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

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Abstract

In recent years most equity trading platforms moved to subsidize the provision of liquidity. Under such a make/take fee structure, submitters of limit orders typically receive a rebate upon execution of their orders, and the exchange covers its costs by charging a higher fee for market orders. Trading rebates have, arguably, been a major facilitator for the emergence of algorithmic trading. We study the impact of this, now prevalent, fee structure on market quality, market efficiency, and trading activity by analyzing the introduction of liquidity rebates on the Toronto Stock Exchange. Using a proprietary dataset, we find that the liquidity rebate structure leads to decreased spreads, increased depth, increased volume, and intensified competition in liquidity provision. Explicitly accounting for exchange fees and rebates, we further find that trading costs for market orders did not decrease and that per share revenues for liquidity providers increase, despite the reduced bid ask spreads and increased competition. Finally, we find no evidence for changes in intermediation or market efficiency.

JEL Classification: G12, G14.

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The equity trading landscape has changed dramatically over the last decade. Worldwide, most public markets moved away from human interactions and are now organized as electronic limit order books, where traders either post passive limit orders that offer to trade a specific quantity at a specific price or submit active market(able) orders that "hit" posted limit orders. Posters of passive limit orders provide, or "make", liquidity, submitters of active market orders "take" liquidity. In contrast to traditional intermediated markets, limit order books rely on the voluntary provision of liquidity and must offer enough of it to attract trading. As a result, it is now the industry standard to subsidize passive trading volume.

This practice, known as make/take fees, is controversial. It has been argued that the subsidies caused excessive intermediation by attracting algorithmic traders that solely focus on capturing fee rebates.[1] Moreover, while some market-making firms are in favour of liquidity subsidies, other market participants have voiced concerns that make/take fees could result in excessive costs for liquidity takers.[2] To the best of our knowledge, there is no empirical study that conclusively addresses advantages and disadvantages of make/take fees. The present study aims to fill this gap.

Our analysis is based on trading fee changes on the Toronto Stock Exchange (TSX) and uses a proprietary database.[3] The TSX phased in the liquidity fee rebates on two distinct dates, introducing them on October 01, 2005 for all securities that were interlisted with NASDAQ or AMEX and on July 01, 2006 for the remainder of the securities. We study the 2005 change,[4] after which an active marketable order incurred a per share fee of $.004 and a passive limit order that is "hit" received a per share fee rebate of $.00275.

[1]See "Rise of the machines: Algorithmic trading causes concern among investors and regulators", The Economist July 30th 2009.

[2]See, for instance, the comments for the make/take fee structure in the options markets sent to the SEC by GETCO at http: //www.getcollc.com/images/uploads/getco_comment_090208.pdf, or the petition by Citadel in favor of a fee cap at http: //www.sec.gov/rules/petitions/2008/petn4-562.pdf. Responding to these concerns, the SEC even imposed a 30-cent ceiling on stock exchanges for 100-share equity trades.

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[4]The 2006 event also involved a change in the fees for the NASDAQ and AMEX interlisted securities, making it difficult to isolate the effect of liquidity rebates.

Active orders for stocks that did not move to this rebate structure incurred a cost of 1/55 of 1% (1.8 basis points) of the dollar value of the transaction and passive orders were free. To put the make/take fees into perspective, the median end July 2005 closing price in our sample of 73 companies that were interlisted with NASDAQ and AMEX is $6.08. The per share taker fee of $0.004 translates into a fee of 6.58 basis points at the median, the passive side's per share rebate of $.00275 translates into 4.52 basis points at the median.

Our empirical strategy is an event study on the introduction of the fee rebates. Since the change affected the incentives for liquidity provision for only a subset of companies, we are able to control for market wide conditions by matching securities that were affected with securities that were not. We then perform tests using a difference-in-differences approach to capture the marginal impact of the fee structure change on market quality, trader welfare, volume, and competition for liquidity provision.

We assess market quality by standard bid-ask spread, depth and market efficiency measures. We find that, compared to the control group, securities that were interlisted on NASDAQ or AMEX experienced a decrease in their time weighted quoted spreads of 12.1 basis points and an increase in their quoted depth.[5] Studying autocorrelations of midquote returns, and the 5/30 minute and 15/30 minute variance ratios to detect changes in market efficiency, we find no effect. We thus conclude that the fee rebates improve liquidity offered throughout the day and that there is no evidence that they affect market efficiency.

A liquidity taker's welfare is commonly measured by the transaction costs, which are proxied by the effective spread. For a buyer initiated transaction, the effective spread is twice the difference between the average per share price and the prevailing midpoint of the quoted bid and offer prices. We observe a marked decline in effective spreads, which indicates that liquidity makers passed on some of their fee rebate to takers. After adjusting the effective spread to account for the exchange fees, however, we find no evidence that

[5]Bid-ask spreads on the TSX are, on average, larger than those on U.S. exchanges, even though the TSX is one of the world's largest exchanges by market capitalization and trading volume. Since 2005, however, spreads have fallen substantially.

transaction costs have declined — instead we identify a (statistically weak) increase.

A liquidity maker's per share revenue is commonly proxied by the magnitude of the price reversal after a transaction, and it is measured by the realized spread. For a buyer initiated transaction, the realized spread is twice the difference between the average per share price and the midpoint of the quoted bid and offer prices several minutes after the transaction. Here, too, we observe a decline in the spread.

The decrease in the spreads suggests that liquidity providers pass on some of their rebate to liquidity takers. One question is whether competition is so fierce that the entire rebate gets "competed away". To fully capture the revenue benefit to liquidity providers, we adjust the realized spread to include the fee rebate. We find that the total revenues to liquidity makers actually increased and that this effect is particularly pronounced for stocks with low competition for liquidity provision.

A key objective of subsidizing liquidity provision is for the exchange to attract more volume. We indeed find an increase in volume, which is somewhat surprising considering that transaction costs actually went up. A potential criticism of fee rebates is that an increase in volume may be caused merely by increased intermediation. The argument is that to capture liquidity rebates, an intermediary such as an algorithm "injects" itself between two (cost insensitive) traders who would have otherwise transacted on their own. As our data allows us to identify orders that originate from clients, we can study intermediation by analyzing the fraction of client to non-client trades. If there are relatively more client to non-client trades, then the higher volume is at least partly due to an increase in intermediation. Yet we do not find any change in the fraction of client to non-client trades and are left with the puzzle that both volume and transaction costs have increased.

Finally, with the introduction of fee rebates, ceteris paribus, it becomes cheaper to post limit orders. It is then imaginable that institutions see the introduction of rebates as an opportunity to enter the market for liquidity provision. To asses the extent of competition, we count the number of improvements in the best bid and offer prices and depth, the number of liquidity providing market participants that are involved in transactions, and

we compute the Herdindahl Index of market concentration. The latter, also known as the Herfindahl-Hirschman Index,[6] is widely used as a proxy for the competitiveness of a given industry — for instance, the U.S. Department of Justice and the Federal Trade Commission use it to assess the effects of a merger on competition — and it is computed as the sum of the squared market shares. The higher the index, the lower the level of competition. When it comes to trading, the good provided is liquidity. In traditional dealer markets, market share in liquidity is synonymous with market share in volume and the Herfindahl index for the concentration of market making is computed based on dealers' shares of volume (see Ellis, Michaely, and O'Hara (2002) and Schultz (2003)). In an electronic limit order book such as the TSX, liquidity is supplied by passive orders. We thus measure a trader's market share as the fraction of limit order volume that this trader provides.

We find a significant increase in the number of improvements in the bid ask spread and depth, which we show to be driven by improvements in depth. The number of spread improvements, on the other hand, declines. Since the average depth also increases, we conclude that after the fee change, traders compete more aggressively on depth. We further show that the increase in the number of quote improvements is driven by two factors. First, traders compete more aggressively for liquidity provision, as is implied by a decrease in the Herfindahl Index. Second, we find (weak) evidence that the fee rebates attract new entry in the market for liquidity provision.

To summarize our results, we find that competition, particularly on depth, intensifies. Although liquidity providers lower spreads in response to the fee change, their per share revenues increase, taking rebates into account. This hints at the possibility that competition in prices is less relevant than competition for market share in liquidity provision.

Colliard and Foucault (2011) provide theoretical guidance for the effects of a fee change. They show that trader welfare is affected only by the total fee, i.e. the sum of maker and taker fees, and that the make/take fee composition has no impact, provided

[6]See, e.g. Tirole (1988); see also Hirschman (1964) for a discussion of the origin of the index.

the tick size is zero, because quotes adjust to neutralize any fee redistribution. In our study, the total fee increases for stocks with low prices and declines for stocks with high prices. Since the fees change for all stocks, we cannot address changes in the composition. However, we do find support for Colliard and Foucault's theoretical prediction that an increase in the total fee decreases taker welfare. Furthermore, our findings support their prediction that the bid-ask spread decreases in the take fee and increases in the make fee.

Foucault, Kadan, and Kandel (2009) find theoretically that the optimal make/take fee composition depends on the relative levels of competition among the liquidity providers and liquidity demanders, and on the relative monitoring costs for these two groups. They argue that the lower fee (or a rebate) on the liquidity makers will increase the trading rate and aggregate welfare only under some conditions (for instance, when liquidity providers have higher monitoring costs than liquidity demanders, or when the level of competition among liquidity providers is low compared to that among liquidity demanders). When these conditions are not satisfied, the optimal make/take fee structure would impose higher fees on makers rather than on takers. Finally, our work also relates to Degryse, Van Achter, and Wuyts (2011) who theoretically study the impact of clearing and settlement fees on liquidity and welfare.

The next section reviews trading on the TSX and the details of the fee changes. Section 2 describes the data, the sample selection, and the regression methodology. Section 3 discusses results on market quality and efficiency. Section 4 describes trader welfare, Section 5 presents results on volume and intermediation, Section 6 discusses competition. Section 7 concludes. Tables and figures are appended.

1 The Toronto Stock Exchange and its Trading Fees

1.1 Trading on the TSX

The Toronto Stock Exchange (TSX) has been an electronic-only trading venue since it closed its physical floor in 1997. In 2005, the TSX was the seventh largest exchange

world-wide in terms of market capitalization of traded securities and twelfth largest in dollar trading volume.[7]

Trading on the TSX is organized in an upstairs-downstairs structure. Orders can be filled by upstairs brokers (usually these are very large orders), who have price improvement obligations, or they can be cleared via the consolidated (electronic) limit order book. The TSX limit order book generally follows the so-called price-time priority.[8] It is constructed by sorting incoming limit orders lexicographically, first by their price ("price priority") and then, in case of equality, by the time of the order arrival (with the earlier orders enjoying the "time priority"). Transactions in the limit order book occur when active orders — market orders (orders to buy or sell at the best available price) or marketable limit orders (e.g. a buy limit order with a price higher than the current best ask) — are entered into the system. Unpriced market orders occur very infrequently on the TSX, and in what follows we will use the term "active order" to for the marketable portion of an order, and we use "passive order" for a standing limit order that is hit by an active order. Active orders "walk the book", i.e., if the order size exceeds the number of shares available at the best bid or offer price, then the order continues to clear at the next best price.

All orders must be sent to the TSX by registered brokers (the Participating Organizations (P.O.)). Trading is organized by a trading software (the trading engine), and our data is the audit trail of the processing of the trading engine. We describe the data in more detail in Section 2. Orders of sizes below round lot size (for the companies in our sample this size is 100 shares) are cleared by the equity specialist, referred to as the Registered Trader (RT). Similarly, portions of orders that are not multiples of the round lot size (e.g. 99 shares of a 699 share order) will be cleared by the RT, after the round lot portion of the order has cleared (e.g. the 99 shares of a 699 share order will clear after, and only if, the 600 shares have cleared). Furthermore, the RT has the obligation to provide minimum fills when there are no standing limit orders, but the RT's powers

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

[8]One exception to this rule is a so-called unintentional cross, where time priority is overruled if active and passive orders are submitted by the same broker.

are small compared to those of the NYSE designated market maker (formerly referred to as the specialist),[9] and the RT is involved in only about 1.3-1.4% of the dollar volume in our sample (see Table 3).

The TSX with its public, electronic limit order book thus largely relies on its users to voluntarily supply liquidity by posting limit orders. This system contrasts traditional systems where dealers are institutionally obliged to make a market.

