The HOT Study
Phases I and II of IIROC’s Study of High Frequency Trading Activity on Canadian Equity Marketplaces

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Study Period August 1, 2011 to October 31, 2011

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I. Introduction
Over the past several years, the Canadian equity marketplace has experienced significant growth in high-speed, low-latency, and technologically-driven trading activity commonly known as high frequency trading (“HFT”), which has transformed market dynamics across the industry. The advent of decimalization, multiple marketplaces, increased competition among marketplaces, the globalization of trading and the advancement of trading technologies have all laid the groundwork for HFT. The events of May 6, 2010 and a number of ensuing studies focused on algorithmic trading and HFT have only served to increase the world-wide scrutiny of this activity and highlight its relevance on trading across multiple asset classes.

HFT is an issue that has polarized market participants. In discussions concerning this activity, most participants have an opinion, which is either supportive of the benefits of HFT or critical of its harmful effects. Proponents of HFT say it results in enhanced liquidity, reduced spreads and greater market efficiency. Critics of HFT say it exacerbates market volatility by withdrawing liquidity when most needed, takes unfair advantage of “real” investors, contributes confusion and cost through excess message traffic, and undermines investor confidence. At the 2012 International Organization of Securities Commissions (“IOSCO”) Annual Conference, high frequency trading was a major topic of discussion. Questions and concerns raised by participants at the IOSCO Conference included the following:

- Is displayed order flow by high frequency traders too “fleeting”?
- Is the liquidity provided real or illusory?
- Does high frequency trading exacerbate volatility?
- Do high frequency traders seek informational advantages over other investors—retail and institutional—through their trading strategies?

Many academics have also taken an interest in HFT and numerous studies have been conducted, although in many instances the effectiveness of previous academic studies has been hampered by a lack of complete and consolidated market data. As part of this study, IIROC undertook a comprehensive review of literature, including studies, articles and academic publications concerning HFT, algorithmic trading and other issues related to our study. A summary of the literature most relevant to our study is found in Appendix A. Any reading of the large body of literature regarding HFT reveals no precise definition, but rather a general consensus on a set of “commonly held attributes” to describe the activity. IOSCO’s Consultation Report, “Regulatory Issues Raised by the Impact of Technological Changes on
Market Integrity and Efficiency”, October 2011¹ did not attempt to define HFT, but did identify a series of common features and trading characteristics related to HFT:

- It involves the use of sophisticated technological tools for pursuing a number of different strategies, ranging from market making to arbitrage;
- It is a highly quantitative tool that employs algorithms along the whole investment chain: analysis of market data, deployment of appropriate trading strategies, minimisation of trading costs and execution of trades;
- It is characterized by a high daily portfolio turnover and order to trade ratio (i.e. a large number of orders are cancelled in comparison to trades executed);
- It usually involves flat or near flat positions at the end of the trading day, meaning that little or no risk is carried overnight, with obvious savings on the cost of capital associated with margined positions. Positions are often held for as little as seconds or even fractions of a second;
- It is mostly employed by proprietary trading firms or desks; and
- It is latency sensitive. The implementation and execution of successful high frequency trading strategies depend crucially on the ability to be faster than competitors and to take advantage of services such as DEA [direct electronic access] and co-location.

Despite the absence of a clear definition, HFT is of concern to many stakeholders in the Canadian equity marketplace:

- Retail investors complain that their bids and offers are often continuously bettered by the minimum tick size, forcing them to cross the spread by entering market orders to execute a trade;
- Institutional investors, and inventory traders providing liquidity to them, are concerned that algorithms with a technological advantage prey on their large orders, negatively impacting their transaction prices and trading costs;
- Traditional market makers complain they are unable to compete with high frequency electronic liquidity providers (“ELP”);
- Regulators are concerned with the heightened possibility of spoofing, layering, quote stuffing and other potentially manipulative activity; and
- Participants are impacted by increased messaging rates incurring costs for processing and storing data.

It is evident that a full understanding of the scope and breadth of HFT activity is critical to assessing its effect on market quality and integrity, and assisting in determining the type and extent of regulatory action that is appropriate to achieve desired outcomes.

As the Regulation Services Provider for all equity markets in Canada, IIROC receives real-time regulatory data feeds from each of the marketplaces it regulates which is, in turn, fed into our surveillance system (“STEP”) creating a virtual consolidated book. These marketplace feeds contain confidential regulatory markers that are not publicly available. As a result, IIROC has in its database a rich repository of regulatory market data consisting of all orders and trades executed on Canadian equity markets.

IIROC’s unique access to this rich data and the holistic cross-market view of trading activity that it provides has allowed us to initiate a comprehensive and objective study of certain types of trading activity in Canadian equity markets. Using the data to drive the study allows us to view all types of trading activity in an unbiased manner.

IIROC’s Study of High Frequency Trading Activity on Canadian Equity Marketplaces (the “HFT Study”) consists of three phases:

- Phase I – the identification of a study group, (the “HOT group”);
- Phase II - a descriptive statistical analysis of the trading activity of the HOT group on Canadian equity marketplaces; and
- Phase III – a study of the impact of HFT activity on Canadian marketplaces with respect to market quality and market integrity (the “Impact Study”).

This report summarizes the results of Phases I and II which will form the basis of the impact analysis being undertaken in Phase III of the HFT Study.
A. Regulatory Initiatives Regarding HFT in Other Jurisdictions

IOSCO’s 2011 report focused substantially on HFT; more specifically, its characteristics, the trading strategies employed, observed impacts on markets, and potential risks posed to market integrity and efficiency. The IOSCO consultation report acknowledged the lack of empirical evidence on the impact of HFT and attributed it to both “a limited availability of appropriate datasets, and to empirical and theoretical difficulties raised by the exercise”. Previous academic literature focused mainly on measures of liquidity, price discovery and volatility rather than generally on the risks to market integrity. The report commented that isolating the impacts of HFT is complicated, as the trading environment is dynamic in terms of competition, structural changes, market turbulence and regulatory reforms.

