working paper HEC Paris http://ssrn.com/abstract=1286193.

Schultz, Paul, 2003, Who makes markets, *Journal of Financial Markets* 6, 49–72.

SEC, 2010, Concept release on market structure, Release No. 34-61358, File No. S7-02-10, Discussion paper, Securities and Exchange Commission http://www.sec.gov/rules/concept/2010/34-61358.pdf.

Skjeltorp, Johannes Atle, Elvira Sojli, and Wing Wah Tham, 2013, Identifying cross-sided liquidity externalities, Working paper Erasmus University Rotterdam http://ssrn.com/abstract=2026593.

Thompson, Samuel B., 2011, Simple formulas for standard errors that cluster by both firm and time, *Journal of Financial Economics* 99, 1–10.

Weston, James P., 2000, Competition on the Nasdaq and the impact of recent market reforms, *Journal of Finance* 55, 2565–2598.

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

The table lists summary statistics for selected variables for five groups of securities: the NASDAQ/AMEX-cross-listed companies (the treatment group), the treatment group's non-crosslisted matches, and the three subsamples of the treatment group: securities with increases, decreases and no changes in their total fees relative to the control group's post-event fee of 1.81 bps. Unless otherwise specified, the numbers are average per day per security. 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 trades, and dealer crosses.

			NASDAQ/AMEX cross-listed	Non-crosslisted	fee increase	fee neutral	fee decrease
Number of firms			65	65	23	22	20
Total intraday July 2005 share volume	(millions)	Mean	3.017	4.036	3.879	2.054	3.085
		StD	(4.404)	(9.635)	(5.372)	(1.853)	(5.112)
		Median	1.435	1.888	2.096	1.207	1.343
Total intraday July 2005 dollar volume	(millions)		$ 39.95	$ 41.93	$ 10.49	$ 16.10	$ 100.10
			$ (95.81)	$ (123.70)	$ (15.82)	$ (17.82)	$ (157.40)
			$ 10.41	$ 13.51	$ 4.62	$ 10.26	$ 28.46
Total July 2005 transactions	(thousands)		4.784	3.533	2.938	3.621	8.187
			(6.547)	(5.338)	(2.788)	(2.944)	(10.390)
			2.554	2.011	1.921	2.728	3.663
Closing price end July 2005 (in $)			$ 12.67	$ 12.81	$ 2.40	$ 7.429	$ 30.26
			$ (18.06)	$ (17.84)	$ (0.81)	$ (2.17)	$ (24.63)
			$ 6.62	$ 6.63	$ 2.46	$ 7.02	$ 19.57
Market capitalization end July 2005	(billions)		$ 1.47	$ 1.66	$ 0.33	$ 0.51	$ 3.82
			$ (4.79)	$ (6.36)	$ (0.28)	$ (0.29)	$ (8.29)
			$ 0.51	$ 0.46	$ 0.20	$ 0.46	$ 0.96
Time weighted quoted spread (bps)			62.97	82.24	101.90	51.69	30.64
			(47.00)	(46.77)	(54.21)	(22.55)	(19.94)
			51.42	80.97	96.14	50.26	24.17
Time weighted quoted spread (cents)			4.33	5.96	2.16	3.45	7.80
			(4.22)	(5.03)	(0.85)	(1.22)	(6.18)
			3.28	4.02	1.96	3.42	5.62
Herfindahl Index broker level			0.22	0.23	0.24	0.22	0.21
			(0.06)	(0.06)	(0.07)	(0.05)	(0.07)
			0.22	0.23	0.23	0.23	0.19
Number of brokers			13.5	12.9	12.0	13.2	15.5
			(5.2)	(5.4)	(4.7)	(4.0)	(6.5)
			12.8	11.9	11.4	12.0	13.9

Table II
Pre-sample Summary Statistics by Trader Group

The table lists selected summary statistics for the group of retail vs. non-retail traders for five groups of securities: the NASDAQ/AMEX-cross-listed companies (the treatment group), the treatment group's non-crosslisted matches, and the three subsamples of the treatment group: securities with increases, decreases and no changes in their total fees relative to the control group's post-event fee of 1.81 bps. The statistics are for the pre-sample month of July 2005. The numbers are the average per day per security for the respective groups of retail and non-retail traders. Variable *% passive* is the fraction of volume that a trader trades with limit orders (the remaining volume is traded with market orders); variable *% limit orders* signifies the fraction of all orders that a trader submits that are limit orders (the remaining fraction are market orders); variable *price impact of market orders* is defined as the signed change in the midpoint of the bid-ask spread from the time of the trade to five minutes after the trade, and it is interpreted as a measure for the information content of the market order. Per stock per day, all variables are volume-weighted across the traders in the respective groups; the displayed numbers are average per stock per day. We present the means, standard deviations (in parentheses), and medians.