1.2 Details of the Change in Trading Fees

The TSX was a monopolist for equity trading in Canada during our sample period, and the lack of market fragmentation allows us to isolate the impact of liquidity rebates. When fee rebates were introduced in Europe or the U.S., on the other hand, these markets were already beginning to fragment.

The TSX phased in the liquidity rebates on two discrete dates, introducing them on October 01, 2005 for the TSX companies that were interlisted on NASDAQ or AMEX; on July 01, 2006 all remaining companies switched; we focus on the 2005 change of fees.[10]

Prior to October 01, 2005, all TSX securities were subject to the so-called value-based trading fee system, under which the active side of each transaction incurred a fee based on the dollar amount of the transaction (1/50 of 1% a the dollar-amount in the months immediately preceding October 01) and the passive side incurred no fee or rebate. On October 01, TSX-listed securities that were also interlisted with NASDAQ and AMEX switched to a volume-based trading regime, under which for each traded share the active side had to pay a fee of $.004 and the passive side obtained a rebate on its exchange fees of $.00275. All other securities remained at the prevailing value-based regime, although, the fees were slightly reduced — after October 01, 2005, active orders incurred a fee of

[9]Subject to tight rules, the RT has the right to participate in orders to unload a pre-existing inventory position that she or he built up in the process of providing liquidity to markets. The RT has no informational advantage over other traders.

[10]We restrict attention to the 2005 change for two reasons: first, in 2006 there was a change in the level of fees simultaneously with the switch to a make/take fee structure. Second, a difference-in-differences analysis in 2006 has less statistical power because the treatment group, non-interlisted securities, is much larger than the control group, interlisted stocks.

1/55 of 1% of the dollar-amount of the transaction and passive orders remained free. The value based taker fee per trade is capped at $50, the volume based taker fee and maker rebate are capped at $100 and $50, respectively.

Compared to the old value based fee structure, the new volume based billing yields the TSX higher per share fee revenue for securities that trade below $6.875. Liquidity takers pay less for securities that trade above $22.[11] To put these fees into perspective, the median closing price at the end of July 2005 in our sample of the companies that were interlisted with NASDAQ and AMEX is $6.08. Under the "old" value-based system, the per share taker fee is 1.8 basis points (which is $0.00111 at the median), there was no maker fee or rebate, and thus the TSX's per share revenue is 1.8 basis points. Under the "new" volume based billing, the taker fee is $0.004 (or 6.58 basis points at the median), the passive side's rebate is $.00275 per share (or approximately 4.52 basis points at the median), and thus the TSX's revenue at the median price is about 2 basis points.

2 Data, Sample Selection, and Methodology

2.1 Data Sources

Our analysis is based on a proprietary dataset, provided to us by the Toronto Stock Exchange (TSX). Data on market capitalization, monthly volume, splits, and (inter-) listing status is obtained from the monthly TSX e-Reviews publications. Data on the CBOE's volatility index VIX is from Bloomberg. We analyze the effect of the fee structure change by looking at a 4 month window (2 months before and 2 months after the introduction of the liquidity rebates), from August 01, 2005 to November 30, 2005. The TSX participating organizations are billed at the end of each month, and the event window was chosen to include the month immediately following the change as well as one month after the first bill that was based on the new fee structure. We exclude trading days that have no

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

or limited U.S. trading (an example is the U.S. Thanksgiving and the Friday following it); information on scheduled U.S. market closures is obtained from the NYSE Calendar. We further exclude October 11, 2005 and November 21, 2005 as the TSX data included several recording errors for these days.

The TSX data that is provided to us is the input-output of the central trading engine, and it includes all messages that are sent to and from the brokers. The data contains public and private information for all orders, cancellations and modifications sent to the limit order book, public and private information on all trade reports, and details on dealer (upstairs) crosses. Further, the data contains all the system messages and user notifications, for instance, announcements about changes in the stock status, such as trading halts and freezes, announcements about estimated opening prices, indications that there is too little liquidity in the book (the spread is too wide), and so on.

Each message consists of up to 500 subentries, such as the date, ticker symbol, time stamp, price, volume, and further information that depends on the nature of the message. For instance, order submission, notification and cancellation messages contain information about the order's price, total and displayed volume, the orders's time priority, broker ID, trader ID, order number (new and old for modifications), information about the nature of the account (e.g. client, inventory or equity specialist), information about whether an order is submitted anonymously or whether the broker number is to be displayed in the TSX pay-for data feed,[12] information about whether an order is a short sale, and some further details that we do not exploit in this project.

For each order that is part of the trade, the data additionally contains the volume of the transaction as well as the public (as sent to the data feeds) and private (the actual) remaining volumes, information on whether an order was filled by a registered trader and where it was executed (e.g. in the public limit order book, with a specialist outside the limit order book (for oddlots), in the market for special terms orders, or crossed by a

[12]In accordance with Canadian regulations, the choice of whether to attribute the order to a particular dealer remains with the dealer. Submitting a non-anonymous order may be advantageous for time priority reasons. Traders can also specify that they do not want to clear against an anonymous order.

broker). The liquidity supplier rebates only affect trades that clear via the limit order book. Consequently, we exclude opening trades, oddlot trades, dealer crosses, trades in the special terms market, and trades that occur outside normal trading hours.

Importantly for the construction of the liquidity and competition measures, the transaction data specifies the active (liquidity demanding) and passive (liquidity supplying) party, thus identifying each trade as buyer-or seller-initiated. Finally, one useful system message is the "prevailing quote". It identifies the best bid and ask quotes as well as the depth at the best quotes, and it is sent each time there is a change in the best quotes or the depth at these quotes. This message allows us to precisely identify the prevailing quote at each point in time.

2.2 Sample Selection

We construct our sample as follows. Out of 3,000+ symbols that trade on the TSX, we include only common stock and exclude debentures, preferred shares, notes, rights, warrants, capital pool companies, stocks that trade in US funds, companies that are traded on the TSX Venture and on the NEX market, exchange traded funds, and trust units. We require that the companies had positive volume in July 2005, according to the TSX e-Review, and were continuously listed between July 2005 and November 2005. We further exclude securities that had stock splits, that were under review for suspension, that had substitutional listings, and that had an average daily midquote below $1.

Differently to commonly applied filters, we retain companies with dual class shares. This is due to a peculiarity of the Canadian market, where, 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)). We exclude Nortel (symbol: NT) because it was involved in a high profile accounting scandal at the time of our sample period (along with Worldcom and Enron). Finally, we omit companies that have insuf-

ficient trading for the computation of major liquidity measures; specifically, we require that there is enough data to compute the realized spread for 95% of the 80 trading days that comprise our sample.

We determine a company's interlisted status from the TSX e-Reviews. We then classify companies as "interlisted with NASDAQ or AMEX" in our 2005 sample if they were interlisted with NASDAQ or AMEX from August to November 2005 and non-interlisted with NASDAQ and AMEX if they were not interlisted from August to November. Companies that changed their (inter-)listing status during the sample period or for which the status was unclear were omitted from the sample.

We are then left with 73 NASDAQ and AMEX interlisted companies and 374 TSX only and NYSE interlisted companies. In what follows, we will refer to companies that are interlisted with NASDAQ and AMEX as "interlisted", and we will refer to companies that are listed only on the TSX or that are interlisted with NYSE as "non-interlisted".

2.3 Matched Sample

We construct the matched sample as follows. Using one-to-one matching without replacement, we determine a unique non-interlisted match for each of the interlisted securities based on closing price, market capitalization, and a level of competition for liquidity provision, as measured by the Herfindahl Index (formally defined in the next subsection).

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

traders' behavior, welfare and the levels of intermediation.[13] Finally, we aim to identify the impact of the introduction of the liquidity rebates, and according to Foucault, Kadan, and Kandel (2009), who study the make/take fees theoretically, this impact depends on the level of competition among traders.

We randomize the order of matching by sorting the stocks in the treatment group (i.e. the interlisted securities) alphabetically by 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. Tables 14 and 15 contain the list of interlisted companies and their matches.

2.4 Measuring Competition: The Herfindahl Index

We quantify competition among traders by the Herfindahl Index. The index is widely used to assess market concentration and it computed as the sum of the squared market shares. We study the market for liquidity provision. In an electronic limit order book, liquidity is provided by passive orders and a trader's market share is the fraction of passive limit order volume that this trader provides.[14] The Herfindahl Index for different levels of liquidity providing entities (e.g., broker, trader) per day t per security i is

$$HHI_{it} = \sum_{k=1}^{n_t} \left(\frac{passive\ volume_{it}^k}{\sum_{k=1}^{n_t} passive\ volume_{it}^k}\right)^2, \tag{2}$$

[13] 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.

[14] 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.

where n_t is the number liquidity providing entities on day t in security i and $passive\ volume_{it}^k$ is the $k-$th entity's total passive volume for that day and security. Higher values of the index correspond to higher levels of market concentration and thus to lower levels of competition (value 1 corresponds to monopolistic liquidity provision).

We consider two levels of liquidity providing entities, namely, the broker and the trader level. At the broker level, the passive volume per security per day is the total intraday passive volume of that broker, excluding dealer crosses. The "broker level HHI" does not differentiate between trades that brokers post by client request and that they post on their own accounts to make a market. To better understand the behavior of institutions that provide liquidity on an ongoing basis, we compute the index for traders that trade in and out of their inventories; in our data such trades stem from either an inventory or a equity specialist account. We refer to the latter index as the "trader level HHI."

We also compute the number of liquidity providing brokers and liquidity providing inventory traders to shed some light on possible changes in competition indices.

2.5 Panel Regression Methodology

For each security in our sample and for each of their matches, we compute a number of liquidity and market activity measures for the 4 month window around the event date (2 months before and after October 01, 2005). Our panel regression analysis employs a difference in differences approach and thus controls for market-wide fluctuations. To additionally control for U.S. events that may affect interlisted securities differentially, we include the CBOE volatility index VIX in our regressions. For each measure, we run the following regression[15]

$$dependent\ variable_{it} = \beta_0 + \beta_1 fee\ change_t + \beta_2 \mathsf{VIX}_t + \sum_{j=1}^{8} \beta_{2+j}\, control\ variable_{ij} + \epsilon_{it},$$

[15]This regression methodology is similar to that in Hendershott and Moulton (2011). We discuss an alternative methodology in the appendix.

where *dependent variable*$_{it}$ is the time t realization of the measure for treatment group security i less the realization of the measure for the ith control group match; *fee change*$_t$ is an indicator variable that is 1 after the event date and 0 before; VIX_t is the closing value of CBOE's volatility index for day t, and *control variable*$_{ij}$ are security level control variables for the company and its match: the log of the market capitalization, the log of the closing price, and the share turnover and the daily midquote return volatility in the month before the event window, July 2005.[16] Summary statistics for our treatment and control group are in Table 2.

We conduct inference in all regressions in this paper using double-clustered Cameron, Gelbach, and Miller (2011) standard errors, which are robust to both cross-sectional correlation and idiosyncratic time-series persistence.[17] For brevity we display only the estimates for the coefficient β_1 on the fee change dummy, and we omit the estimates for the constant as well as estimates for the coefficients on VIX and on the controls. The number of observations roughly equals the number of companies in the treatment group multiplied with the number of trading days in our sample periods (correcting for a small number of missing observations when a company or its match did not trade for a day), at most 5,840 observations.

Regressions for Subsamples. In addition to analyzing the impact of the fee structure change on the entire sample, we estimate the effects separately for the groups of treatment companies above and below the median with respect to pre-sample (July 31, 2005) market capitalization, total July 2005 trading volume (in shares), and the average July 2005 Herfindahl index of market concentration at the broker level. Medians of market capitalization, volume, and the Herfindahl Index are, respectively, $475 million, 1.795

[16] In unreported regressions we further controlled for company fixed effects. We also used dynamic instead of the July 2005 static controls for prices. In both cases, the results are similar.

[17] Cameron, Gelbach, and Miller (2011) and Thompson (2010) 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.

million shares, and 0.2296 (Table 2). We estimated the following equations

$$\begin{aligned} \textit{dependent variable}_{it} &= \beta_0 + \beta_1 \textit{fee change}_t \times \textit{above median}_i \\ &\quad + \beta_2 \textit{fee change}_t \times \textit{below median}_i + \beta_3 \textit{above median}_i \\ &\quad + \beta_4 \mathsf{VIX}_t + \sum_{j=1}^{8} \beta_{4+j} \textit{control variable}_{ij} + \epsilon_{it}, \end{aligned} \tag{3}$$

where *above median*$_i$ is an indicator variable that equals 1 if security i has market capitalization (or trading volume, TSX share of volume, Herfindahl index) above the median; similarly for the variable *below median*$_i$.