In 2010, the United States Securities and Exchange Commission (“US SEC”) published a Market Structure Concept Release 2 which acknowledged significant changes to market structure in terms of the speed of trading, volume, average trade size and market fragmentation. The Concept Release posed specific questions for comment which included: What is the impact of the rising prominence of proprietary firms that trade in very large volumes? Do their high-speed systems and enormous message traffic threaten the integrity of trading center operations and present systemic risk? Have they brought greater liquidity and efficiency to our markets?

In February 2012, the US Commodity Futures Trading Commission (“CFTC”) established a sub-committee to focus on HFT. One of the tasks of this subcommittee was to make recommendations regarding the definition of HFT as an initial step towards identifying and assessing the impact of HFT and to guide the determination of appropriate regulatory and policy responses. The sub-committee draft definition 3 generally considers HFT as a form of automated trading that uses: algorithms for decision-making, order initiation, generation, routing or execution without any human direction; low-latency technology; high-speed connections to markets; and high message rates.

In November 2010, the Australia Securities and Investments Commission (“ASIC”) issued a Consultation Paper, “Australian equity market structure: Proposals” 4. This paper considered

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both the benefits and challenges arising from HFT and raised a number of questions concerning: fairness with respect to speed of access to markets and market data; the impact of high speed and volume of order entry and cancellation on price discovery; the impact on long-term investor confidence; the impact on data and data management costs; and the need for risk controls. In November 2012, ASIC announced the creation of two task forces, one of which will analyze the prevalence, nature and impact of HFT in the Australian market and abroad, and assess whether the current framework is adequate for HFT. ASIC plans to undertake a thematic review and will gather information through questionnaires and meetings with industry participants. The analysis conducted on this intelligence, together with consideration of international developments, will inform ASIC on whether new rules, guidance, or law reform are required.

In April 2010, the Committee of European Securities Regulators (“CESR”) (now called the European Securities and Markets Authority or “ESMA”) issued a call for evidence on market structure issues in the European equity markets which, among other questions, sought information on HFT with respect to strategies, impacts, and potential benefits. Following this publication, CESR created an action plan to undertake further work to better understand HFT strategies. CESR identified potential risks to investor protection, fair and orderly trading, market integrity and financial stability. In 2011, ESMA published “Guidelines on systems and controls in an automated trading environment for trading platforms, investment firms and competent authorities”, which became effective May 2012. The ESMA Guidelines cover electronic trading systems operated by regulated markets or multilateral trading facilities; their use, and the use of trading algorithms, by investment firms; and the provision of direct market access or sponsored access by investment firms. As such, the guidelines address some aspects of high frequency trading.

Proposals to reform the European Commission’s “Markets in Financial Instruments Directive” (“MiFID”) were initiated in December 2010, issued in final form in October 2011, modified in October 2012, and are still under debate. Among other things, the revised MiFID (“MiFID II”) proposes instituting a minimum resting time of 500 milliseconds, establishing acceptable order-
to-trade ratios to be set at the marketplace and product level, and setting order cancellation or modification fees.

In July 2012, the German Ministry of Finance published a discussion draft of the “Act for the Prevention of Risks and the Abuse of High Frequency Trading” ("HFT Act")\(^9\), which proposes new definitions of algorithmic trading and algorithmic high frequency trading. The HFT Act is modeled after the European Commission’s MiFID II proposals, and introduces measures that anticipate and complement European efforts to regulate high frequency trading.

**B. IIROC Guidance on Manipulative and Deceptive Trading**

IIROC has published proposed guidance on certain manipulative and deceptive trading practices\(^10\) with a focus on trading strategies using automated order systems or direct electronic access. The proposed guidance confirms IIROC’s position that certain trading practices – such as layering, spoofing, quote stuffing, quote manipulation and abusive liquidity detection – while often associated with high frequency trading, are considered manipulative and deceptive activities for the purposes of UMIR, whether manual or automated, or representative of fast or slow trading.

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\(^9\) See [http://www.bundesfinanzministerium.de/Content/EN/Pressemitteilungen/2012/2012-09-26-speed-limit-for-high-frequency-trading.html](http://www.bundesfinanzministerium.de/Content/EN/Pressemitteilungen/2012/2012-09-26-speed-limit-for-high-frequency-trading.html).

II. Overview of IIROC’s Study

C. Structure of the Study

The HFT Study consists of three phases:

- **Phase I** identifies a study group based on User IDs trading on Canadian equity marketplaces.
- **Phase II** is a descriptive statistical analysis of the trading activity of the study group on Canadian equity marketplaces and seeks to answer the five fundamental queries – who, what, where, when and how – as related to HFT.
- **Phase III** will assess the impact of HFT activity on Canadian marketplaces with respect to market quality and market integrity. As part of this phase, further analysis will be conducted with the aim to provide a more in-depth view of HFT and other related trading behaviours from multiple perspectives. We will also attempt to identify and quantify the different high frequency trading strategies being employed in our markets and their impacts on different market participants.

This review summarizes the results of Phases I and II which will form the basis of the impact analysis being undertaken in Phase III of the HFT Study.

D. The Regulatory Feed

The majority of the Canadian equity marketplaces11 provide trading data in a standardized form to IIROC via a real-time regulatory feed (“the Regulatory Feed”). This data includes all trade, order and quote messages and contains both public and confidential regulatory information.

During the time period of our study, the marketplaces providing data through the Regulatory Feed included Alpha ATS (“ALF”), Chi-X Canada (“CHX”), Instinet Canada Cross Limited (“ICX”), MATCH Now (“TCM”), Omega ATS (“OMG”), Pure Trading (operated by CNSX Markets Inc.) (“PTX”), Sigma X Canada ATS (“SGX”), TMX Select (“TMS”), Toronto Stock Exchange (“TSX”), and TSX Venture Exchange (“TSXV”).