	Type of trader	Unit		NASDAQ/AMEX cross-listed	Non-crosslisted	fee increase	fee neutral	fee decrease
% passive	Retail	percent	Mean	44.0	35.7	44.1	44.0	44.0
			StD	(16.5)	(12.2)	(15.5)	(17.3)	(16.7)
			Median	43.7	35.6	43.6	43.6	43.8
	Non-Retail			51.9	60.5	51.7	51.8	52.1
				(7.5)	(10.4)	(7.0)	(7.6)	(7.8)
				51.5	59.0	51.5	51.3	51.5
% limit orders	Retail	percent		73.8	66.7	72.6	73.1	75.5
				(11.8)	(12.5)	(12.1)	(12.8)	(10.2)
				74.9	68.5	73.8	74.5	75.7
	Non-Retail			96.1	83.3	97.4	95.5	95.3
				(4.2)	(10.3)	(2.0)	(4.8)	(4.7)
				97.4	84.8	98.0	97.1	96.8
price impact of market orders	Retail	bps		24.0	29.2	19.2	24.2	28.2
				(49.2)	(54.7)	(37.0)	(51.7)	(56.1)
				13.9	18.7	11.8	13.7	17.1
	Non-Retail			52.1	61.8	38.4	55.0	62.1
				(57.2)	(66.5)	(39.0)	(62.9)	(63.1)
				36.1	45.2	28.4	35.9	44.5

Table III
Bid-Ask Spreads and Price Impact

The table examines the effect of the change of trading fees on the effective spread, the effective spread plus twice the taker fee, the 5-minute price impact, the realized spread, and the realized spread plus twice the maker rebate. The 5-minute price impact is defined as the signed change in the midpoint of the bid-ask spread from the time of the trade to five minutes after the trade, and it measures the information content of the market order. All measures are in basis points of the prevailing midpoint, and they are calculated as the volume-weighted average per day per security. The treatment group are the 65 NASDAQ/AMEX cross-listed securities; the sample period is from August 1, 2005 to November 30, 2005. The estimation is based on the following regression specification:

$$\Delta DV_{it} = \alpha_1 \textit{fee down}_i + \alpha_2 \textit{fee neutral}_i + \textit{event}_t \times (\beta_1 \textit{fee down}_i + \beta_2 \textit{fee neutral}_i + \beta_3 \textit{fee up}_i) + \gamma \mathsf{VIX}_t + \delta X_i + \xi + \epsilon_{it},$$

where ΔDV_{it} is the day t realization of the dependent variable for treatment group security i less the realization of the measure for the ith control group match; $\textit{event}_t$ is a dummy variable that is 1 after October 1 2005 and 0 before; VIX_t is the closing value of CBOE's volatility index for day t, X_i is a vector of the aforementioned security level control variables (it is omitted in the fixed effects specification), and ξ is the intercept. Dummy variables $\textit{fee down}_i$, $\textit{fee neutral}_i$, and $\textit{fee up}_i$ are indicator variables for whether security i is, respectively, in the fee decrease, fee neutral or fee increase sub-sample. We estimate the specification with and without fixed effects. 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. Standard errors are in parentheses and they are clustered by security and date.

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

Table IV
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, which is 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 a dummy variable that is 1 after October 1 2005 and 0 before; dummy variables $fee\ down_i$, $fee\ neutral_i$, and $fee\ up_i$ are indicator variables for whether security i is, respectively, in the fee-decrease, fee-neutral or fee-increase sub-sample. We estimate the specification with and without fixed effects. Coefficients for control variables and the VIX 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. Standard errors are in parentheses and they are clustered by security and date.

Dependent Variable	*log* dollar volume		transactions		fill rate	
Stock fixed effects	No	Yes	No	Yes	No	Yes
$event_t \times fee\ down_i$	0.05	0.05	43.15	43.15	2.58***	2.58***
	(0.10)	(0.11)	(38.03)	(43.35)	(0.84)	(0.87)
$event_t \times fee\ neutral_i$	0.32*	0.32*	55.87*	55.87*	1.37**	1.37**
	(0.18)	(0.18)	(29.76)	(30.26)	(0.64)	(0.67)
$event_t \times fee\ up_i$	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
$fee\ down \neq fee\ up$					Yes***	Yes***
$fee\ down \neq fee\ neutral$						
$fee\ up \neq fee\ neutral$					Yes***	Yes***

Table V
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 security: % limit orders, % passive, log (aggressive dollar volume), and cum fee total costs. % limit orders is the % of all order that are limit orders; % passive is the percent of volume traded with passive limit orders; log (aggressive dollar volume) is the logarithm of the total dollar volume traded with marketable orders; and cum fee total costs are computed as the volume-weighted difference of the cum fee effective spread paid (for active orders) and the cum fee realized spread received (for passive orders). The presented results are based on estimating equation (3):