Furthermore, as we explain in Section 1.2, under the new volume-based make/take fee structure liquidity takers pay lower fees for stocks that trade at high prices (above \$22). We thus estimated the effects separately for stocks with July 31 closing prices above and below \$22, where the regression equation is the same as (3), except *above median*$_i$ equals 1 if security i's July 31 closing price is above \$22; likewise for *below median*$_i$. We will henceforth refer to a closing price of \$22 as the "break-even price." Similarly, in Section 1.2 we also explain that the total fees, i.e. taker fee minus maker rebate, increase for securities that trade at prices below \$6.875 and otherwise decrease. We thus study subsamples of securities with July 31 closing prices above and below \$6.875.

We report only the estimates of interest, i.e. the estimated coefficients on the interaction terms *fee change*$_t \times$ *above dummy*$_i$ and *fee change*$_t \times$ *below dummy*$_i$. Results from tests for differences in the coefficients are indicated in the respective tables.

3 Market Quality

3.1 Quoted Liquidity

We measure quoted liquidity using time and trade weighted quoted spreads and depth. The *quoted spread* is the difference between the best price at which someone is willing to buy, or the offer price, and the best price at which someone is willing to sell, or

the bid price. We express the spread measures in basis points as a proportion of a prevailing quote midpoint. *Share depth* is defined as average of the number of shares that can be traded on the bid and offer side; the *dollar depth* is the dollar amount that can be traded at the bid and the offer. We use logarithms of the depth measures to ensure a more symmetric distribution since several Canadian companies, particularly, non-interlisted ones, historically have very large depth. High liquidity refers to large depth and small spreads.

The trade weighted spread and depth are the prevailing spread and depth averaged over transactions, and they capture the impact of the fee change on executions. The time weighted measures additionally reflect the availability of liquidity throughout the day.

Results. Figure 1 shows a marked decline in the quoted spread after the event date and an increase in the dollar depth. The summary statistics in Table 3 paint a similar picture, and our panel regressions further confirm these observations. The panel regression results for the change in the quoted spread are in the first two columns of Table 4. The first column depicts the time weighted quoted spreads, the second column displays the trade weighted quoted spreads.

The average price for interlisted companies on September 30, 2005, was \$12.07, the median price was \$5.66. The size of the rebate in 2005 was ¢.275 per share, which translates into 4.56 and 9.72 basis points at the average and median prices, respectively, for a round-trip transaction (i.e., a simultaneous passive buy and sell). We observe that the estimate on the time weighted quoted spread declines by 12.09 basis points, the trade weighted quoted spread declines by 9.34 basis points. The latter is roughly the amount of the rebate at the median price and around double the rebate at the mean price. These results are significant at the 1% level.

When considering subsamples, we find that significant effects arise for stocks that trade below the break-even price for market orders, \$22, for all levels of competition, market capitalization, and total fees, and for stocks that have high volume. Further, the coefficient estimates differ significantly for subsamples with respect to the break-even price.

Table 5 displays the results of our panel regressions on depth. We find that time and trade weighted share and dollar depth all increase significantly. Further, these increases are significant in the subsamples of securities with prices below the break-even price for market orders, with prices above the break-even price for total fees, with high competition, with high market capitalization, and with low trading volume.

In summary, quoted liquidity improves in that spreads become tighter and more shares/dollar volume can be traded at the best bid and offer prices.

3.2 Effective Liquidity

Quoted liquidity only measures posted conditions, whereas effective liquidity captures the conditions that traders decided to act upon. The costs of a transaction to the liquidity demander are measured by the *effective spread*, which is is the difference between the transaction price and the midpoint of the bid and ask quotes at the time of the transaction. For the t-th trade in stock i, the proportional effective spread is defined as

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

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 includes identifiers for the active and passive side for each transaction, thus precisely signing the trades. Further, our data is message by message, as processed by the trading engine, and it includes quote changes. The prevailing quote is thus precisely identified as the last quote before the transaction.

The change in liquidity provider profits is measured by decomposing the effective spread into its permanent and transitory components, namely the *price impact* and the *realized spread*,

$$espread_{ti} = priceimpact_{ti} + rspread_{ti}. \tag{5}$$

The price impact reflects the portion of the transaction costs that is due to the presence of informed liquidity demanders, and a decline in the price impact would indicate a decline in adverse selection. The realized spread reflects the portion of the transaction costs that is attributed to liquidity provider revenues. In our analysis we use the five-minute realized spread, which assumes that liquidity providers are able to close their positions at the quote midpoint five minutes after the trade. The proportional five-minute realized spread is defined as

$$rspread_{ti} = 2q_{ti}(p_{ti} - m_{t+5\ \min,i})/m_{ti}, \tag{6}$$

where p_{ti} is the transaction price, m_{ti} is the midpoint of the quote prevailing at the time of the t-th trade, $m_{t+5\ \min,i}$ is the midpoint of the quote 5 minutes after the t-th 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.

Results. Figure 2 plots the 5-day moving averages of the effective spread and the price impact for each of our the treatment group of interlisted and their control group matches. The figure suggests that the change in the fee structure led to a decrease in the effective spread, and it also indicates a decline in the price impact. The summary statistics in Table 3 point to significant improvement of liquidity, and the panel regressions confirm this observation.

The third column of Table 4 shows that after the fee change effective spreads fell significantly, by about 10 basis points. We further find significant effects in subsamples with prices below the break-even price of \$22, for low market capitalization, high trading volume, and all levels of competition. Coefficients for the subsample estimates differ significantly for below vs. above the break-even price.

The fourth column of Table 4 displays our regression results for realized spreads. We find that 5-minute realized spreads decline by 5.23 basis points. In subsamples we find significant effects for prices blow the break-even price, high competition, and high volume. The price impact, listed in the fifth column of Table 4 declines by 5 basis

points. In subsamples we find significant effects for prices blow the break-even price, low competition, low market capitalization, and high volume.

The decline in transaction costs, as measured by the effective spread, can be due to liquidity makers foregoing some of their revenue, or it can be attributed to a change in trade informativeness. We conclude that the liquidity providers share some portion of the rebate by lowering their revenue and also that adverse selection declines. The decline in adverse selection is consistent with the idea that narrower spreads attract new, price-sensitive uninformed traders and informed traders with weaker information. Our findings on an increase in volume that we discuss in Section 5 further support this idea.

With perfect competition for liquidity provision, liquidity makers would pass on their credits to liquidity takers across the board. We find, however, that the effective spread declines *only* for the subsample of securities that have higher per share fees for liquidity takers under the new volume based make/take fee system compared to the old value-based billing. Since the realized spread also declines significantly for this subsample, we conclude that liquidity providers only pass on their rebates for the subset of securities that experienced an increase in liquidity takers fees.

Colliard and Foucault (2011) provide some theoretical guidance for the effects of a fee change. Their model predicts that the bid-ask spread decreases in the take fee and increases in the make fee. In our study, the make fee declines (from 0 to $-\$.00275$ per share), and we find that spreads decline, as predicted (see Table 4). The take fee, on the other hand, increases for stocks with low prices and declines for stocks with high prices. Consistent with the theoretical predictions, we find that spreads decline for low price stocks, and that the coefficient for high price stocks is insignificantly different from 0.

3.3 Market Efficiency

We measure market efficiency with two standard proxies, the return autocorrelation and the variance ratio. Specifically, we analyzed the impact of the liquidity rebate structure on

the first order autocorrelations of 5-, 15-, and 30-minute midquote returns, and the 5/30 minute and 15/30 minute variance ratios, as described in Campbell, Lo, and MacKinley (1997), calculated for each security each day. Prices that follow a random walk, should have a return autocorrelation of zero. Autocorrelations are negative on average, thus an increase in autocorrelation or a decrease in its absolute value would signify improved market efficiency. The 5-minute/30-minute variance ratio is six times the 5-minute variance of midquote returns divided by the 30-minute variance of midquote returns; similarly for the 15-/30 minute variance ratios. The variance ratio evaluates whether short-term price changes are reversed on average. Such reversals, if they exist, would indicate that over short horizons, trades cause prices to deviate from the (efficient) equilibrium price. As there is usually some excess volatility, the variance ratio is commonly greater than one, and thus a decline in the variance ratio would indicate improved market efficiency.

Table 6 displays the results of our panel regressions the impact of the fee change on autocorrelations and variance ratios.[18] We do not find significant effects for any of the measures.

4 Trader Welfare

The effective spread is often considered to be the best measure for transaction costs. The spread does not, however, include exchange fees. To determine a liquidity demander's welfare, it is important to explicitly account for these fees. We thus compute

$$fee\ adjusted\ espread_{ti} = (2q_{ti}(p_{ti} - m_{ti}) + 2 \times exchange\ fee_{ti})/m_{ti}, \tag{7}$$

where $exchange\ fee_{ti}$ is the per share fee to remove liquidity. Before the change of fees it is $1/50 \times 1\% \times p_{ti}$ for all securities, and after the change it is $1/55 \times 1\% \times p_{ti}$ for non-interlisted stocks and \$0.004 for interlisted stocks.

Similarly, the realized spread is considered to measure the benefit to the liquidity

[18]The table displays the results using signed autocorrelations; results for absolute values are similar.

provider. To explicitly account for liquidity rebates, we compute

$$\textit{rebate adjusted rspread}_{ti} = (2q_{ti}(p_{ti} - m_{t+5\ \min,i}) + 2 \times \textit{fee rebate}_{ti})/m_{ti}, \tag{8}$$

where $\textit{fee rebate}_{ti}$ is the per share maker fee rebate. It is 0 for all securities before the fee change. After the change it is 0 for non-interlisted stocks and \$.00275 for interlisted stocks.

Results. Focussing only on effective and realized spreads and omitting exchange fees may give the misleading impression that liquidity demanders unambiguously benefit while liquidity takers obtain reduced revenue. Figure 3 shows instead that after the fee change, the passive side benefited, and it indicates that the costs for the active side did not decrease.

Table 7 shows the regression results for fee and rebate adjusted spreads. We find that the fee adjusted effective spreads increase, although the significance is only at the 10% level. The table also shows that total liquidity provider revenues increase, and thus the liquidity rebates more than compensate the liquidity providers for the revenue that is passed on to liquidity demanders. Furthermore, there are stark differences in revenues between low and high competition and low and high price stocks.[19]

Colliard and Foucault (2011) predict that the fee adjusted effective spread (the "cum fee" spread in their paper) increases in the total fee. In our case, total fees decline for stocks priced below \$6.875 (see Section 1.2). Consistent with the theoretical predictions, we find that for the subsample with prices below \$6.875, exchange fee adjusted effective spreads increase. For prices above \$6.875, the coefficient is negative, but statistically insignificant. Further, the difference in the subsample coefficients is statistically significant.

[19]The increase for low price stocks is probably in part caused by the fact that the fixed amount rebate has a stronger relative impact when the price is low.

5 Volume

One key question is whether changes in fees have any effect on trading behavior. If traders engage in the same transactions irrespective of the exchange fees, then the change in fees is merely redistributive and has no impact on aggregate welfare.

To detect changes in behavior, we study the impact of the fee change on the number of shares traded, the dollar amount of all trades, and the number of transactions. We further decompose these numbers into volume that stems from clients and non-clients to understand if there are changes in intermediation.

Aggregate Volume. Table 8 displays our results on volume and the number of transactions, measured in logarithms. Our results suggest that the fee change increases volume, dollar volume, and the numbers of transactions.

Intermediated Volume. One possible explanation for the increase in volume is an increase in intermediation. When traders are not overly sensitive to transaction costs, an intermediary, such as an algorithm programmed to take advantage of fee rebates, may be able to inject itself between two traders who would have otherwise transacted on their own. We proxy for the extent of intermediation by the fraction of volume that occurs between a client and an intermediary.[20] Table 10 shows our findings on intermediated trades and indicates no change in the extent of intermediation.