Further information was provided directly by CNSX Markets Inc. (“CNSX”) and was included in all analysis of trading broken out by listed marketplace.

11 During the time period of our study, Liquidnet Canada Inc. was not providing data through the Regulatory Feed; accordingly, Liquidnet Canada trading activity was not included in the Study data. Note that Liquidnet Canada was providing data through another means during the period of the study, and now provides data through the Regulatory Feed.
IIROC was therefore able to rely on a rich cross-market dataset for the purposes of conducting this study.

E. Study Period – August to October, 2011

For the purposes of Phase I and II of this study, the period of August 1 to October 31, 2011 was chosen (the “Study Period”). The Study Period encompasses:

- 3 calendar months;
- 63 trading days;
- all listed securities traded on a Canadian equity marketplace and included in the Regulatory Feed;
- more than 228 million trade messages; and
- more than 9.86 billion new, amend or cancel order messages.

The period between August 1 and October 31, 2011 saw some market turmoil as a result of world events such as the uncertainty concerning the Eurozone debt crisis and its resolution, the aftermath of the Japanese earthquake, and fears of global recession. In response, Canadian equity markets saw both declines and gains. We chose this period to ensure that our study dealt with periods of volatility as one of the criticisms often levied at HFT firms is their withdrawal in times of market stress.
S&P TSX Composite Index

Figure 2 shows the value of the S&P TSX Composite Index ("TSX Composite") over the Study Period.

Two measures of volatility are plotted in Figure 2. For a description of how these measures of volatility were calculated, see Appendix B.

Figure 2 illustrates that the highest peaks in volatility occur around three sharp dips in value: August 8, September 23, and October 4, 2011. Additional smaller peaks in volatility occur on August 18, September 9 and October 26, 2011.
S&P TSXV Composite Index

Figure 3 shows the value of the S&P TSXV Composite Index (“TSXV Composite”) over the Study Period. Figure 3 illustrates that the highest peaks in volatility occur around two pronounced dips in value: August 8, and the period between September 20 and October 4, 2011.

*Figure 3: S&P TSXV Composite Index & Two Measures of Volatility*
III. Phase I – Determination of the Study Group

As was discussed earlier, there is no set definition of HFT. Many of the attributes commonly ascribed to the activity are difficult to measure both objectively and with trading data. Further, different trading strategies may result in different measurable data “footprints”.

F. Focus on Order-to-trade Ratios

The following characteristics are often associated with HFT. They are grouped below according to how they could be measured or determined:

Measurable Using the Regulatory Feed:

- message frequency of orders or trades;
- response times (that is, the time taken to cancel an order – an indication of response time capability); and
- order-to-trade ratio.

Measurable through Reliance on Outside Sources:

- use of co-location services, direct market access ("DMA") and other means of minimizing latency; and
- automation (information regarding which would need to be requested from Participants\(^{12}\) or could possibly be inferred from certain response time measurements).

Both measures that rely on outside sources would introduce an element of subjectivity which could potentially undermine IIROC’s commitment to an unbiased review of trading. Of the three measures that we could apply using the Regulatory Feed, the order-to-trade ratio is most relevant to a number of industry concerns, including rising costs for marketplaces, dealers and regulators to consume and/or store vast quantities of data, concerns that the rapid entry and cancellation of orders creates “evaporating” or “phantom” liquidity, and regulatory concerns regarding the effect of high order rates on market integrity and market quality. It is for these reasons that the decision was made to focus on the order-to-trade ratio and define a group that has a relatively high value for this metric.

\(^{12}\) For the purposes of this report, the capitalized term Participant is used as defined in UMIR: (a) a dealer registered in accordance with securities legislation of any jurisdiction and who is: (i) a member of an Exchange, (ii) a user of a QTRS, or (iii) a subscriber of an ATS; or (b) a person who has been granted trading access to a marketplace and who performs the functions of a derivatives market maker.
We recognize that in focusing on this attribute, our study will contain activity which may not have the other attributes commonly ascribed to HFT. It is for this reason that we analyze the composition of the HOT group on a more granular level in the Study.

G. **Focus on User IDs**

The Regulatory Feed provides a Participant’s trading number and a User ID for every order and each side of every trade. A User ID is a unique identifier available in the IIROC Regulatory Feed and is the most granular means of identifying trading entities available in the Regulatory Feed. One User ID may identify:

- a single approved trader (for example a registered market maker or inventory trader);
- a business stream (for example, orders originated by a Participant’s online discount brokerage system); or
- a client who accesses the markets directly through a DMA relationship with a Participant\(^\text{13}\).

IIROC does not assign the User ID; rather it is assigned by a Marketplace at the request of the Participant. A DMA client may have more than one User ID if they trade through multiple Participants. In some cases, the DMA client may also be assigned different User IDs to trade on different marketplaces. A DMA client may also choose to have more than one User ID for business or administrative purposes. A DMA client that is a foreign dealer, for example, may use multiple User IDs for different trading activity, such as orders from its affiliates, clients, or its own proprietary trading desks.

We recognize that by focusing on both order-to-trade ratio and User IDs our study group may encompass various types of activity and trading strategies. Notwithstanding, we determined that User IDs would be the most objective means of identifying clients or traders that engage in activity which exhibits the attributes commonly ascribed to HFT. As will be seen in the results of Phase II of our study, we were also able to analyze various aspects of the data using other attributes ascribed to HFT such as high number of trades, average trade size, speed of response, and direct market access.

H. **Defining HOT User IDs – Methodology**

Having chosen to focus on order-to-trade ratios and to use User IDs in our approach to the study, our next step was to identify User IDs which exhibited a high order-to-trade ratio, or

\(^{13}\) See TSX Rules and Policies 2-501 through 2-503 which set out requirements for TSX Participants that offer DMA, including a list of categories of clients that are eligible to be DMA clients. Other marketplaces have similar rules and policies.
“HOT User IDs”. Below is a summary of our methodology. To review the methodology in detail, please refer to Appendix B.

