# High Frequency Trading
# A Closer Look

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## Introduction

High Frequency Trading (HFT) has been in the spotlight lately and there has been a considerable amount of discussion on the topic. There are valid arguments made on both sides of the fence on the issue of HFTs.

The purpose of this paper is to discuss a few of the common debates around the industry. We highly recommend a quick read of our High Frequency Trading paper as a prequel to this piece.

We would also like to note that while HFTs have been getting a lot of bad press lately, they are simply taking advantage of the incentives and opportunities provided by marketplaces and the regulatory framework itself. The strategies employed by HFTs are generally not illegal in nature since they work within the confines of the existing regulatory framework and are fuelled by marketplace pricing policies.

## Do HFTs increase or decrease volatility?

This is one of the trickier questions to answer on the debate on HFT. We have heard both sides of the argument on the street and thus we decided that further investigation on the issue of volatility was necessary.

Due to the short term nature of the trading styles of HFTs, we believe an intra-day volatility measure to be more appropriate than inter-day volatility. This poses somewhat of a challenge since intra-day volatility is not as straightforward to measure as inter-day volatility and the calculation is more subjective. e.g. Do we use trades or quotes in the calculation? Do we bucket by minute or tick by tick? Can high/low be used as a proxy for volatility? In the end, we decided to calculate volatility on a tick by tick basis and interpret it as a 1 standard deviation move over the course of a trading day.

In order to evaluate the effect of HFTs on volatility, we compared the ratio of intra/inter-day volatility of July 2008 with the same ratio calculated for July 2009 for all TSX stocks that traded 25,000 shares or more on average per day. The idea behind this methodology is that intra-day volatility in relation to inter-day would normalize for market volatility changes (ie intra and inter-day volatilities should increase/decrease the same amount keeping the ratio constant and any difference in the ratio can be attributed to a change in the nature of trade mechanics as opposed to a change in the market's volatility).

The following tables show the results broken down by stock price levels. We would also like to note that we got similar results when we weighted the volatility numbers by volume or price so as to make sure we are not cherry-picking data.

**Simple average:**

| Stock Value | July 2008 intra/inter volatility | July 2009 intra/inter volatility | % Difference | % Volume Increase |
|---|---|---|---|---|
| **$0 - $1** | 0.1835 | 0.2071 | **12.9** | 235 |
| **$1.01 - $5** | 0.0958 | 0.1910 | **99.4** | 189 |
| **$5.01 - $10** | 0.1161 | 0.1999 | **72.2** | 263 |
| **$10.01 - $20** | 0.2138 | 0.1765 | **-17.4** | 96 |
| **$20+** | 0.1913 | 0.1782 | **-6.9** | 28 |

**Value weighted:**

| Stock Value | July 2008 intra/inter volatility | July 2009 intra/inter volatility | % Difference | % Volume Increase |
|---|---|---|---|---|
| **$0 - $1** | 0.2332 | 0.3206 | **37.5** | 235 |
| **$1.01 - $5** | 0.1687 | 0.1982 | **17.5** | 189 |
| **$5.01 - $10** | 0.1249 | 0.2990 | **139.5** | 263 |
| **$10.01 - $20** | 0.5529 | 0.2030 | **-63.3** | 96 |
| **$20+** | 0.2068 | 0.2037 | **-1.5** | 28 |

The results are quite telling and confirm our gut instinct on what has been going on in the marketplace. We see a sharp increase in intra-day volatility relative to inter-day volatility for stocks under $10. We have argued that this is the sweet spot for HFTs as the low dollar value stocks provide the highest

rebate levels in percentage terms (see Appendix B for trading fees). The other smoking gun is the breakdown of volume increases… again, we see the low dollar value stocks have the greatest increase which fits our thesis on where the HFTs prefer to focus.

## How beneficial is the liquidity provided by HFTs?

One of the oft touted benefits of HFTs is the increase in liquidity they provide. Tighter spreads and greater volumes on the bid / offer are often cited as prime benefits of HFT activity in a marketplace. While we agree that this helps the typical retail investor (who usually has smaller orders that get done in a single trade), further investigation is needed on whether HFTs help the larger institutional client base (who generally have larger orders that require more time in the market).