Market Participation. The increase in volume could also stem from the entry of new traders. We study changes in market participation by analyzing client volume. Table 9 displays our findings and shows that client volume increases significantly. This finding is consistent with the result on the decreased price impact if one believes that the reduced spreads attract price sensitive or less well informed traders. New entry is, however, somewhat surprising because transaction costs did not decline (Section 4).

[20]Our data identifies client trades as well as equity specialist, broker inventory, and option market maker trades. We classify all parties other than clients as intermediaries.

6 Competition in Liquidity Provision

With the introduction of fee rebates, ceteris paribus, it becomes cheaper to post limit orders. It is then imaginable that institutions see the introduction of rebates as an opportunity to enter the market for liquidity provision. To asses the extent of competition, we count the number improvements of the best bid and offer prices and depth, the number of liquidity providing market participants that are involved in transactions, and we compute the Herdindahl Index of market concentration (introduced in Section 2.4).

6.1 Improvements in the Quoted Bid-Ask Spread and Depth.

The first column in Table 12 summarizes our findings on the total number of spread and depth improvements. We find a significant increase in the number of improvements, which indicates increased competition. The second and third columns show that this increase is driven by improvements in depth, while the number of spread improvements declines. Since the average depth also increased, we conclude that after the fee change, traders compete more aggressively on depth.

The decline in the number of spread improvements is consistent with our finding that average depth increases. As depth increases, fewer trades walk the book and there may be fewer opportunities to improve the spread after the book was depleted. Furthermore, since quoted spreads decline, there is less room for improving the spread.

Our findings on the increase in the number of quote improvements are consistent with Foucault, Kadan, and Kandel (2009) who predict, in particular, that the liquidity providers' monitoring activity increases as their fee decreases.

6.2 Market Participation and Concentration.

The increase in the number of quote improvements could be driven by two factors: first, existing traders may compete more aggressively, and second, the liquidity rebates may have attracted new traders. The Herfindahl Index at the trader level, which we focus on

here, is based the shares of passive volume that traders provide from their inventory, and it captures the first factor.

The first column of Table 11 displays our results on the trader level HHI. The decline in the index signifies reduced market concentration and increased competition. Looking at the subsample of stocks that trade below $22, we find that competition increases significantly. This finding is consistent with the significant increase in depth that we observe there.

To assess market participation, we count the number of liquidity providing brokerages and the number of liquidity providing inventory traders. The number of brokers per security per day is the number of unique broker IDs that were on the passive side of transactions. The number of inventory traders is the number of unique trader IDs that traded on an inventory or equity specialist accounts and that were on the passive side of transactions. Table 2 shows for interlisted stocks that the median numbers of brokers and inventory traders were 12 and 4, respectively. Columns two and three in Table 11 reveal that the number of brokers and traders both increased after the change, although the coefficient on the number of traders is significant only at the 10% level.

We thus conclude that competition in the market for liquidity provision increased and that this increase is at least in part driven by market entry.

7 Conclusion

The introduction of fee rebates for passive volume on the Toronto Stock Exchange led to a substantial decline in bid-ask spreads, an increase in depth and an increase in volume. The changes in spreads are consistent with theoretical predictions, but the increase in volume is puzzling since transaction costs, accounting for both the spread and the exchange fees, did not go down. That being said, the increase in volume is consistent with a theoretical prediction of Colliard and Foucault (2011) who find a positive relation of trading fees and volume for some parameter values.

We also find that after the introduction of the fee rebates, liquidity providers compete more aggressively for market share in the "make" market. Furthermore, even though liquidity providers lower their spreads in response to the fee change, when taking rebates into account, liquidity providers' per share revenues increase. These two findings together suggest that competition in depth is at least as important as competition in spreads.

Appendix: Alternative Methodology

Alternative Specification. Our main regression equation uses as dependent variables the time realization of various measures for treatment group security less the realization of the measure for the control group match. An alternative differences in differences approach is to regress the levels directly on the event and the interlisting status as the main effects and on the interaction of these two. The coefficient on the latter is then the variable of interest. Specifically, the alternative regression equation is

$$\begin{aligned} \textit{dependent variable}_{it} &= \beta_0 + \beta_1 \textit{fee change}_t + \beta_2 \textit{interlisted}_i + \beta_3 \textit{fee change}_t \times \textit{interlisted}_i \\ &\quad + \beta_4 \mathsf{Volatility}_t + \sum\nolimits_{j=1}^{4} \beta_{3+j} \textit{control variable}_{ij} + \epsilon_{it}, \end{aligned} \tag{9}$$

where $\textit{dependent variable}_{it}$ is the time t realization of the measure security i; $\textit{fee change}_t$ is an indicator variable that is 1 after the event date and 0 before; $\textit{interlisted}_i$ is an indicator variable that is 1 if the security is interlisted and 0 otherwise; $\mathsf{Volatility}_t$ is the closing value of a volatility index for day t, and $\textit{control variable}_{ij}$ are security level control variables for the company: a variable that relates to the price of security i, the log of the market capitalization on July 31, 2005, and the share turnover and the daily midquote return volatility in the month before the event window, July 2005. The variable of interest for our study is β_3.

We ran regression (9) for several variations of the security price based control: the log of the closing price on July 31, 2005 (as in the main text), the midquote for stock i on

day t as well as its logarithm, the return of stock i from day $t-1$ to t, the return for stock i from day $t-2$ to $t-1$. We further used two volatility indices: the CBOE's VIX and the TMX's MVX. The MVX is based on the implied volatility of index options on the TSX60 stock index and it is highly correlated ($> 70\%$) with the VIX.

The regression results using this alternative specification are similar.

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Table 1
Summary Statistics on Trading Activity for Interlisted Companies and their Non-Interlisted Matches

The table lists aggregate trading volume numbers for the August-November 2005 sample period for NASDAQ/AMEX-interlisted companies and their respective matches. Percentage numbers are for the share that the respective number has of total volume.

		NASDAQ/AMEX interlisted		Non-interlisted	
Total volume (excluding special terms market)	Share volume	1,847,794,191		2,140,879,197	
	Dollar volume	$ 20,517,866,297		$ 26,768,731,058	
	Transactions	1,966,642		1,451,526	
Intraday		1,313,804,000	71.1%	1,349,823,200	63.0%
		$ 14,726,937,292	71.8%	$ 15,962,222,831	59.6%
		1,808,270	91.9%	1,247,051	85.9%
Open		28,873,204	1.6%	46,924,654	2.2%
		$ 356,600,562	1.7%	$ 584,311,868	2.2%
		32,269	1.6%	48,900	3.4%
Afterhours		87,457,828	4.7%	107,148,290	5.0%
		$ 2,180,634,369	10.6%	$ 2,215,202,425	8.3%
		21,516	1.1%	17,704	1.2%
Dealer crosses		413,080,078	22.4%	631,005,919	29.5%
		$ 3,056,619,162	14.9%	$ 7,753,556,056	29.0%
		5,248	0.3%	7,595	0.5%
Oddlots		4,579,081	0.2%	5,977,134	0.3%
		$ 197,074,912	1.0%	$ 253,437,878	0.9%
		99,339	5.1%	130,276	9.0%
Equity specialist		66,763,881	3.6%	92,300,034	4.3%
(all trades, including oddlots)		$ 276,512,711	1.3%	$ 362,617,083	1.4%
		269,071	13.7%	325,678	22.4%
Number of market orders		1,240,327		779,492	
Non-client market order volume		493,981,000	27%	393,193,700	18%
Non-client market order transactions		585,996	30%	293,166	20%
Client market order volume		819,823,000	73%	956,629,500	82%
Client market order transactions		1,222,274	70%	953,885	80%

Table 2
Pre-sample Summary Statistics of Interlisted Companies and their Matches

The table lists selected summary statistics for the NASDAQ/AMEX-interlisted companies and their matches for the pre-sample month of July. Unless otherwise specified, the numbers are average per day per company. The letter M signifies millions. intraday volume refers to transactions that occur in the open market during regular trading hours (9:30-16:00), excluding oddlot trades, special terms orders and dealer crosses.

		NASDAQ/AMEX interlisted	Non-interlisted
Total July intraday volume in shares	Mean	2,837,000	3,784,000
	StE	(4,426,000)	(9,333,000)
	Median	1,308,000	1,857,000
Total July intraday dollar volume		$37.1M	$39.7M
		($95M)	($125M)
		$8.617M	$12.4M
Total July transactions		4,407	3,320
		(6413)	(5209)
		2,354	1,870
Closing price end July 2005		$ 11.95	$ 12.13
		(17.30)	(17.09)
		$ 6.08	$ 6.12
Market capitalization end July 2005		$1,330M	$1,500M
		($4,540M)	($6,020M)
		$475M	$392M
Time weighted quoted spread (in bps)		73.76	93.83
		(52.87)	(60.03)
		60.77	90.18
Time weighted quoted spread (in cents)		¢4.781	¢6.271
		(¢4.644)	(¢5.210)
		¢3.525	¢4.578
Time weighted dollar depth		$15,196	$20,759
		(13,173)	(16,632)
		$11,786	$16,825
Herfindahl Index, broker level		0.235	0.249
		(0.075)	(0.081)
		0.23	0.247
Herfindahl Index, trader level		0.476	0.592
		(0.171)	(0.209)
		0.471	0.607
Number of brokers		12.73	12.16
		(5.384)	(5.504)
		11.9	11.45
Number of market making traders		5.88	4.576
		(5.176)	(5.536)
		4.15	3.1

Table 3
Summary Statistics of Interlisted Companies and their Matches: Before and After the Change of Fees

The table lists selected summary statistics for the NASDAQ/AMEX-interlisted companies and their matches for the sample period August-November 2005, per day per company. All measures for spreads and transaction costs are in basis points of the prevailing midquote. The standard errors presented for the difference-in-differences are adjusted by factor $\sqrt{73}$; * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

		Treatment group of NASDAQ/AMEX interlisted stocks		Control group of non-interlisted stocks		
		Before	After	Before	After	Diff-in-Diff
Intraday dollar volume (in logs)	Mean	13.08	13.1	13.36	13.22	0.169**
	StE	(1.594)	(1.643)	(1.412)	(1.503)	(0.081)
	Median	12.97	13.04	13.25	13.2	
Time weighted quoted spread		70.59	71.63	88.96	103.2	-13.25***
		(50.510)	(52.070)	(55.090)	(65.890)	(3.430)
		53.86	66.71	84.47	87.17	
Effective spread		60.58	62.18	79.28	91.93	-11.05***
		(42.310)	(43.570)	(49.520)	(60.660)	(3.112)
		45.18	60.35	77.23	81.42	
Time weighted dollar depth (in logs)		9.364	9.38	9.722	9.637	0.101***
		(0.667)	(0.714)	(0.576)	(0.618)	(0.038)
		9.336	9.279	9.725	9.591	
Exchange fee adjusted effective spread		64.58	81.72	83.28	95.56	4.862
		(42.300)	(56.170)	(49.520)	(60.660)	(3.445)
		49.18	72.6	81.22	85.05	
Rebate adjusted realized spread		18.19	30.8	39.16	43.05	8.726***
		(20.940)	(32.510)	(31.300)	(38.090)	(2.717)
		12.75	21.11	34.87	35.4	
Client to non-client trades as a fraction of total volume		45.7%	46.0%	41.3%	40.7%	0.78%
		(0.081)	(0.092)	(0.092)	(0.103)	(0.009)
		46.3%	46.3%	40.8%	40.8%	
Herfindahl Index, trader level		0.449	0.428	0.596	0.607	-0.0317**
		(0.174)	(0.170)	(0.213)	(0.214)	(0.014)
		0.464	0.424	0.608	0.606	

Table 4
Panel Regressions Results for Marginal Changes in Bid-Ask Spreads

Dependent variables are treatment group value minus control group value for time weighted and trade weighted quoted spread, effective spread, and 5-minute realized spread and price impact. All spreads and the price impact are measured in basis points of the prevailing midquote.