The following data points were calculated from the Regulatory Feed for each User ID, for each month of the Study Period:

- Number of Trades – buy and sell sides of the trades were attributed to the buying User ID and the selling User ID.
- Number of New and Amended Order Messages (Cancelled Order Messages were not included in this number\(^\text{14}\)).

For each User ID for each month, the number of trades was plotted against the number of new and amended orders. Figure 4 shows the resulting 8513 data points, which have been plotted on a logarithmic scale.

*Figure 4: Actual Orders vs. Trades*

Next, the log was taken of the number of orders and trades, and the transformed data points were plotted with a line of best fit, based on a linear least squares regression. The line of best

\(^\text{14}\) At the time of the Study Period, Marketplaces treated a request to “Change Former Order” (“CFO”) differently with respect to how the information is sent to IIROC. Some marketplaces sent one “amend order” message while other marketplaces sent a “cancel order” message followed by a “new order” message. The effect (an amended order) was the same, but for the purposes of calculating an order-to-trade ratio using IIROC’s Regulatory Feed, the number of orders was sometimes doubled when both “cancel order” and “new order” messages were included in the measure. By excluding “cancel order” messages, we are able to treat CFO orders on all marketplaces equitably. This issue has been resolved and all marketplaces are now sending information regarding CFO’s in a consistent manner.
fit was used to de-trend the relationship between orders and trades. We then created a
histogram of the de-trended log orders in order to observe the shape of the distribution (Figure
5). The standard deviation of the de-trended log orders is 0.6903.

Figure 5: Frequency of De-trended Log Orders

Based on the shape of the distribution seen in Figure 5 a cut-off point of 1.25 standard
deviations was chosen to divide the observations into an inlier group, categorized as “OTHER”
in the Study (in blue) and an outlier group, categorized as “HOT” (in red). Based on this
methodology, the HOT group has an order-to-trade ratio which is greater than approximately
11.2:1. A total of 947 observations are captured in the HOT group, representing approximately
11% of the User ID population.

Table 1: Characteristics of Study Period HOT Group

<table>
<thead>
<tr>
<th>Standard Deviation</th>
<th>Number of Standard Deviations</th>
<th>% of User ID population</th>
<th>Number of User IDs</th>
<th>Approximate Minimum Order-to-trade Ratio</th>
<th>Minimum Detrended Log Orders</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6903</td>
<td>1.25</td>
<td>11.13%</td>
<td>947</td>
<td>11.20</td>
<td>0.8635</td>
</tr>
</tbody>
</table>
In Figure 6, we have returned to our original figure showing Orders vs. Trades, using colour to represent the HOT group (red), and the OTHER group (blue).

In the subsequent analysis of trading activity (Phase II), the HOT User IDs for each month were used to evaluate that month’s trading activity only. For example, only HOT User IDs which were active and HOT in August were used to evaluate the HOT trading activity in August. This took into account:

- User IDs that were only used in certain months; and
- User IDs that changed strategies (some months exhibiting HOT trading activity and other months exhibiting OTHER trading activity).

### Table 2: Number of HOT User IDs by Month

<table>
<thead>
<tr>
<th>Month</th>
<th>August</th>
<th>September</th>
<th>October</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of HOT User IDs</td>
<td>331</td>
<td>325</td>
<td>291</td>
</tr>
<tr>
<td>Total Number of Trades for all User IDs</td>
<td>83,149,180</td>
<td>74,535,609</td>
<td>69,421,714</td>
</tr>
<tr>
<td>% of Trades by HOT User IDs</td>
<td>42.87%</td>
<td>42.72%</td>
<td>39.53%</td>
</tr>
</tbody>
</table>

Further analysis, including verification of User IDs with Participants, gave confidence that we had identified User IDs displaying consistent behavior, and that there were no significant
changes in the distribution of order-to-trade ratios over the 3 months of the Study Period which would require us to use different criteria to identify the HOT group month by month.
IV. Phase II – Statistical Analysis of HOT Activity

Our goal in Phase II was to quantify trading by HOT User IDs on Canadian equity marketplaces, producing findings that will be of interest to regulators, industry professionals and investors. The data derived in Phase II will also inform Phase III of the HFT Study.

Our analysis was designed to provide measurements which would answer the following questions:

- Who are the HOT User IDs?
- What are they trading?
- When do they trade or place orders?
- Where do they trade or place orders?
- How do they trade or place orders?

**NOTE:** The following sections of the report provide a summary and examples of our findings. To review the full results, please refer to Appendix B. Unless otherwise indicated:

- the results refer to trading activity (including orders and trades) in all TSX- and TSXV-listed securities on all Canadian equity marketplaces in the Regulatory Feed during the Study Period;
- the results compare activity by the HOT User IDs (“the HOT group”) with the rest of the User IDs (“the OTHER group”); and
- each trade is considered twice – once for the buyer and once for the seller – resulting in two times the exchange-reported volume, value and number of trades.

I. *Who are the HOT User IDs?*

**Overview**

The HOT User IDs represent:

- 11% of the User IDs active in the Study Period;
- 22% of share volume traded;
- 32% of dollar value traded;
- 42% of trades executed; and
- 94% of new and amended orders.

*Table 3: Additional Comparisons between HOT and OTHER*

<table>
<thead>
<tr>
<th>Trading Activity</th>
<th>Average Price per Share</th>
<th>Average Value per Trade</th>
<th>Average Volume per Trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOT</td>
<td>$14.88</td>
<td>$4,145</td>
<td>278</td>
</tr>
<tr>
<td>OTHER</td>
<td>$8.92</td>
<td>$6,280</td>
<td>704</td>
</tr>
</tbody>
</table>
The HOT group trades in higher-priced securities, in smaller volumes per trade and slightly smaller values per trade than the OTHER group.