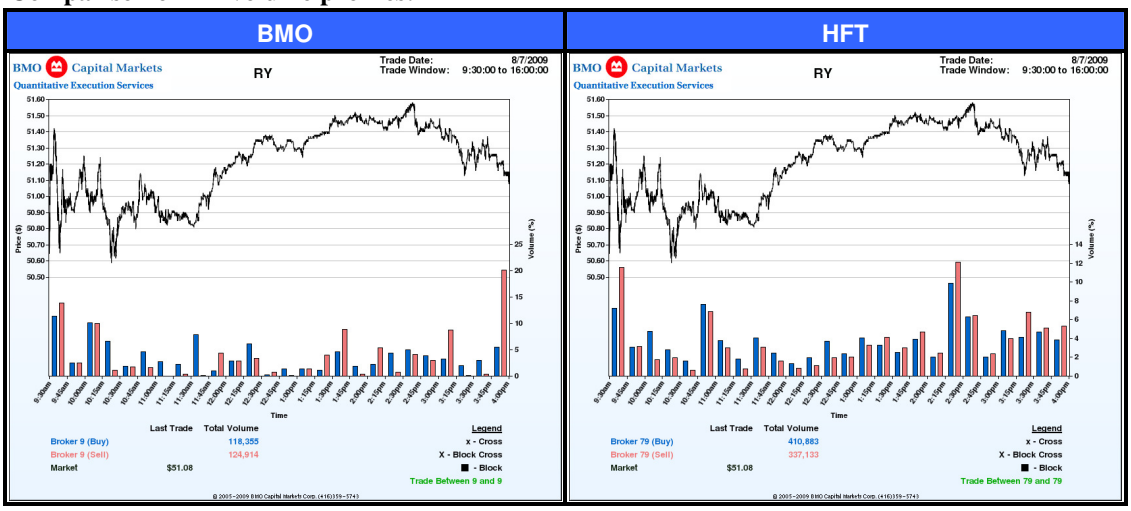
Fundamental investors typically prefer buying (selling) from (to) other fundamental investors, for the simple reason that the transaction does not create further demand / supply. Hence a natural cross is often preferred to a facilitation trade which simply shifts the demand / supply. However, in case a natural is not found, a facilitation trade can 'time-shift' this liquidity for an investor by taking on the position and then offsetting it at a later time when liquidity becomes available.

HFTs take this concept of 'time-shifting liquidity' to the extreme where the average time a stock is held is typically measured in minutes if not seconds. While facilitation traders can hold on to positions for several days or weeks, HFTs typically don't hold exposures overnight. Thus, a fundamental investor making use of the liquidity provided by an HFT is also increasing demand / supply on the same side seconds later, as the HFT looks to flatten its position on the stock.

To investigate the short term nature of this liquidity, we took snapshots of a few stocks over the course of a trading day (See below & Appendix A). There is a stark difference between the volume profiles of BMO's trading vs HFT's trading (we use CIBC as a proxy for HFTs since we believe a significant percentage of their flow is HFT driven). The difference between the buy volume (blue bars) vs sell volume (red bars) distribution for any 15 minute bucket is erratic for BMO but a lot smoother for HFTs. Put another way, BMO's volume patterns are representative of fundamental buyers / sellers participating in the marketplace whereas HFT volume profiles highlight the 'short term' nature of their liquidity.

The closely matched buy and sell volume profiles also indicate that HFTs are typically not running statistical arbitrage strategies but are instead running short term market making strategies.

**Comparison of RY volume profiles:**




We encourage you to try our website analytics tool on other stocks of interest over various dates. http://qes.bmo.com/posttrade/stockanalyzer.php

It should also not come as a surprise that the logical practice for any smart HFT would be to recognize the direction of the flow over the course of time and start trading alongside rather than contra (ie why stand in the path of an oncoming train?). This is the key reason why we believe the liquidity provided by HFTs should be of concern to fundamental investors. That is not to say that the practice is illegal. Market structure in Canada is such that any rational, efficient market participant would do exactly the same.