Specifications that apply to this and all subsequent tables. The treatment group in 2005 are the NASDAQ and AMEX interlisted securities. Each dependent variable is regressed on a dummy variable set equal to one for dates after October 01, 2005 and zero before, daily market volatility as measured by the CBOE VIX index, and the following control variables for the security and its match: log(market capitalization) and log(price) at July 31, 2005, and dollar turnover and return volatility in July 2005. Coefficients for volatility, control variables, and the constant are not reported for brevity. The full sample for 2005 is 73 securities. Standard errors are in parentheses; * indicates significance at the 10% level, ** at the 5% level, **+ at the 2%, and *** at the 1% level. Standard errors are robust to time series and cross-sectional correlation. Results other than the full sample are split by the median for the control group for July 2005 market capitalization ($475M), total volume (1.795M shares), and the Herfindahl Index (.2296). The break-even price for market orders is $22, for higher prices, market orders are cheaper under the new regime. The break-even price for maker plus taker fees is $6.875; for higher prices, the total fee is lower under the new regime. We report only the coefficient estimates for the interaction terms; see Section 2.5 for the full specification for the estimated equation. We test for equality of coefficients, where "Yes" indicates that we reject the hypothesis.

	time weighted quoted spread	trade weighted quoted spread	effective spread	5 min realized spread	5 min price impact
full sample	-12.0928***	-9.3401***	-10.0538***	-5.2311**	-5.0015**+
	(3.4968)	(2.8437)	(3.0374)	(2.3381)	(2.0678)
			— Break-even Price for Market Orders —		
above $22	-1.6723	-1.2625	-1.0578	-1.7872	0.7251
	(5.1254)	(3.7694)	(4.0810)	(2.5619)	(3.2556)
below $22	-13.7469***	-10.6247***	-11.4844***	-5.7810**	-5.9144**+
	(3.8598)	(3.1530)	(3.3793)	(2.6466)	(2.3920)
Different Coefficient?	Yes**	Yes**	Yes**	–	–
			— Herfindahl Index —		
low competition	-13.1704**	-10.4836**	-11.4119**	-3.9198	-7.8241**
	(5.9463)	(4.7917)	(4.9770)	(3.9657)	(3.7789)
high competition	-11.0444***	-8.2329***	-8.7383**+	-6.4991**+	-2.2761
	(3.5352)	(3.0805)	(3.5879)	(2.7042)	(2.6600)
Different Coefficient?	–	–	–	–	–
			— Market Capitalization —		
above median	-7.3514***	-4.5349**	-4.8206*	-2.5039*	-2.3538
	(2.7585)	(2.2464)	(2.7051)	(1.3444)	(2.3949)
below median	-16.7061***	-14.0315***	-15.1628***	-7.9036*	-7.5986**
	(6.0966)	(4.9732)	(5.2298)	(4.3566)	(3.7889)
Different Coefficient?	–	Yes*	Yes*	–	–
			—Break-even Price for Total Fees —		
above $6.875	-10.2158**	-6.7037**	-6.7714**	-5.4727**+	-1.3784
	(4.5753)	(3.0908)	(3.3447)	(2.1683)	(1.9157)
below $6.875	-13.6414***	-11.5233***	-12.7719***	-5.0470	-7.9979**
	(4.9228)	(4.3463)	(4.6598)	(3.9422)	(3.7080)
Different Coefficient?	–	–	–	–	–
			— Share Trading Volume —		
above median	-15.5000***	-12.5071***	-14.3684***	-6.8560**+	-7.5999***
	(4.8567)	(3.7086)	(4.0492)	(2.9331)	(2.6160)
below median	-8.7777*	-6.2767	-5.8707	-3.6713	-2.4701
	(4.7358)	(4.1754)	(4.4619)	(3.6929)	(3.4007)
Different Coefficient?	–	–	–	–	–

Table 5
Panel Regressions for Depth at the Best Bid and Offer Prices

Dependent variables are treatment group value minus control group value for the trade weighted and time weighted depth. Depth is measured in the log of the number of shares and the log of the dollar amount. Specifications for the panel regression and significance levels are as in Table 4.

	share depth throughout the day	share depth at transaction	$ depth throughout the day	$ depth at transaction
full sample	0.0898**+	0.0837**+	0.1133***	0.1070***
	(0.0369)	(0.0360)	(0.0394)	(0.0384)
		— Break-even Price for Market Orders —		
above $22	0.0992	0.0688	0.0414	0.0111
	(0.0777)	(0.0633)	(0.0985)	(0.0838)
below $22	0.0884**	0.0861**	0.1247***	0.1223***
	(0.0402)	(0.0398)	(0.0419)	(0.0414)
Different Coefficient?	–	–	–	–
		— Herfindahl Index —		
low competition	0.0562	0.0397	0.0865	0.0695
	(0.0498)	(0.0501)	(0.0533)	(0.0526)
high competition	0.1226**+	0.1263***	0.1393***	0.1434***
	(0.0489)	(0.0458)	(0.0522)	(0.0496)
Different Coefficient?	–	–	–	–
		— Market Capitalization —		
above median	0.1294***	0.1229***	0.1304**+	0.1241***
	(0.0482)	(0.0450)	(0.0511)	(0.0476)
below median	0.0513	0.0454	0.0967*	0.0903
	(0.0512)	(0.0514)	(0.0551)	(0.0549)
Different Coefficient?	–	–	–	–
		—Break-even Price for Total Fees —		
above $6.875	0.1445***	0.1339***	0.1587***	0.1483***
	(0.0481)	(0.0439)	(0.0505)	(0.0464)
below $6.875	0.0448	0.0422	0.0759	0.073
	(0.0495)	(0.0505)	(0.0536)	(0.0539)
Different Coefficient?	–	–	–	–
		— Share Trading Volume —		
above median	0.0559	0.0563	0.0982*	0.0985*
	(0.0507)	(0.0493)	(0.0523)	(0.0511)
below median	0.1228**+	0.1103**	0.1280**+	0.1153**
	(0.0484)	(0.0479)	(0.0534)	(0.0520)
Different Coefficient?	–	–	–	–

Table 6
Panel Regressions for Market Efficiency Measures

Dependent variables are treatment group value minus control group value for the x-minute autocorrelation and x-/y-minute variance ratios. Details on these measures are in Section 3. Specifications for the panel regression and significance levels are as in Table 4.

	5-minute autocorrelation	15-minute autocorrelation	30-minute autocorrelation	5/30-minute variance ratio	15/30-minute variance ratio
full sample	0.0026	0.0061	0.0018	-0.0062	0.0083
	(0.0068)	(0.0082)	(0.0098)	(0.0081)	(0.0082)
			— Break-even Price for Market Orders —		
above $22	-0.0214	-0.0145	-0.0014	-0.0118	-0.0157
	(0.0155)	(0.0187)	(0.0200)	(0.0166)	(0.0243)
below $22	0.0064	0.0095	0.0023	-0.0053	0.0122
	(0.0072)	(0.0085)	(0.0109)	(0.0093)	(0.0089)
Different Coefficient?	–	–	–	–	–
			— Herfindahl Index —		
low competition	0.0017	0.0162	0.0038	-0.0082	-0.0032
	(0.0101)	(0.0102)	(0.0145)	(0.0146)	(0.0117)
high competition	0.0035	-0.0032	-0.0000	-0.0042	0.0190*
	(0.0088)	(0.0123)	(0.0132)	(0.0104)	(0.0098)
Different Coefficient?	–	–	–	–	–
			— Market Capitalization —		
above median	0.0048	-0.0136	0.0006	0.0007	0.0104
	(0.0090)	(0.0115)	(0.0132)	(0.0137)	(0.0108)
below median	0.0004	0.0262***	0.0031	-0.0132	0.0061
	(0.0106)	(0.0093)	(0.0149)	(0.0112)	(0.0122)
Different Coefficient?	–	–	Yes***	–	–
			—Break-even Price for Total Fees —		
above $6.875	0.0091	-0.0101	0.0035	0.0088	0.0159
	(0.0094)	(0.0115)	(0.0150)	(0.0130)	(0.0113)
below $6.875	-0.0029	0.0201**	0.0004	-0.0190*	0.0018
	(0.0089)	(0.0103)	(0.0124)	(0.0107)	(0.0116)
Different Coefficient?	–	–	–	–	–
			— Share Trading Volume —		
above median	0.0026	0.0016	0.0032	-0.0105	0.0070
	(0.0077)	(0.0123)	(0.0162)	(0.0108)	(0.0092)
below median	0.0027	0.0107	0.0005	-0.0019	0.0096
	(0.0106)	(0.0107)	(0.0113)	(0.0135)	(0.0126)
Different Coefficient?	–	–	–	–	–

Table 7
Panel Regressions for Transaction Costs and Rebate Benefits

Dependent variables are treatment group value minus control group value for proportional effective spreads, adjusted for active order exchange fees, and realized 5 minute spreads, adjusted for exchange fee rebates as described in (7) and (8). Costs and benefits are measured in basis points of the prevailing midquote. Specifications for the panel regression and significance levels are as in Table 4.

	exchange fee adjusted effective spreads	rebate adjusted realized 5 minute spreads
full sample	5.6538*	8.0544***
	(3.3209)	(2.5238)
	— Break-even Price for Market Orders —	
above $22	-2.4563	-0.2473
	(4.1147)	(2.6138)
below $22	6.9440*	9.3770***
	(3.7366)	(2.8674)
Different Coefficient?	Yes*	Yes**+
	— Herfindahl Index —	
low competition	9.8563*	13.1860***
	(5.4822)	(4.3179)
high competition	1.5773	3.0968
	(3.8412)	(2.7434)
Different Coefficient?	–	Yes**
	— Market Capitalization —	
above median	2.2950	4.8913***
	(3.1257)	(1.5057)
below median	8.9320	11.1541**+
	(5.7850)	(4.7828)
Different Coefficient?	–	–
	—Break-even Price for Total Fees —	
above $6.875	-4.411	-1.345
	(3.2416)	(1.9756)
below $6.875	13.9760***	15.8351***
	(5.0483)	(4.0637)
Different Coefficient?	Yes***	Yes***
	— Share Trading Volume —	
above median	1.7195	6.6988**
	(4.1914)	(2.9735)
below median	9.4669*	9.3517**
	(5.1549)	(4.1513)
Different Coefficient?	–	–

Table 8
Panel Regressions for Volume and Transactions

Dependent variables are treatment group value minus control group value for the logarithms of share volume, dollar volume and the number of transactions. Note that an incoming active order can trigger multiple transactions. Specifications for the panel regression and significance levels are as in Table 4.

	volume in shares	dollar volume	trans-actions
full sample	0.1709**	0.1945**+	0.20***
	(0.0752)	(0.0821)	(0.06)
	— Break-even Price for Market Orders —		
above $22	-0.0136	-0.0719	0.06
	(0.1854)	(0.1925)	(0.12)
below $22	0.2003**+	0.2369***	0.22***
	(0.0806)	(0.0879)	(0.07)
Different Coefficient?	–	–	–
	— Herfindahl Index —		
low competition	0.0929	0.1228	0.12
	(0.1052)	(0.1135)	(0.08)
high competition	0.2466**+	0.2640**+	0.27***
	(0.0988)	(0.1088)	(0.09)
Different Coefficient?	–	–	–
	— Market Capitalization —		
above median	0.1285**	0.1297*	0.17***
	(0.0629)	(0.0685)	(0.05)
below median	0.2124	0.2577*	0.22**
	(0.1296)	(0.1402)	(0.11)
Different Coefficient?	–	–	–
	—Break-even Price for Total Fees —		
above $6.875	0.1871*	0.2013*	0.20**
	(0.1134)	(0.1168)	(0.1000)
below $6.875	0.1576	0.1890*	0.20**+
	(0.0979)	(0.1106)	(0.0800)
Different Coefficient?	–	–	–
	— Share Trading Volume —		
above median	0.0830	0.1255	0.16**
	(0.0825)	(0.0930)	(0.08)
below median	0.2574**	0.2626**	0.23**+
	(0.1184)	(0.1274)	(0.09)
Different Coefficient?	–	–	–

Table 9
Panel Regressions for Total Volume by Trader Type

Dependent variables are treatment group value minus control group value for the logarithms of share volume, dollar volume and transactions, split by client and non-client orders. Both the active and passive sides of a trade are counted, and thus the sum of client and non-client volume is twice the daily volume. Specifications for the panel regression and significance levels are as in Table 4.