**Composition of the HOT Group**
The following facts and figures explore how the HOT User IDs access the Canadian marketplaces. The terms used in the figures below are defined as follows:

- **DMA** - Participants provide to IIROC (either directly, or through TMX Group Inc.) a list of clients with whom they have a DMA relationship and the User ID(s) used by the client to access Canadian equity marketplaces. These lists are updated periodically by the Participant. For the purposes of this study, we used the August 2011 DMA client lists.
- **NDMA-IN** – Non-DMA trades indicated as “inventory” based on the account type provided on the Regulatory Feed. Generally, “inventory” activity refers to a Participant’s proprietary trading activity.
- **NDMA-CL** – Non-DMA trades indicated as “client” based on the account type provided on the Regulatory Feed.
- **NDMA-Other** – Non-DMA trades indicated as “specialist”, “non-client” or “options market maker” based on the account type provided on the Regulatory Feed.

Please note that the DMA attribute applies to the User ID, so all trades by a particular User ID will be included in the DMA category. However, the attribute of account type is particular to the order or trade and can be modified on an order-by-order basis. The following analysis reflects the account type used for each trade.

While only 40% of the HOT User IDs were identified as DMA, they were responsible for 75% of the volume traded, 75% of the value traded, and 82% of the number of trades executed by all of the HOT User IDs.
Figure 7 shows that HOT User IDs with DMA have an average order-to-trade ratio of 46, which is below the average order-to-trade ratio for all HOT User IDs of 56 (marked on the chart with a purple line). The order-to-trade ratio is 54 for NDMA-CL, 151 for NDMA-IN and 147 for NDMA-Other.

Figure 8 compares the order-to-trade ratio for common shares (“Common”) and exchange traded funds and notes (“ETF/Ns”) by DMA and Non-DMA account type.

Figure 8: Order-to-trade Ratio of HOT User IDs by DMA and Non-DMA Account Type in Selected Security Types
Figure 8 shows that the average order-to-trade ratio is higher in ETF trading for all groups, but particularly for the NDMA groups.

Whether measured by volume traded, valued traded or number of trades executed NDMA-CL and DMA were more active in common shares and NDMA-IN and NDMA-Other were more active in ETF/Ns. A full description of these findings can be found in Appendix B.

Who are HOT User IDs Trading With?
The following facts and figures explore how different participants are interacting in the market.
The data has been analyzed on a single-counted basis. All other analysis in this report (unless noted) was conducted on a double-counted basis. The following information is provided to clarify the difference between the two methods of counting.

Use of Single Counting vs. Double Counting
As discussed above, HOT User IDs are responsible for 22% of all share volume, 32% of all dollar value and 42% of all trades. These figures were calculated using a double-counting method, in which the volume, value & number of trades for each HOT User ID was noted for both the buyer and seller of each trade. These figures were then divided by a double count of the total volume, value & number of trades. An example follows:

Figure 9: Example of Double Counting Volume

\[
\frac{28 \text{ HOT buy volume} + 16 \text{ HOT sell volume}}{100 \text{ buy volume} + 100 \text{ sell volume}} = 22\% \text{ (Double counted)}
\]

In contrast, as we will demonstrate below, on a single-counted basis, HOT User IDs are involved in 37% of the volume of all trades, as the buyer, the seller, or both. Using this method, the volume, value & number of trades for HOT User IDs were noted on either one side, the other side, or both sides of a trade. These figures were then divided by a single count of the volume, value or number of trades. An example based on figure 11 below follows:

Figure 10: Example of Single Counting Volume

\[
\frac{22 \text{ HOT to Other (ex R) volume} + 8 \text{ HOT to Retail volume} + 7 \text{ HOT to HOT volume}}{15 \text{ Other (ex R) volume} + 8 \text{ Retail volume} + 7 \text{ HOT volume}} = 37\% \text{ (Single counted)}
\]

\(^{15}\) All other trading excluding Retail and HOT.

\(^{16}\) Six of the most active Participants whose business model is known to encompass a large retail component were asked to provide the User IDs which were used exclusively (more than 95%) to direct order execution or full service retail order flow to the marketplace during the period of the study. As such, the Retail category describes a specific subset of all possible retail order flow. The remainder of the retail order flow during the study period is captured in the Other (ex R) category.
We can reconcile the two methods as follows:

**Figure 11: Example of Single Counting Volume (Reconciling to Double Count)**

\[
\text{Percentage Volume} = \frac{28 \text{ HOT buy volume} + 16 \text{ HOT sell volume} - 7 \text{ HOT buy to HOT sell volume}}{100 \text{ trade volume}} = 37\% \text{ (Single counted)}
\]

**Trading by Market Participant and Counterparty**

Analysis was conducted to explore the trading activity by HOT User IDs, broken out by the types of market participants with whom they traded. The following chart compares the trading activity of the HOT User IDs to the trading activity of a subset of retail customers trading through certain retail User IDs (“Retail”) and the remaining User IDs (“Other (ex R)”). For the purposes of this summary we focus on share volume traded; other measures can be found at Appendix B.

**Figure 12: Percentage of Volume by Type of Market Participant and Counterparty**

When we consider what type of market participant is on each side of the trade, and count each trade only once, Figure 12 shows that HOT User IDs are involved in 37% of the volume of all
trades. In 7% of all single-counted volume, HOT User IDs are trading with other HOT User IDs. In 8% of all single-counted volume, HOT User IDs are trading with a subset of retail flow.

Figure 13: Percentage of Volume by Retail Participant and Counterparty

![Pie chart showing percentage of volume by retail participant and counterparty]

Figure 13 shows that HOT User IDs are the counterparty to 27% of all retail flow by share volume traded (single counted).

J. How do HOT User IDs trade?

Response Time of HOT User IDs
The following section explores the response times of which HOT User IDs are capable, using resting time as a proxy.