Nevertheless, the HFT liquidity needs to be considered for the purposes of cost modelling and marketshare analysis since it is what we would call 'phantom' liquidity. Users of algorithms that work off volume participation levels need to account for this phantom flow and adjust their participation rates accordingly. '1/4 of the volume' is the new '1/3 of the volume' so to speak.

To answer the original question, "how useful is the liquidity provided by HFTs?", we note that the nature of HFT liquidity makes it suitable for retail flow by increasing bid / offer sizes. However, the longer term nature of larger institutional order flow makes the value of HFT liquidity questionable.

## HFTs – Weapons of mass quotation!

One of the effects that the HFTs have had on the marketplace is the increase in message counts relative to the increase in volumes. The avalanche of automated orders being placed in and out of marketplaces has caused the 'order-to-trade' ratios to skyrocket in the marketplace. While this ratio has increased across all venues, the effect is more noticeable on marketplaces that have a greater percentage of their order flow from HFTs.

Historically, the TSX has averaged about 10 - 15 orders/trade prior to 2006 but has had a significant run-up in the ratio in the last 2 years. Today, Pure and Chi-X (part owned by Getco, one of the largest HFTs in the US) lead the pack indicating the HFTs preference for these ATSs. The following tables highlight the drastic difference in order-to-trade ratios for the various ATSs in Canada.

**Aug 10th 2009:**

| Marketplace | Orders | Trades | Order/Trade Ratio |
|---|---|---|---|
| TSX | 27,812,224 | 536,386 | 52 |
| TSXV | 117,013 | 21,559 | 5 |
| Chi-X | 16,013,453 | 70,543 | 227 |
| Pure Trading | 1,642,025 | 6,483 | 253 |
| Alpha Trading | 1,309,787 | 77,190 | 17 |
| Omega* | 0 | 0 | 0 |

**Source: ITS, *Omega had an outage on Aug 10, 2009**

**July 3rd 2009 (US markets closed):**

| Marketplace | Orders | Trades | Order/Trade Ratio |
|---|---|---|---|
| TSX | 3,967,105 | 231,739 | 17 |
| TSXV | 51,861 | 8,647 | 6 |
| Chi-X | 246,952 | 4,778 | 52 |
| Pure Trading | 537,075 | 4,580 | 117 |
| Alpha Trading | 758,166 | 19,397 | 39 |
| Omega | 14,122 | 481 | 29 |

**Source: ITS**

There are a number of reasons why this increase in the 'order-to-trade' ratio is an issue. As order-to-trade ratios increase, there is an explicit technology cost on the industry to keep pace with the increased message traffic. These costs can be quite significant and require constant investment in infrastructure simply to keep pace.

The constant upgrades and investment in technology has often been cited as the great technology arms race. We discuss a few examples to highlight the issue:

**Data feeds** – As message traffic has increased, vendors have had significant depreciation in the latency of their data feeds. What used to be standard feeds have latencies higher than 500ms (an eternity in the modern electronic marketplace). Various data feed vendors have offered more direct versions of their feeds at significantly higher pricing models.

**Data storage** – Another area where there has been an increase in costs is data storage. This includes everything from the physical storage media, database allocations, application rewrites in order to handle larger volumes of data.

**Compliance** – Monitoring all this data for compliance is also getting more challenging due to the sheer sizes involved and the amount of noise generated by the increase in orders.

The flickering nature of quotes also makes trading trickier and can create false signals for algos designed to react to quote changes.

## Why the HFTs love the Canadian marketplace

So why is HFT flourishing in Canada? There are a number of reasons that make Canada an extremely lucrative marketplace for HFTs.

**Marketplace incentives –** Canadian marketplaces have one of the highest levels of passive rebates in the world. This is attractive for HFTs since the majority of their trading strategies trade passively to capture these rebates. We have attached a schedule of trading fees for various places across the globe in Appendix B.