	share volume		dollar volume		transactions	
	non-client	client	non-client	client	non-client	client
full sample	0.2007***	0.1511*	0.2245***	0.1745**	0.2160***	0.1716**+
	(0.0769)	(0.0781)	(0.0827)	(0.0850)	(0.0624)	(0.0693)
			— Break-even Price for Market Orders —			
above $22	0.0210	-0.0358	-0.0341	-0.0939	0.1164	0.0089
	(0.1434)	(0.2084)	(0.1436)	(0.2151)	(0.1176)	(0.1473)
below $22	0.2286***	0.1808**	0.2648***	0.2172**+	0.2317***	0.1974***
	(0.0855)	(0.0825)	(0.0919)	(0.0899)	(0.0693)	(0.0745)
Different Coefficient?	Yes***	–	Yes*	–	Yes**	–
			— Herfindahl Index —			
low competition	0.1050	0.0809	0.1369	0.1106	0.1738**	0.0710
	(0.1027)	(0.1109)	(0.1107)	(0.1191)	(0.0823)	(0.0910)
high competition	0.2929***	0.2191**	0.3088***	0.2365**	0.2566***	0.2690***
	(0.1064)	(0.1003)	(0.1141)	(0.1105)	(0.0876)	(0.0918)
Different Coefficient?	–	–	–	–	–	–
			— Market Capitalization —			
above median	0.1327**	0.1137	0.1336**	0.1150	0.1505***	0.1623***
	(0.0608)	(0.0716)	(0.0638)	(0.0776)	(0.0518)	(0.0629)
below median	0.2678**	0.1876	0.3141**	0.2326	0.2805***	0.1806
	(0.1341)	(0.1316)	(0.1437)	(0.1422)	(0.1061)	(0.1143)
Different Coefficient?	–	–	–	–	–	–
			—Break-even Price for Total Fees —			
above $6.875	0.2100*	0.1644	0.2252**	0.1783	0.2135**	0.1682
	(0.1135)	(0.1170)	(0.1122)	(0.1217)	(0.0942)	(0.1034)
below $6.875	0.1930*	0.1401	0.2239**	0.1715	0.2181***	0.1742**
	(0.1004)	(0.1019)	(0.1142)	(0.1137)	(0.0791)	(0.0876)
Different Coefficient?	–	–	–	–	–	–
			— Share Trading Volume —			
above median	0.0632	0.0911	0.1049	0.1336	0.1215*	0.1736*
	(0.0805)	(0.0901)	(0.0894)	(0.1005)	(0.0704)	(0.0886)
below median	0.3364***	0.2105*	0.3429***	0.2156*	0.3093***	0.1704*
	(0.1222)	(0.1203)	(0.1306)	(0.1291)	(0.0966)	(0.0978)
Different Coefficient?	Yes*	–	–	–	–	–

Table 10
Panel Regressions on the Fraction of Intermediated Trades

Dependent variables are treatment group value minus control group value for the client to non-client fraction of total volume. Specifications for the panel regression and significance levels are as in Table 4.

	share volume	dollar volume	transactions
full sample	1.070	1.070	0.690
	(0.980)	(0.980)	(0.850)
	— Break-even Price for Market Orders —		
above $22	0.910	0.910	0.930
	(1.930)	(1.920)	(2.150)
below $22	1.100	1.100	0.650
	(1.070)	(1.070)	(0.880)
Different Coefficient?	–	–	–
	— Herfindahl Index —		
low competition	0.970	0.970	1.780
	(1.440)	(1.440)	(1.200)
high competition	1.170	1.180	-0.370
	(1.190)	(1.190)	(1.020)
Different Coefficient?	–	–	–
	— Market Capitalization —		
above median	0.000	0.000	-0.730
	(1.050)	(1.050)	(1.060)
below median	2.120	2.120	2.080*
	(1.580)	(1.590)	(1.180)
Different Coefficient?	–	–	Yes*
	—Break-even Price for Total Fees —		
above $6.875	0.0126	0.0127	0.0042
	(0.0112)	(0.0112)	(0.0119)
below $6.875	0.0091	0.0091	0.0091
	(0.0148)	(0.0148)	(0.0109)
Different Coefficient?	–	–	–
	— Share Trading Volume —		
above median	-0.230	-0.230	-0.550
	(1.290)	(1.290)	(0.950)
below median	2.340*	2.330*	1.890
	(1.300)	(1.300)	(1.230)
Different Coefficient?	–	–	Yes*

Table 11
Panel Regressions on Competition Indicators

Dependent variables are treatment group value minus control group value for the trader level Herfindahl Index, the number of liquidity providing brokers and the number of liquidity providing traders that trade on inventory accounts. The Herfindahl Index is defined in (2), the number of brokers is the number of broker IDs that are on the passive side of trades, the number of inventory traders is the number of trader IDs that are on the passive side of trades while using their inventory account. All measures are per stock per day. A decrease in the Herfindahl Index indicates a decrease in market concentration and thus an increase in competition for liquidity provision. Specifications for the panel regression and significance levels are as in Table 4.

	trader level Herfindahl Index	number of brokers	number of inventory traders
full sample	-0.0350**+	0.6903**	0.5007*
	(0.0144)	(0.3410)	(0.2617)
	— Break-even Price for Market Orders —		
above $22	0.0325	-0.6283	0.1746
	(0.0362)	(0.5968)	(0.6439)
below $22	-0.0459***	0.8996**+	0.5525*
	(0.0144)	(0.3717)	(0.2886)
Different Coefficient?	Yes**	Yes**	–
	— Herfindahl Index —		
low competition	-0.0305*	0.6522	0.2476
	(0.0180)	(0.4214)	(0.2154)
high competition	-0.0392*	0.7274	0.7470*
	(0.0209)	(0.5009)	(0.4404)
Different Coefficient?	–	–	–
	— Market Capitalization —		
above median	-0.0114	0.0573	0.4874
	(0.0163)	(0.3202)	(0.4215)
below median	-0.0588***	1.3062**+	0.5137*
	(0.0212)	(0.5500)	(0.2657)
Different Coefficient?	Yes**	Yes**	–
	—Break-even Price for Total Fees —		
above $6.875	-0.0146	0.2103	0.1426
	(0.0217)	(0.5037)	(0.3695)
below $6.875	-0.0521***	1.0863**+	0.7962**
	(0.0168)	(0.4351)	(0.3523)
Different Coefficient?	–	–	–
	— Share Trading Volume —		
above median	-0.0334*	0.3055	0.4937
	(0.0187)	(0.4320)	(0.4318)
below median	-0.0367*	1.0647**	0.5075*
	(0.0204)	(0.4944)	(0.2698)
Different Coefficient?	–	–	–

Table 12
Panel Regressions for Improvements in the Best Bid and Offer

Dependent variables are treatment group value minus control group value for the total number of improvements at the best bid and offer (BBO) as well as its decomposition into the number of improvements with regards to prices and depth. Specifically, the number of improvements in the BBO is computed, for each stock and day, by counting the number of times that there is an increase in the number of shares available at the bid or offer for a fixed or an improved prices and the number of times that the bid is increased or the offer decreased. Specifications for the panel regression and significance levels are as in Table 4.

	Number of BBO improvements	spread improvements	depth improvements	Number of BBO changes
full sample	102.2**+	-54.3***	156.5***	236.3***
	(41.2)	(9.8)	(47.3)	(58.0)
		— Break-even Price for Market Orders —		
above $22	76.5	-179.9**	256.4	127.0
	(230.1)	(78.6)	(220.0)	(285.7)
below $22	106.3***	-34.4***	140.7***	253.6***
	(41.2)	(9.1)	(39.5)	(82.8)
Different Coefficient?	–	Yes*	–	–
		— Herfindahl Index —		
low competition	-4.2	-48.9***	44.7**+	31.1
	(28.4)	(17.1)	(18.9)	(50.7)
high competition	205.8***	-59.5***	265.3***	435.9***
	(72.0)	(15.2)	(82.9)	(99.4)
Different Coefficient?	Yes***	–	Yes***	Yes***
		— Market Capitalization —		
above median	189.2***	-71.6***	260.8***	406.2***
	(73.1)	(16.3)	(83.8)	(97.5)
below median	17.6	-37.5**	55.1**	71.0
	(37.3)	(17.0)	(27.5)	(72.4)
Different Coefficient?	Yes**	–	Yes**+	Yes***
		—Break-even Price for Total Fees —		
above $6.875	170.1*	-90.8***	260.9***	393.1***
	(89.5)	(24.3)	(89.2)	(133.1)
below $6.875	46.2**	-24.2***	70.4***	106.9**
	(21.6)	(4.0)	(26.2)	(52.7)
Different Coefficient?	−	Yes**+	Yes**	−
		— Share Trading Volume —		
above median	208.3***	-38.2**	246.5***	383.2***
	(73.2)	(16.6)	(78.8)	(100.4)
below median	-1	-70.0***	69.0*	93.4
	(53.4)	(23.8)	(37.5)	(94.7)
Different Coefficient?	Yes**+	–	Yes**	Yes**

Table 13
Panel Regressions on the Equity Specialist's Trading Activity

Dependent variables are treatment group value minus control group value for measures of trading activity of the equity specialist (registered trader): the total active and passive share volume, dollar volume, and the number of transactions. Volume is in logarithms. Specifications for the panel regression and significance levels are as in Table 4.

	share volume		dollar volume		transactions	
	passive	active	passive	active	passive	active
full sample	0.1997**+	0.0791	0.1884***	0.0450	5.68**+	2.51**
	(0.0835)	(0.0938)	(0.0606)	(0.0751)	(2.42)	(1.27)
			— Break-even Price for Market Orders —			
above $22	0.0294	0.0610	0.0967	-0.0388	7.08	5.74
	(0.2002)	(0.1481)	(0.0858)	(0.0904)	(10.46)	(5.71)
below $22	0.2255***	0.0976	0.2020***	0.0726	5.45**	2.00
	(0.0869)	(0.1108)	(0.0674)	(0.0902)	(2.36)	(1.30)
Different Coefficient?	–	–	–	–	–	–
			— Herfindahl Index —			
low competition	0.0641	-0.0436	0.1044	-0.0815	0.36	-0.02
	(0.0852)	(0.1201)	(0.0726)	(0.1133)	(2.71)	(0.94)
high competition	0.3121**+	0.1675	0.2588***	0.1315	10.83***	4.98**
	(0.1230)	(0.1213)	(0.0847)	(0.0895)	(3.73)	(2.37)
Different Coefficient?	Yes*	–	–	–	Yes**	Yes*
			— Market Capitalization —			
above median	0.1253	-0.0028	0.1469**+	-0.0317	6.96**	3.44
	(0.0917)	(0.0754)	(0.0601)	(0.0552)	(3.50)	(2.25)
below median	0.2763**	0.1907	0.2296**	0.1533	4.42	1.62
	(0.1297)	(0.1863)	(0.0999)	(0.1539)	(3.24)	(1.38)
Different Coefficient?	–	–	–	–	–	–
			— Share Trading Volume —			
above median	0.1036	0.0229	0.1042	-0.0180	7.74*	4.91**
	(0.1028)	(0.1134)	(0.0792)	(0.0838)	(4.13)	(2.26)
below median	0.3019**+	0.1739	0.2766***	0.1407	3.69*	0.17
	(0.1179)	(0.1408)	(0.0819)	(0.1217)	(2.19)	(1.20)
Different Coefficient?	–	–	–	–	–	Yes*

Figure 1
Quoted Liquidity: Spreads and Depth

The top left panel plots the time-weighted quoted spreads for the group of NASDAQ/AMEX interlisted securities and their matches (labelled as "TSX"). The bottom left panel plots depth at the best bid and offer prices. The top and bottom right panels plot the differences of, respectively, quoted spreads and depth for interlisted securities vs. their non-interlisted matches. All plots are 5-day moving averages. Spreads are measured in basis points of the midpoint, depth is measured in the logarithm of the average dollar amount available for trading at the best bid and offer prices.