Definition of Resting Time
High speeds and fast response times are often associated with HFT. Ideally, we would like to be able to measure the response time of decision-making – the time taken for an entity (human or computer) to observe a change in the trading environment and take action. However, given the complexity of linking trigger and reaction events using our data, we chose instead to measure resting time, defined as the time elapsed between placing an order and cancelling it, to provide a proxy for measuring the response time capabilities of a User ID. Details of the methodology are included in Appendix B.
**Response Time Category**

Using the methodology, three speed categories – Slow, Fast and Inconclusive\(^\text{17}\) – were established. In summary, 32% of User IDs in the HOT group were classified as Fast, 12% were classified as Slow, and the remaining 56% as inconclusive.

The 32% of HOT User IDs which were categorized as Fast were responsible for the largest portion of HOT trading, whether measured by volume (84%), value (87%) or number of trades (90%).

The figures related to volume are illustrated below; other measures can be found at Appendix B.

*Figure 14: Average Daily Volume Traded by Market Participant and Response Time Category*

Figure 14 shows that 84% of all HOT trading by volume is by Fast User IDs. In contrast, smaller absolute and relative volumes of trading are by Other (ex R) and Retail User IDs categorized as Fast.

The 18% of HOT User IDs which were categorized as Fast and carried the DMA attribute were responsible for a large portion of HOT trading, whether measured by volume (68%), value (71%) or number of trades (78%).

---

\(^{17}\) Slow – User IDs for which all observed resting times ≥ 00:00:00.864; Fast – User IDs for which 5% or more of all observed resting times were ≤ 00:00:00.010 and there were more than 20 observations in the month; Inconclusive – User IDs for which at least one observed resting time was faster than human (< 00:00:00.864) but which did not meet the criteria of a Fast User ID. This included many of the User IDs which had less than 20 (including zero) cancel observations in the month. For additional details see Appendix B.
Figure 15 shows 91% of the volume of trading by DMA HOT User IDs is by those categorized as Fast. In contrast, 63% of the volume of trading by NDMA HOT User IDs is by those categorized as Fast.

**Anonymous vs. Attributed**

At the point of entering an order onto a marketplace, a trader can make the order:

- **Attributed** – the order and any subsequent trade will include the participant’s trading number in the public trade record; or
- **Anonymous** – the order and any subsequent trade will not include the participant’s trading number in the public trade record; instead, the generic “001” Participant number will be displayed.

It should be noted, however, that the Regulatory Feed contains full Participant attribution with a flag to indicate that the orders and trades were marked anonymous.

Table 4 compares the anonymous trading activity of the HOT User IDs to Retail and OTHER. A full description of these observations can be found in Appendix B.
Table 4: HOT vs. OTHER vs. Retail - Average Daily Anonymous Volume, Value and Trades

<table>
<thead>
<tr>
<th></th>
<th>% of Average Daily Volume Traded Anonymously</th>
<th>% of Average Daily Value Traded Anonymously</th>
<th>% of Average Daily Trades Traded Anonymously</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOT</td>
<td>35</td>
<td>39</td>
<td>46</td>
</tr>
<tr>
<td>OTHER</td>
<td>23</td>
<td>21</td>
<td>32</td>
</tr>
<tr>
<td>Retail</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

In summary, HOT User IDs use the Anonymous marker more often than other market participants, whether measured by volume, value or number of trades.

**Dark vs. Lit**

Dark encompasses activity, both orders and trades, on fully dark Canadian equity marketplaces and activity using fully hidden dark order types on displayed (or “lit”) Canadian equity marketplaces. For the Study Period, dark trading represented 5% of total share volume.

HOT User IDs were responsible for a larger percentage of dark activity than lit, when measured by volume (39% vs. 21% and illustrated below) and value (36% vs. 32%). HOT User IDs were responsible for an approximately equal percentage of the number of trades in the dark and the lit (42% vs. 42%). A discussion of the other measures can be found in **Appendix B**.

**Figure 16: Average Daily Volume Traded Dark vs. Lit**

![Average Daily Volume Traded Dark vs. Lit](image-url)
Active vs. Passive
When measured by volume (illustrated below), value or number of trades, about two thirds of all trading by HOT User IDs is passive.

The trades marked NA were passive on both sides, a situation which occurs, for example, with intentional crosses and odd lot crosses. Trades executing on TCM are also marked passive on both sides. It would not be appropriate to add these trades to either the passive or the active categories as they are neither.

Figure 17: Average Daily Volume of Trading by Active/Passive

HOT User IDs are on the passive side of a trade 66% of the time when measured by volume. In contrast, all other market participants are on the passive side of a trade 37% of the time when measured by volume.

Fees and Rebates
For the purposes of calculating fees and rebates, we were able to use 73% of trading (by volume) which included trading in common shares, Exchange-traded Funds or Notes ("ETF/Ns"), preferred shares and units, but excluded intentional crosses, dark markets and order types, opening trades and MOC trades.
HOT User IDs earned more rebates than they paid fees, for a net gain of approximately $250 thousand per day over the Study Period for the securities included in the trading fee sample. Conversely, OTHER User IDs earned more rebates that the HOT User ID group, but paid more fees, for a net cost of approximately -$462 thousand per day over the Study Period for the securities included in the trading fee sample. By extension, it can be estimated that the marketplaces earned the difference of approximately $211 thousand per day.

K. **Who are HOT User IDs Trading Through?**

Our review revealed that the majority of trading activity by the HOT group is executed through seven Participants, which were responsible for 90% of the volume, 91% of the value and 95% of the trades by the HOT User IDs.

**Same-Broker Trading by Participant**

Same-broker trading encompasses both intentional and unintentional crosses.

Overall, HOT User IDs trade within the same broker 23% by volume, 19% by value and 18% by number of trades. This is less than Other (ex R) by volume (37%) and value (29%) and more than Other (ex R) by number of trades (9%). This is more than Retail User IDs by volume (20%), value (16%) and number of trades (12%).