**Snapshot of fees for a $5 stock (bps):**

| | Passive | | Aggressive | |
|---|---|---|---|---|
| Marketplace | min | max | min | max |
| **TSX** | -0.58 | -0.62 | 0.66 | 0.74 |
| **TSX ELP Program** | **-0.66** | **-0.70** | 0.66 | 0.70 |
| **Alpha Trading Systems** | -0.62 | -0.62 | 0.70 | 0.70 |
| **Chi-X Canada** | -0.50 | -0.50 | 0.58 | 0.58 |
| **Pure Trading** | -0.54 | -0.62 | **0.74** | **0.74** |
| | | | | |
| **NYSE** | -0.40 | -0.40 | 0.60 | 0.60 |
| **NASDAQ** | -0.40 | -0.59 | 0.54 | 0.60 |
| **BATS** | -0.48 | -0.48 | 0.50 | 0.50 |
| **DirectEdge** | -0.50 | -0.50 | 0.56 | 0.56 |
| **NYSE ARCA Tape A** | -0.56 | -0.60 | 0.60 | 0.60 |
| **NYSE ARCA Tape B** | -0.44 | -0.46 | 0.56 | 0.56 |
| **NYSE ARCA Tape C** | -0.56 | -0.60 | 0.60 | 0.60 |
| **LSE (London)** | 0.20 | 0.45 | 0.20 | 0.45 |
| **Chi-X Europe** | -0.20 | -0.20 | 0.30 | 0.30 |
| **Turquoise** | -0.20 | -0.24 | 0.28 | 0.28 |
| **HKEX (Hong Kong)** | 0.05 | 0.01 | 0.05 | 0.05 |
| **ASX (Australia)** | 0.28 | 0.03 | 0.28 | 0.28 |

**Source: Exchange websites**

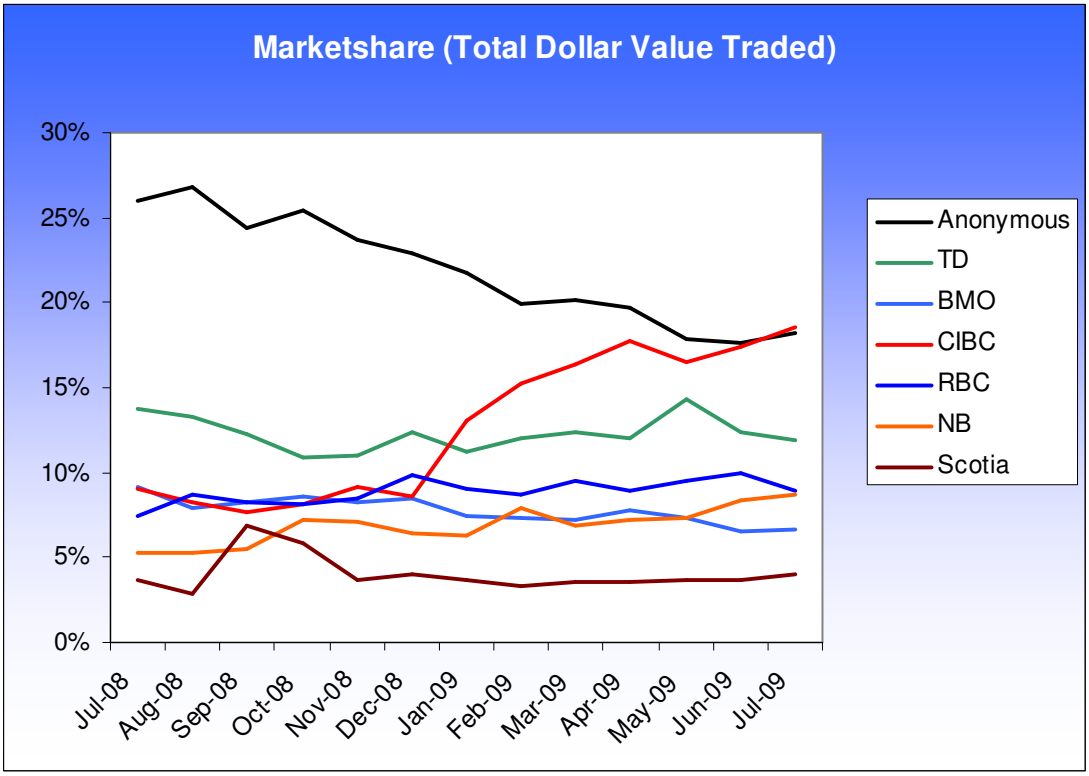
Passive rebates were originally put in place after the decimalization of the marketplaces in order to attract market-makers to post liquidity. However, given the viral increase in HFTs, one can argue that the incentives are perhaps too high and a more balanced approach is required. This is especially true in