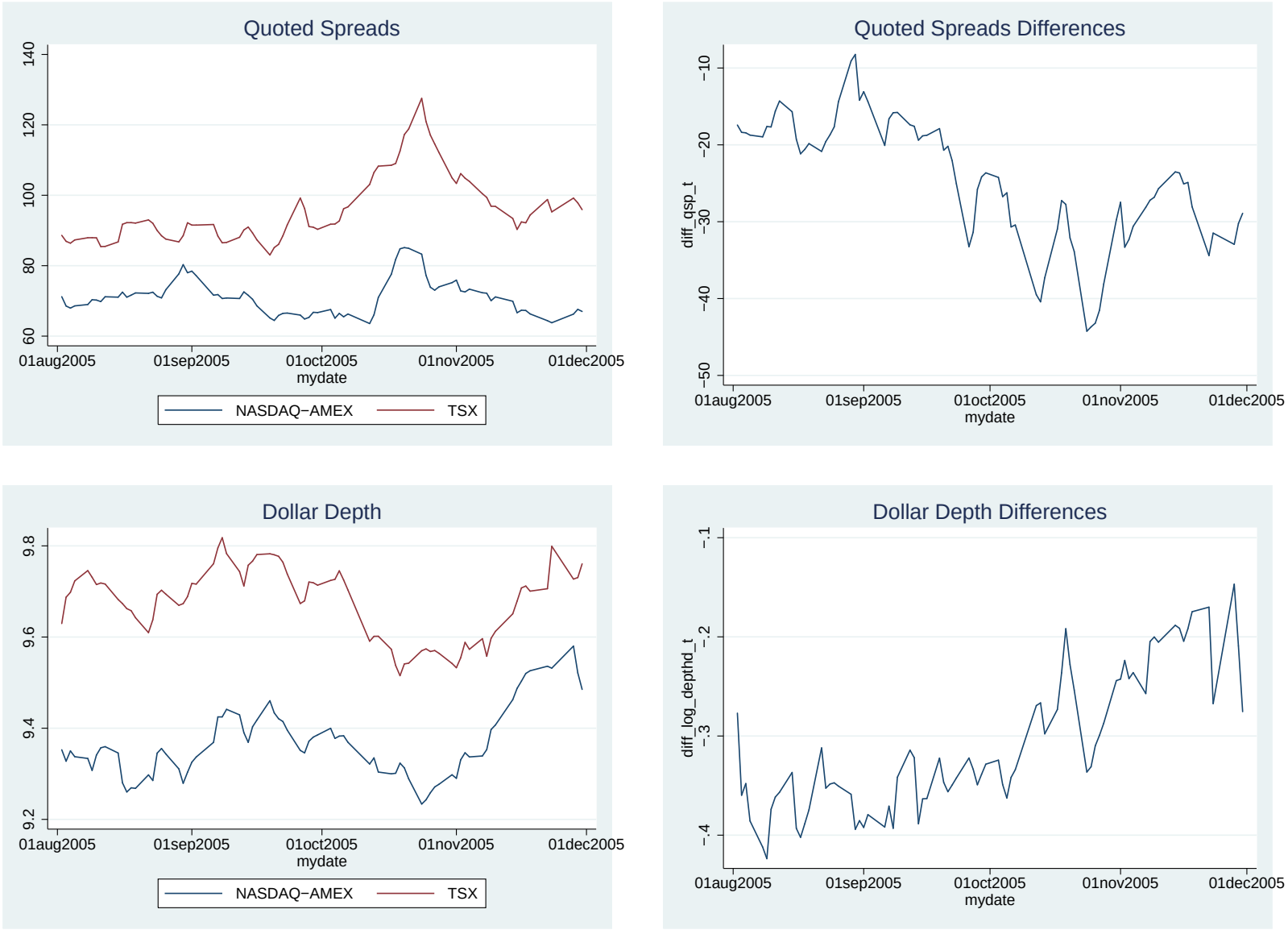


Figure 2
Effective Liquidity: Price Impacts and Effective Spreads

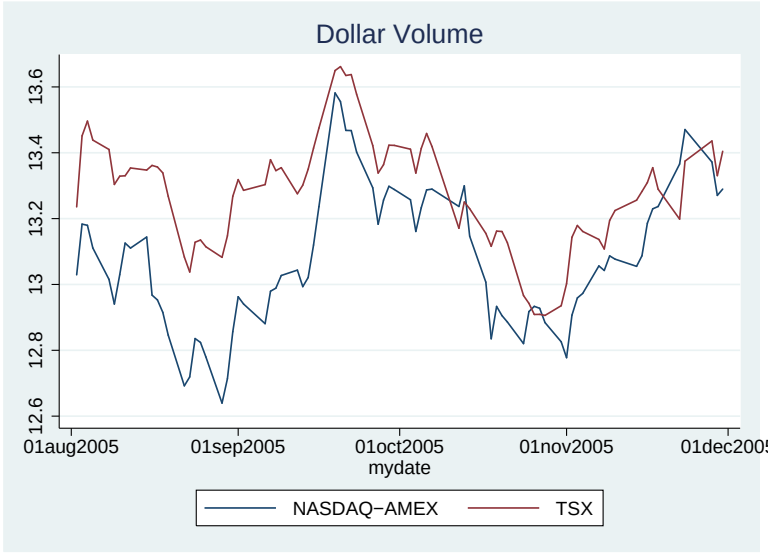
The left panel plots the trade-weighted effective spread for the group of NASDAQ/AMEX interlisted securities and their matches (labelled as "TSX"). The bottom left panel plots the trade-weighted 5-minute price impact. The top and bottom right panels plot the differences of, respectively, effective spreads and price impact for interlisted securities vs. their non-interlisted matches. All plots are 5-day moving averages. Spreads and price impact are measured in basis points of the midpoint.

Figure 3
Plots of Trade Execution Costs for Active Orders and Benefits for Passive Orders

The left panel plots the trade-weighted exchange fee adjusted effective spread for the group of NASDAQ/AMEX interlisted securities and their matches (labelled as "TSX"). The bottom left panel plots the trade-weighted 5-minute rebate adjusted realized spread. The top and bottom right panels plot the differences of, respectively, adjusted effective and realized spreads for interlisted securities vs. their non-interlisted matches. All plots are 5-day moving averages. Spreads are measured in basis points of the midpoint.

Figure 4
Plots of Dollar Volume

The left panel plots the average daily intra-day dollar volume (all trades against standing orders in the limit order book) for the group of NASDAQ/AMEX interlisted securities and their matches (labelled as "TSX"). The right panel plots the differences of the average dollar volume for interlisted securities vs. their non-interlisted matches. All plots are 5-day moving averages. Dollar volume is in logarithm.



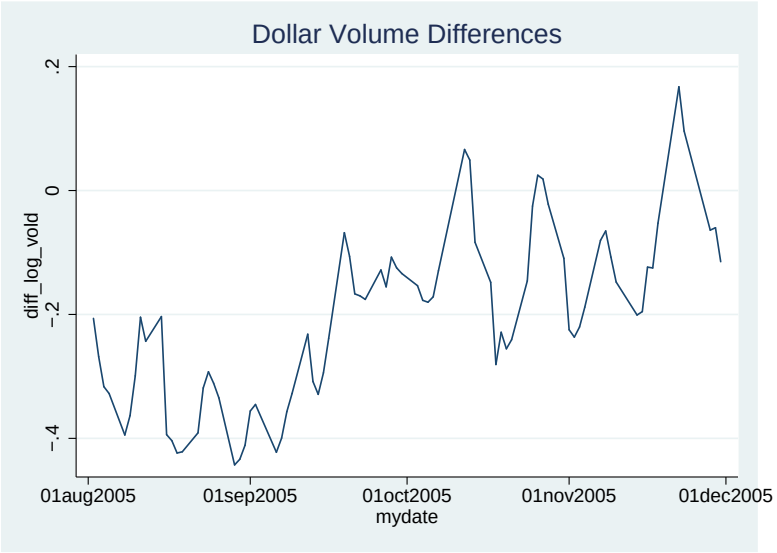
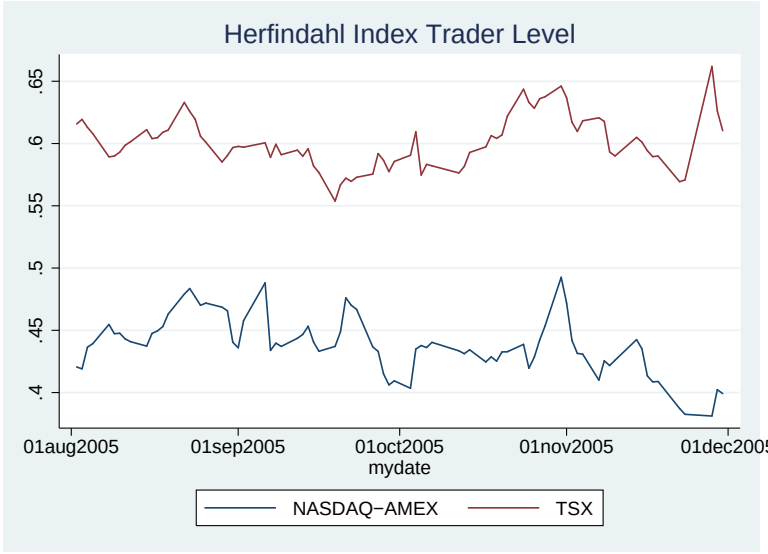


Figure 5
Plots of the Herfindahl Index

The left panel plots the average of the per day per stock trader level Herfindahl Index (see Section 2.4) for the group of NASDAQ/AMEX interlisted securities and their matches (labelled as "TSX"). The right panel plots the differences of the trader level HHIs for interlisted securities vs. their non-interlisted matches. All plots are 5-day moving averages.



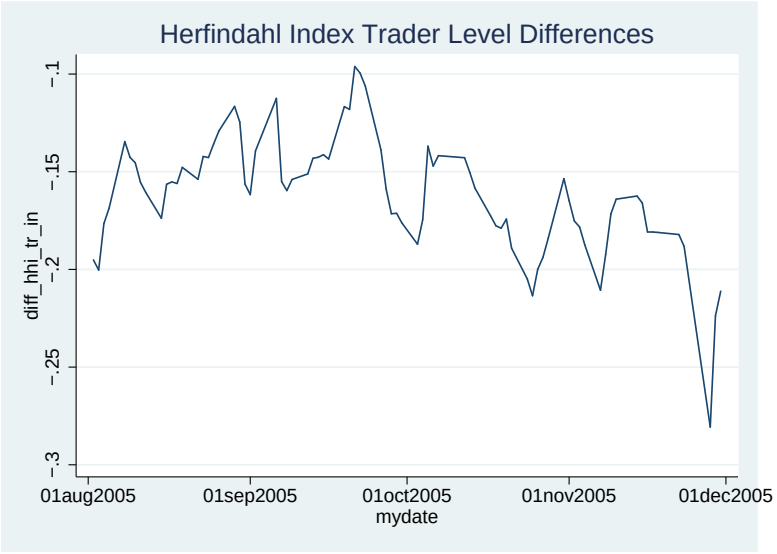
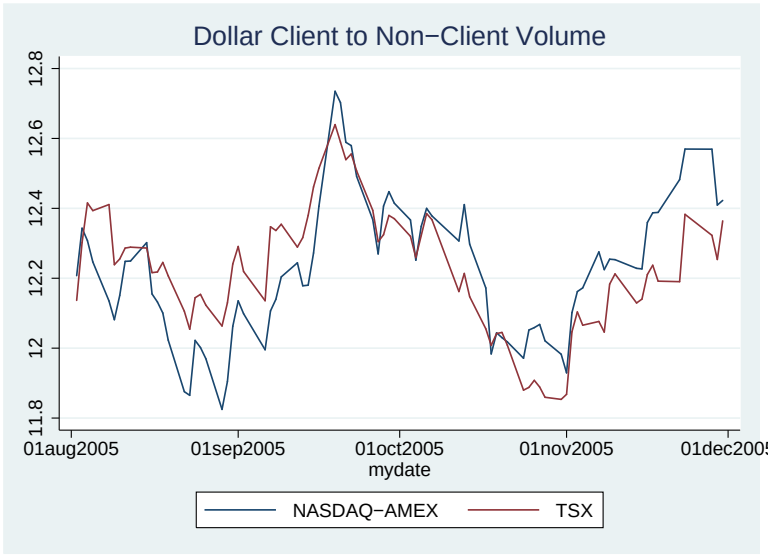
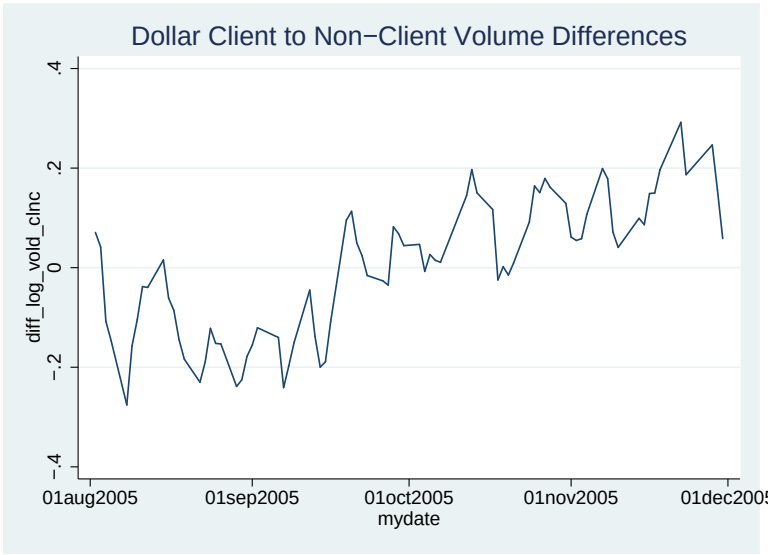
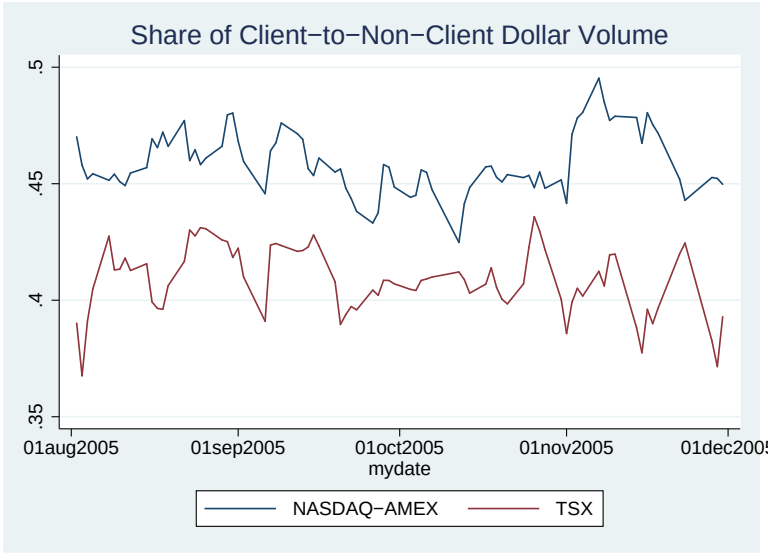