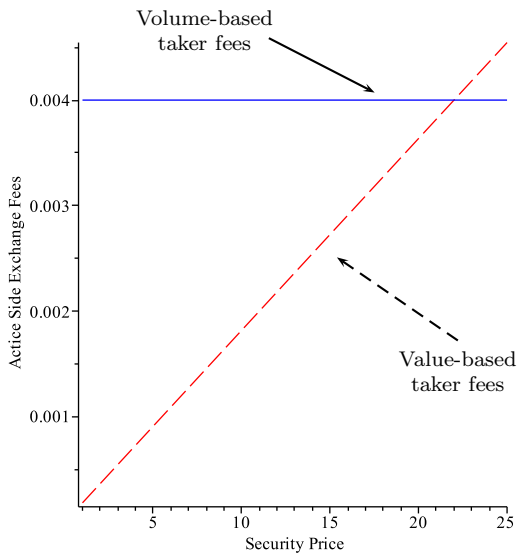
$$\begin{aligned}\Delta DV_{it} \quad = \quad & \alpha_0 retail_{it} + retail_{it} \times (\alpha_1 fee\ down_i + \alpha_2 fee\ neutral_i + event_t \times (\beta_1 fee\ down_i + \beta_2 fee\ neutral_i + \beta_3 fee\ up_i)) \\ & + non\text{-}retail_{it} \times event_t \times (\beta_4 fee\ down_i + \beta_5 fee\ neutral_i + \beta_6 fee\ up_i) + \gamma \mathsf{VIX}_t + \delta X_i + \xi + \epsilon_{it},\end{aligned}$$

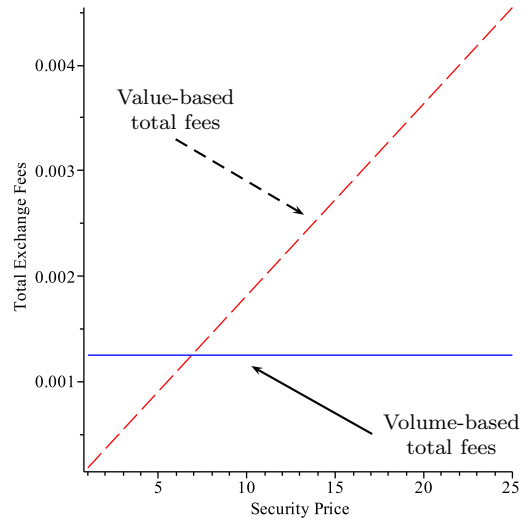
where ΔDV_{it} is the day t realization of the dependent variable for treatment group security i less the realization of the measure for the ith control group match; $event_t$ is a dummy variable that is 1 after October 1 2005 and 0 before; VIX_t is the closing value of CBOE's volatility index for day t, X_i is a vector of the aforementioned security level control variables (it is omitted in the fixed effects specification), and ξ is the intercept. Dummy variables $fee\ down_i$, $fee\ neutral_i$, and $fee\ up_i$ are indicator variables for whether security i is, respectively, in the fee-decrease, fee-neutral or fee-increase sub-sample. Dummy variable $retail_{it}$ is 1 if the value of the dependent variable was for retail traders and 0 otherwise, and $non\text{-}retail_{it} = 1 - retail_{it}$. 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. Standard errors are in parentheses and they are clustered by security and date.

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





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

$$\text{Value-based total fee} = \text{taker} - \text{maker} = \text{price} \times \left(\tfrac{1}{55} \times 1\% - 0\right)$$
$$\text{Volume-based total fee} = \text{taker} - \text{maker} = \$0.004 - \$0.00275$$

Figure 2
Differences in Total Fees

The panel plots the difference of volume- vs. value-based total exchange fees, $(\$.004 - \$.00275)/p - 1/55 \times 1/100$, measured in basis points, against the securities' July 2005 closing prices p, for the sample of cross-listed securities; we omit 9 stocks that have prices above \$22 to improve the exposition of the graph.