the Canadian marketplace where the rebates are among the highest in the world at the expense of the active participants which have the highest aggressive rates.

**Regulatory subsidy –** Canadian regulators have been slow to adapt to the changing marketplace and in providing a framework for trading in a multiple marketplace environment. An example of this is the fact that Canada is the only marketplace in the world which has a trade-through obligation with no cap on trading fees or data fees. By having a trade-through obligation, Canadian regulators force all participants to connect to all the exchanges (thus the marketplaces have a captive client base who can't bypass a market) and by not having a cap on data or active trading fees (ie the fees charged to the participant crossing the spread), the marketplaces can afford to offer outsized passive rebates (ie the rebate given back to the participant sitting on the bid / offer) in order to attract flow.

In short, the rules allow Canadian marketplaces to set their rebates as high as they please without any dealer recourse in having the ability to bypass a marketplace because of the trade-through rule. Contrast this to the US markets where the SEC has set a cap of $0.003 on all aggressive trades, thus forcing the marketplaces to compete on price and other value add instead of a regulatory subsidy.

**Marketshare –** Canadian dealers have always jockeyed for marketshare in the Canadian marketplace since it has often been a factor in driving their Investment Banking revenues. The argument is that the dealers with the highest marketshare in a name are generally best in touch with the flow on that stock thus resulting in more informed new issue placements. Historically, relative marketshare has moved by a few basis points year over year for the major Canadian dealers but the chart below illustrates just how quickly HFTs have changed the landscape.




**Source: TSX, Alpha Trading, Pure Trading**

Dealers have increased their marketshare by essentially 'renting' their broker number to HFTs for a marginal rate (we have heard numbers as low as 3 hundredths of a penny with a cap on maximum fees, far lower than the average DMA client) while HFTs circumvent the need to register as a broker (and be subject to closer regulatory scrutiny and registration costs).

## Conclusion

While there have been HFT like players for quite some time, the recent evolution of the markets has brought a new breed of participant to the Canadian forefront… one that is faster, smarter, and understands nuances of the market microstructure better than the incumbents! Our goal with these series of papers is to educate all market participants on the issues in order to have a better understanding of the evolving landscape.

As always, we encourage a healthy debate and welcome your thoughts and perspectives on the issues at hand. If you have any questions or comments please contact the BMO Quantitative Execution desk at 416-359-5743