Figure 6
Plots of Intermediated Dollar Volume

The top left panel plots the daily dollar volume of trades between clients and non-clients for the group of NASDAQ/AMEX interlisted securities and their matches (labelled as "TSX"). The bottom left panel plots the fraction of such intermediated trades of the total dollar volume. The top and bottom right panels plot the differences of, respectively, levels and fractions of intermediated dollar volume for interlisted securities vs. their non-interlisted matches.







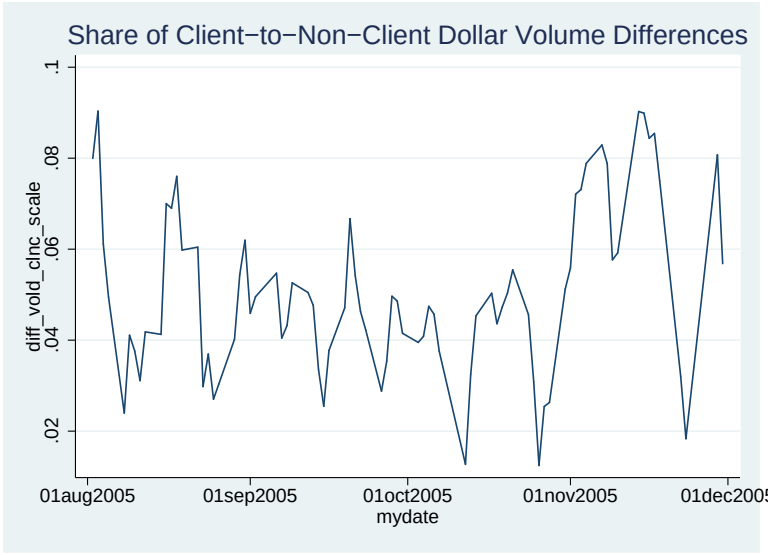


Table 14
List of all interlisted companies and their non-interlisted matches, Part I

Treatment Group: Interlisted with AMEX or NASDAQ		Control group match: non-interlisted	
ABZ	ABER DIAMOND CORPORATION	SBY	SOBEYS INC.
AEZ	AETERNA ZENTARIS INC.	ITX	ITERATION ENERGY LTD. J
ANP	ANGIOTECH PHARMACEUTICALS INC.	AGF.NV	AGF MANAGEMENT LTD. CL 'B' NV
ARZ	AURIZON MINES LTD. J	ENE	ENDEV ENERGY INC.
ATY	ATI TECHNOLOGIES INCORPORATED	TA	TRANSALTA CORPORATION
AXP	AXCAN PHARMA INC.	IMN	INMET MINING CORPORATION
BEV	BENNETT ENVIRONMENTAL INC.	STY	STYLUS ENERGY INC.
BGO	BEMA GOLD CORPORATION J	UTS	UTS ENERGY CORPORATION
BLD	BALLARD POWER SYSTEMS INC.	IUC	INTERNATIONAL URANIUM CORPORATION J
BRA	BIOMIRA INC.	CEK	CASPIAN ENERGY INC. J
CBJ	CAMBIOR INC.	NS	NORSKE SKOG CANADA LIMITED
CEF.NV.A	CENTRAL FUND OF CANADA LTD. CL 'A' NV	SWP	SASKATCHEWAN WHEAT POOL INC.
CLG	CUMBERLAND RESOURCES LTD. J	ANO	ANATOLIA MINERALS DEVELOPMENT LIMITED J
COM	CARDIOME PHARMA CORP.	KEC	KICK ENERGY CORPORATION J
CRY	CRYPTOLOGIC INC.	AAH	AASTRA TECHNOLOGIES LIMITED
CSN	COGNOS INC.	CTR.NV	CANADIAN TIRE CORP. LTD. CL 'A' NV
DAX	DRAXIS HEALTH INC.	IXL	INNOVA EXPLORATION LTD. J
DII.SV	DOREL INDUSTRIES INC. CL 'B' SV	AGA	ALGOMA STEEL INC.
DSG	DESCARTES SYSTEMS GROUP INC. (THE)	GWE	GREY WOLF EXPLORATION INC.
DSM	DESERT SUN MINING CORP. J	ARG	AMERIGO RESOURCES LTD. J
ECG	ENVOY COMMUNICATIONS GROUP INC.	EDV	ENDEAVOUR MINING CAPITAL CORP. ORDINARY J
ELD	ELDORADO GOLD CORPORATION	BBD.MV.A	BOMBARDIER INC. CL 'A' MV
EXF.SV	EXFO ELECTRO-OPTICAL ENGINEERING INC. SV	QUA	QUADRA MINING LTD.
FMI	FORBES MEDI-TECH INC.	WF	WHITE FIRE ENERGY LTD.
FNX	FNX MINING COMPANY INC.	ATA	ATS AUTOMATION TOOLING SYSTEMS INC.
FRG	FRONTEER DEVELOPMENT GROUP INC. J	CSY	CSI WIRELESS INC.
FSV.SV	FIRSTSERVICE CORPORATION SV	CCL.NV.B	CCL INDUSTRIES INC. CL 'B' NV
GAC	GEAC COMPUTER CORPORATION LTD.	HBC	HUDSON'S BAY COMPANY
GAM	GAMMON LAKE RESOURCES INC. J	FAP	ABERDEEN ASIA-PACIFIC INCM INVESTMENT CO LTD.
GSC	GOLDEN STAR RESOURCES LTD.	OIL	OILEXCO INCORPORATED J
HUM	HUMMINGBIRD LTD.	MRG	MERGE CEDARA EXCHANGECO LIMITED EXCHANGEABLE
HYG	HYDROGENICS CORPORATION	SGF	SHORE GOLD INC. J
IDB	ID BIOMEDICAL CORPORATION	KFS	KINGSWAY FINANCIAL SERVICES INC.
IE	IVANHOE ENERGY INC.	UEX	UEX CORPORATION J
IMG	IAMGOLD CORPORATION	LIM	LIONORE MINING INTERNATIONAL LTD.
IMO	IMPERIAL OIL LTD.	RY	ROYAL BANK OF CANADA

Table 15
List of all interlisted companies and their non-interlisted matches, Part II

Treatment Group: Interlisted with AMEX or NASDAQ		Control group match: non-interlisted	
IMX	IMAX CORPORATION	GND	GENNUM CORPORATION
IOL	INTEROIL CORPORATION J	CCA.SV	COGECO CABLE INC. SV
KRY	CRYSTALLEX INTERNATIONAL CORPORATION J	TBC	TEMBEC INC.
MAE	MIRAMAR MINING CORPORATION	IVW	IVERNIA INC. J
MEC.SV.A	MAGNA ENTERTAINMENT CORP. CL 'A' SV	ITP	INTERTAPE POLYMER GROUP INC.
MFL	MINEFINDERS CORPORATION LTD. J	CYT	CRYOCATH TECHNOLOGIES INC.
MPV	MOUNTAIN PROVINCE DIAMONDS INC. J	COB.SV.A	COOLBRANDS INTERNATIONAL INC. CL 'A' SV
MR	METALLICA RESOURCES INC. J	ACA	ASHTON MINING OF CANADA INC.
MX	METHANEX CORPORATION	MNG	MERIDIAN GOLD INC.
NG	NOVAGOLD RESOURCES INC. J	PTI	PATHEON INC.
NGX	NORTHGATE MINERALS CORPORATION	DY	DYNATEC CORPORATION
NNO	NORTHERN ORION RESOURCES INC. J	TRE	SINO-FOREST CORPORATION
NRM	NEUROCHEM INC.	SWG	SOUTHWESTERN RESOURCES CORP. J
NSU	NEVSUN RESOURCES LTD. J	CDV	COM DEV INTERNATIONAL LTD.
ONC	ONCOLYTICS BIOTECH INC.	CNH	CINCH ENERGY CORP. J
OTC	OPEN TEXT CORPORATION	RUS	RUSSEL METALS INC.
OZN	OREZONE RESOURCES INC. J	ZL	ZARLINK SEMICONDUCTOR INC.
PAA	PAN AMERICAN SILVER CORP.	CRW	CINRAM INTERNATIONAL INC.
PCR	PERU COPPER INC. J	SMF	SEMAFO INC. J
PDL	NORTH AMERICAN PALLADIUM LTD.	IFP.SV.A	INTERNATIONAL FOREST PRODUCTS LTD. CL 'A' SV
QLT	QLT INC.	BVI	BLACKROCK VENTURES INC.
RIM	RESEARCH IN MOTION LIMITED	WN	WESTON LTD. GEORGE
RNG	RIO NARCEA GOLD MINES LTD.	MAL	MAGELLAN AEROSPACE CORPORATION
SNG	CANADIAN SUPERIOR ENERGY INC. J	BGC	BOLIVAR GOLD CORP. J
SOY	SUNOPTA, INC.	SGB	STRATOS GLOBAL CORPORATION
SSO	SILVER STANDARD RESOURCES INC.	RRZ	RIDER RESOURCES LTD.
SVN	724 SOLUTIONS INC.	RVE	ROCKYVIEW ENERGY INC.
SW	SIERRA WIRELESS, INC.	FE	FIND ENERGY LTD.
TEO	TESCO CORPORATION	KCO	KERECO ENERGY LTD.
TGL	TRANSGLOBE ENERGY CORPORATION J	WLE	WESTERN LAKOTA ENERGY SERVICES INC.
TLC	TLC VISION CORPORATION	CGS.SV	CANWEST GLOBAL COMMUNICATIONS CORP. SV
TNX	TAN RANGE EXPLORATION CORPORATION J	WPT	WESTPORT INNOVATIONS INC.
VAS	VASOGEN INC.	VIA	VIRGINIA GOLD MINES INC. J
WED	WESTAIM CORPORATION (THE)	WTN	WESTERN CANADIAN COAL CORP. J
YM	YM BIOSCIENCES INC. J	DDS	LABOPHARM INC.
YRI	YAMANA GOLD INC. J	AGI	ALAMOS GOLD INC. J
ZIC	ZI CORPORATION	TOS	TSO3 INC. J