The figure related to volume is illustrated below; other measures can be found at Appendix B.
L. What are HOT User IDs Trading?

Security Types
The following facts and figures explore the types of securities traded by HOT User IDs broken out by common shares (“Common”), ETF/N and Other\(^{18}\).

Table 5: Summary Table of HOT Trading by Security Type

<table>
<thead>
<tr>
<th>Security Type</th>
<th>% of HOT Volume Traded</th>
<th>% of HOT Value Traded</th>
<th>% of HOT Trades Executed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common</td>
<td>68</td>
<td>78</td>
<td>91</td>
</tr>
<tr>
<td>ETF/N</td>
<td>28</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total HOT</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

\(^{18}\) Other includes: Debentures, Units, Preferreds, Warrants, NEX Listed, Notes, Exchangeables, Rights, and Pools. NEX is a separate board of TSX Venture Exchange which provides a trading forum for listed companies that have fallen below TSX Venture's ongoing listing standards – these symbols are differentiated by a “.H” suffix (“NEX listed”). Also, TSXV offers a Capital Pool Company program, in which a shell company can be listed on TSXV prior to acquiring an operating company that meets TSXV listing requirements. Until this acquisition is carried out, the company is listed as a Capital Pool Company (“Pool”).
In Figure 20 and other similar charts throughout the report, the study averages are indicated using a coloured line for comparison purposes: the blue line at 22% represents the average share volume traded by the HOT group, the pink line at 32% represents the average dollar value traded by the HOT group and the green line at 42% represents the average number of trades by the HOT group.

Figure 20 shows that HOT User IDs traded more than their study average in ETF/Ns and Exchangeables, but less than their study average in Common shares and all other security types. Also of interest, HOT User IDs were responsible for close to 60% of all the trading in ETF/Ns by all measures.

Securities which Exhibit a High Order-to-trade Ratio ("HOT Securities")
An analysis of the order-to-trade ratios of securities showed a clustering of the order-to-trade ratio at 10:1 (unlike User IDs, which clustered around an order-to-trade ratio of 1:1).
Figure 21 shows orders versus trades for Common Shares (dark blue dots), US Inter-listed Common Shares (pale green dots) and ETF/Ns (pink dots). Of note:

- Common Shares cluster around the line representing an order-to-trade ratio of 10:1, with some outliers at higher order-to-trade ratios (with more outliers among securities which trade less often)
- The most liquid US Inter-listed Common Shares have an order-to-trade ratio between 10:1 and 100:1 (with more outliers among securities which trade less often)
- The less liquid ETF/Ns have high to very high order-to-trade ratios with many above 1000:1 – in contrast, the more liquid ETF/Ns have order-to-trade ratios around 100:1 or less

**Common Shares**

HOT User IDs traded more in the S2 and S3 categories of common shares exhibiting a percentage of volume, value and number of trades very close to the study period averages. Although HOT User IDs did not trade as much in the S4 category relative to their study average, they were responsible for 97% of the order entry activity, and thus contributed to the classification of the security as a HOT security.
ETF/Ns

HOT User IDs represent a significant portion of the trading in S2, S3 and S4 in ETF/Ns. This matches the observations made earlier in the report that HOT User IDs are responsible for a disproportionate amount of the trading in ETF/Ns (approximately 60%). The portion of trading in ETF/Ns executed by HOT User IDS is much higher than their study average in the S2, S3 and S4 categories (between 10:1 to over 1000:1), and lower in S1.
The following section explores trading activity by HOT User IDs in securities with different levels of liquidity. Five liquidity categories were defined where L1 represents the least liquid securities and L5 represents the most liquid securities. Further information regarding the methodology for defining the liquidity categories is found in Appendix B.

TSX-Listed Securities

Our results show that 77% of the volume, 88% of the value and 84% of the trades executed by HOT User IDs is in the most liquid TSX-listed securities. These figures can be seen in Appendix B.
Figure 24 shows that HOT User IDs trading in TSX-listed securities trade less than their study average in L1, L2, L3 and L4, and higher than their study average in L5. In TSX-listed securities, HOT User IDs trade proportionally more in liquid securities, with the smallest portion of trading in the lowest liquidity category.

In summary, HOT User IDs are trading more in highly liquid TSX-listed securities in both absolute and relative terms.

TSXV-Listed Securities

Our results show that 4% of the volume, 9% of the value and 16% of the trades executed by HOT User IDs is in the most liquid TSXV-listed securities; 88% of the volume, 89% of the value and 82% of the trades executed by HOT User IDs was in the L3 and L4 categories. The figures that illustrate these facts can be seen in Appendix B.
Figure 25 shows that HOT User IDs trade more in higher liquid TSXV-listed securities. In no category do the HOT User IDs trade as much as their study average.

In summary, in TSXV-listed securities, although HOT User IDs are trading more in mid- to high-liquidity securities in absolute terms, they are trading proportionally more in the highly liquid securities.

**Price Categories**

The following section explores the trading activity by HOT User IDs in securities defined by price category.

The price of each order and trade as it was provided to IIROC in the Regulatory Feed was categorized according to Table 6. This methodology was employed in preference to categorizing the orders and trades based on an average reference price for each security. It should be noted that some securities will have traded at the boundary of a price division over the Study Period. In these cases, the orders and trades for a security will sometimes be in one category and sometimes in another.
### Table 6: Price Categories

<table>
<thead>
<tr>
<th>Price Category</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$10.00 and over</td>
<td></td>
</tr>
<tr>
<td>$5.00 to under $10.00</td>
<td></td>
</tr>
<tr>
<td>$1.00 to under $5.00</td>
<td></td>
</tr>
<tr>
<td>$0.10 to under $1.00</td>
<td></td>
</tr>
<tr>
<td>Under $0.10</td>
<td></td>
</tr>
</tbody>
</table>

### TSX-Listed Securities

Figures illustrating the following facts can be seen in Appendix B.