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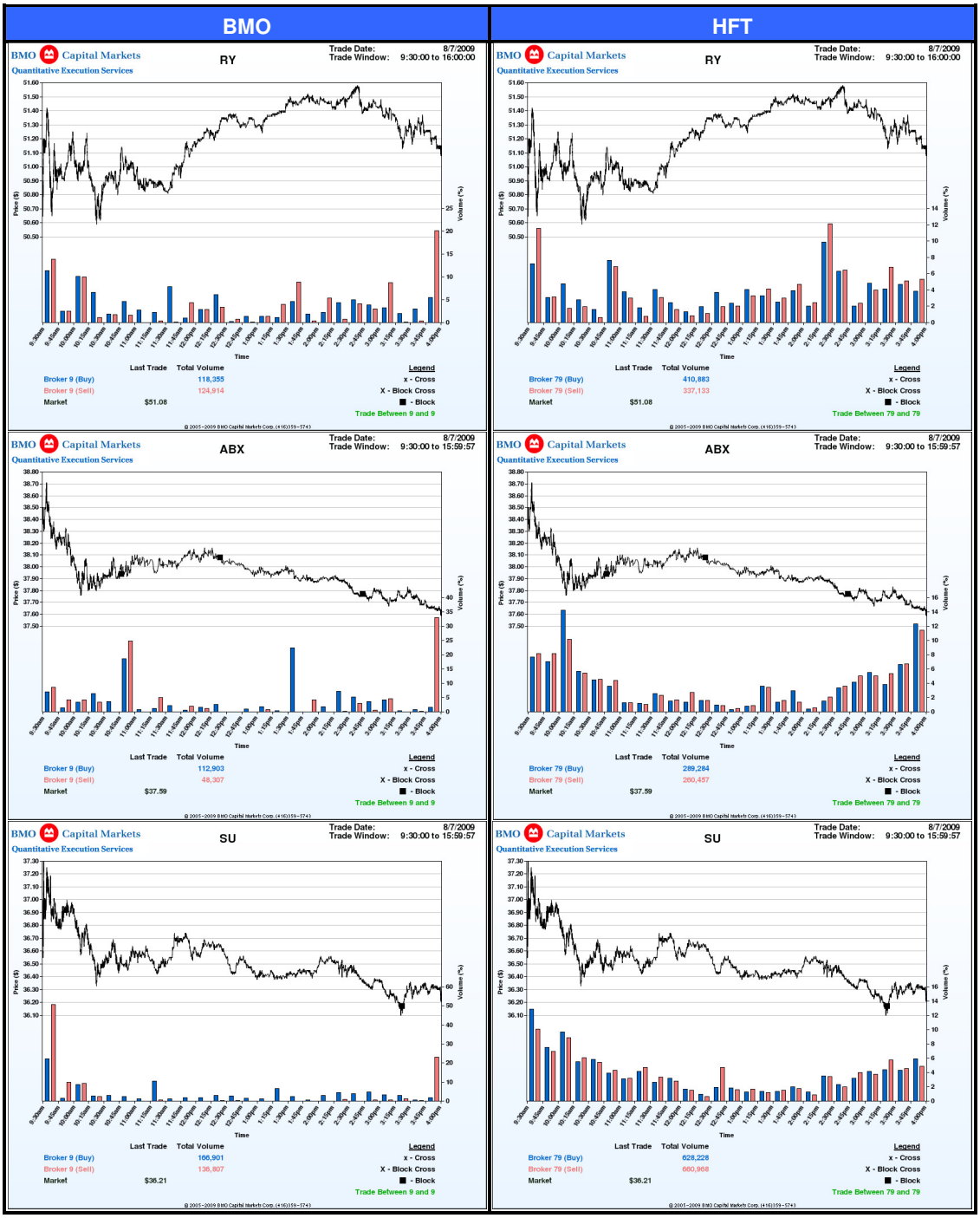
## Appendix A – Volume Profiles

Volume profiles for three Canadian stocks on Aug 7th, 2009. Blue bars represent buys, red bars sells.




**Source: Stock Analyzer:** http://qes.bmo.com/posttrade/stockanalyzer.php

## Appendix B – Trading Fees

Sample trading fees for $0.50, $5, $20 stocks as of Aug 10, 2009.

**$0.50 stock fees (bps):**

| Marketplace | Passive | | Aggressive | |
|---|---|---|---|---|
| | min | max | min | max |
| TSX | -0.20 | -0.60 | 1.20 | 1.60 |
| TSX ELP Program | N/A | N/A | N/A | N/A |
| Alpha Trading Systems | -0.20 | -0.20 | 1.00 | 1.00 |
| Chi-X Canada | -1.00 | -1.00 | 1.60 | 1.60 |
| Pure Trading | -3.60 | -4.40 | 5.20 | 5.20 |
| | | | | |
| NYSE | N/A | N/A | N/A | N/A |
| NASDAQ | N/A | N/A | N/A | N/A |
| BATS | 0.00 | 0.00 | 0.00 | 0.00 |
| DirectEdge | 0.00 | 0.00 | 2.00 | 2.00 |
| NYSE ARCA Tape A | N/A | N/A | N/A | N/A |
| NYSE ARCA Tape B | N/A | N/A | N/A | N/A |
| NYSE ARCA Tape C | N/A | N/A | N/A | N/A |
| LSE (London) | 0.20 | 0.45 | 0.20 | 0.45 |
| Chi-X Europe | -0.20 | -0.20 | 0.30 | 0.30 |
| Turquoise | -0.20 | -0.24 | 0.28 | 0.28 |
| HKEX (Hong Kong) | 0.05 | 0.05 | 0.05 | 0.05 |
| ASX (Australia) | 0.28 | 0.28 | 0.28 | 0.28 |