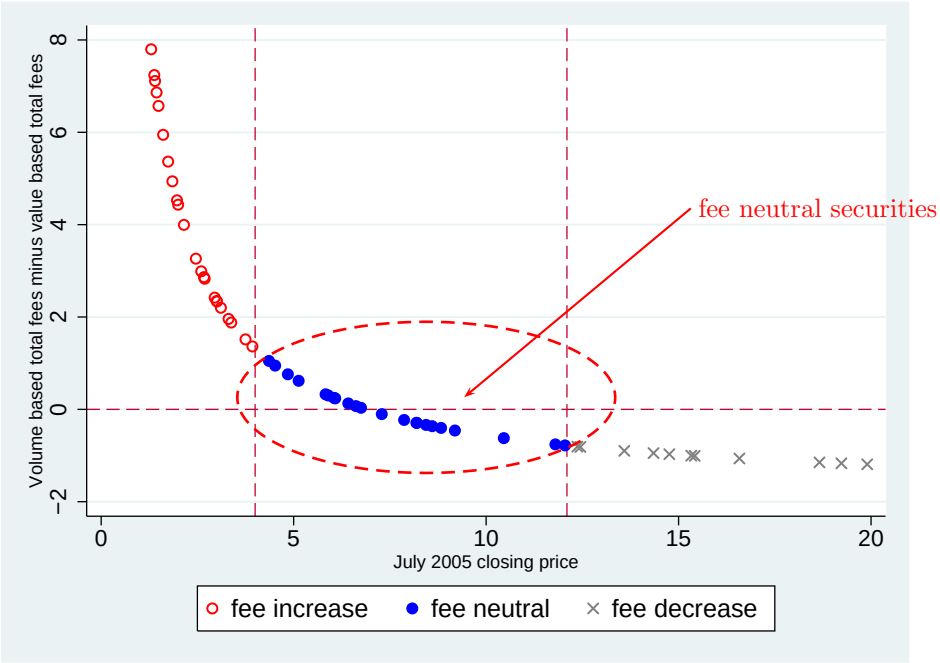


Figure 3
Effective Spreads without and with Taker Fees

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 cross-listed securities for which the total exchange fee after October 1, 2005, was close to the 1.8 basis point post-event total fee of the non-crosslisted securities. 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.

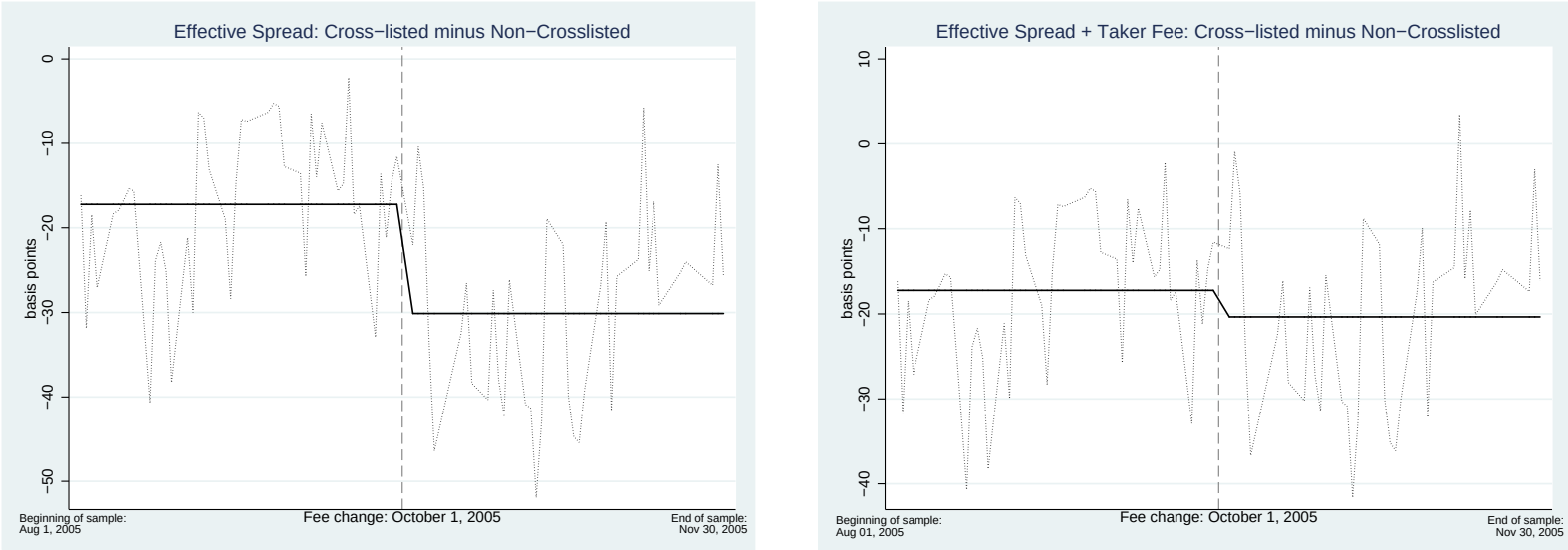


Figure 4
Realized Spreads plus Maker Rebate and Price Impact

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 cross-listed securities for which the total exchange fee after October 1, 2005, was close to the 1.8 basis point post-event total fee of the non-crosslisted securities. 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.