**Source: Exchange websites**

**$5 stock fees (bps):**

| Marketplace | Passive | | Aggressive | |
|---|---|---|---|---|
| | min | max | min | max |
| TSX | -0.58 | -0.62 | 0.66 | 0.74 |
| TSX ELP Program | -0.66 | -0.70 | 0.66 | 0.70 |
| Alpha Trading Systems | -0.62 | -0.62 | 0.70 | 0.70 |
| Chi-X Canada | -0.50 | -0.50 | 0.58 | 0.58 |
| Pure Trading | -0.54 | -0.62 | 0.74 | 0.74 |
| | | | | |
| NYSE | -0.40 | -0.40 | 0.60 | 0.60 |
| NASDAQ | -0.40 | -0.59 | 0.54 | 0.60 |
| BATS | -0.48 | -0.48 | 0.50 | 0.50 |
| DirectEdge | -0.50 | -0.50 | 0.56 | 0.56 |
| NYSE ARCA Tape A | -0.56 | -0.60 | 0.60 | 0.60 |
| NYSE ARCA Tape B | -0.44 | -0.46 | 0.56 | 0.56 |
| NYSE ARCA Tape C | -0.56 | -0.60 | 0.60 | 0.60 |
| LSE (London) | 0.20 | 0.45 | 0.20 | 0.45 |
| Chi-X Europe | -0.20 | -0.20 | 0.30 | 0.30 |
| Turquoise | -0.20 | -0.24 | 0.28 | 0.28 |
| HKEX (Hong Kong) | 0.05 | 0.01 | 0.05 | 0.05 |
| ASX (Australia) | 0.28 | 0.03 | 0.28 | 0.28 |

**Source: Exchange websites**

**$20 stock fees (bps):**

| Marketplace | Passive | | Aggressive | |
|---|---|---|---|---|
| | min | max | min | max |
| TSX | -0.15 | -0.16 | 0.17 | 0.19 |
| TSX ELP Program | -0.17 | -0.18 | 0.17 | 0.18 |
| Alpha Trading Systems | -0.16 | -0.16 | 0.18 | 0.18 |
| Chi-X Canada | -0.13 | -0.13 | 0.14 | 0.15 |
| Pure Trading | -0.14 | -0.16 | 0.19 | 0.19 |
| | | | | |
| NYSE | -0.10 | -0.10 | 0.15 | 0.15 |
| NASDAQ | -0.10 | -0.15 | 0.14 | 0.15 |
| BATS | -0.12 | -0.12 | 0.13 | 0.13 |
| DirectEdge | -0.13 | -0.13 | 0.14 | 0.14 |
| NYSE ARCA Tape A | -0.14 | -0.15 | 0.15 | 0.15 |
| NYSE ARCA Tape B | -0.11 | -0.12 | 0.14 | 0.14 |
| NYSE ARCA Tape C | -0.14 | -0.15 | 0.15 | 0.15 |
| LSE (London) | 0.20 | 0.45 | 0.20 | 0.45 |
| Chi-X Europe | -0.20 | -0.20 | 0.30 | 0.30 |
| Turquoise | -0.20 | -0.24 | 0.28 | 0.28 |
| HKEX (Hong Kong) | 0.05 | 0.05 | 0.05 | 0.05 |
| ASX (Australia) | 0.28 | 0.28 | 0.28 | 0.28 |

**Source: Exchange websites**