- Of the total volume of trading by HOT User IDs, 55% is in securities priced $10.00 and over, 18% in securities $5.00 – under $10.00, and the remaining 27% in securities under $5.00;
- Of the total value of trading by HOT User IDs, 87% is in securities priced at $10.00 and over, and the remaining 13% in securities under $10.00; and
- Of the total trades executed by HOT User IDs, 72% were in securities priced at $10.00 and over, and the remaining 28% in securities under $10.00.

### Figure 26: Percentage of Trading by HOT User IDs by Price Category: TSX-Listed
Figure 26 shows that HOT User IDs trading in TSX-listed securities trade below their study average at prices below $1.00, and at their study average at prices above $1.00. It appears that HOT User IDs trade proportionally more the higher the price; however, the proportions of trading in the $5.00 to under $10.00 and the $10.00 and over categories are almost the same, suggesting that above a certain price, HOT User IDs do not trade an increasing portion.

In summary, the majority of HOT User IDs’ trading is in TSX-listed securities priced above $1.00 in both absolute and relative terms.

TSXV-Listed Securities

Figures illustrating the following facts can be seen in Appendix B.

- Of the total volume traded by HOT User IDs, 54% is in securities priced $0.10 to under $1.00 and 31% is in securities priced $1.00 to under $5.00.
- Of the total value traded by HOT User IDs, 26% is in securities priced $0.10 to under $1.00 and 64% is in securities priced $1.00 to under $5.00.
- Of the total trades executed by HOT User IDs, 24% is in securities priced $0.10 to under $1.00 and 70% is in securities priced $1.00 to under $5.00.

HOT User IDs traded predominantly in two price categories of TSXV-listed securities, $0.10 to under $1.00 and $1.00 to under $5.00. These two categories account for 85% of the volume, 90% of the value and 94% of the number of trades made by HOT User IDs in TSXV-listed securities. More volume is traded by HOT User IDs in the $0.10 to under $1.00 category, and more value and trades are executed by HOT User IDs in the $1.00 to under $5.00 category.

*Figure 27: Percentage of Trading by HOT User IDs by Price Category – TSXV-Listed*
Figure 27 shows that HOT User IDs trading in TSXV-listed securities trade proportionally most in the price category $1.00 to under $5.00, with HOT User IDs trading proportionally less in the lesser and greater price categories. In no category do the HOT User IDs trade as much as their study average.

In summary, the majority of HOT User IDs’ trading is in TSXV-listed securities priced above $1.00 and less than $5.00 in both absolute and relative terms.

**Inter-listed Securities**

The following section explores the trading in US Inter-listed\(^{19}\) securities by HOT User IDs.

A list of securities inter-listed between TSX and a US exchange\(^{20}\) was obtained from TMX Group Inc. and used to identify trades in inter-listed securities. It should be noted that the trading behavior described below is specific to the Canadian market, as we did not have access to information from US exchanges. Overall, HOT User IDs trade a higher percentage in US inter-listed securities than in non-inter-listed securities, whether measured by volume (illustrated below), value, or number of trades.

**Figure 28: Average Daily Volume of Trading by HOT User IDs in US Inter-listed Securities**

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\(^{19}\) A US inter-listed security is described in UMIR as a security that is listed on a Canadian exchange and is also listed on an exchange in the United States.

\(^{20}\) TMX Datalinx provided three lists of TSX-US inter-listed securities dated August 15, September 9 and October 19. These lists are created when there are changes to the list, rather than at regular monthly intervals.
Figure 28 shows that HOT User IDs are responsible for 36% of all trading in US inter-listed securities by volume. This is higher than their percentage of trading in non-inter-listed securities, and higher than their study average of 22%.

Further (not illustrated) the total trading by all Participants in US inter-listed securities relative to trading in non-inter-listed securities is 23% by volume, 59% by value and 55% by number of trades.

**S&P TSX 60 Index**

A list of securities which were components of the S&P TSX 60 Index\(^2\) (“S&P TSX 60”) during the Study Period was obtained from the TMX Group Inc. The following section explores trading by HOT User IDs in the S&P TSX 60 securities as a portion of all TSX-listed securities (TSXV-listed securities were excluded) on the Canadian markets over the Study Period.

HOT User IDs traded a higher percentage in TSX 60 Index securities than in TSX-listed securities that are not constituents of the Index, whether measured by volume (illustrated below), value or number of trades.

*Figure 29: Average Daily Volume by HOT User IDs in S&P TSX 60 Securities*

By volume, HOT User IDs trade more in S&P TSX 60 securities than their study average (33% vs. 22%) and more than in TSX-listed securities that are not constituents of the Index (33% vs. 26%).

\(^2\) TMX Datalinx provided information regarding the constituents of the S&P TSX 60 Index for the Study Period.
Further (not illustrated) the total trading by all Participants in securities in the S&P TSX 60 relative to trading in TSX-listed securities that are not constituents of the Index is 27% by volume, 59% by value and 49% by number of trades.

*S&P TSXV 30 Index*

A list of securities which were components of the S&P TSXV 30 Index\(^{22}\) (“S&P TSXV 30”) during the Study Period was obtained from TMX Group Inc. The following section explores trading activity by HOT User IDs in the S&P TSXV 30 securities as a portion of all TSXV-listed securities (TSX-listed securities were excluded) on the Canadian markets over the Study Period.

HOT User IDs traded a higher percentage in TSXV 30 Index securities than in TSXV-listed securities that are not constituents of the Index, whether measured by volume (illustrated below), value or number of trades.

*Figure 30: Average Daily Volume by HOT User IDs in S&P TSXV 30 Securities*

![Average Daily Volume Chart](image)

By volume, HOT User IDs trade less in S&P TSXV 30 securities than their study average (14% vs. 22%) and more than in TSXV-listed securities that are not constituents of the Index (14% vs. 4%).

Further (not illustrated) the total trading by all participants in securities in the S&P TSXV 30 is 10% by volume, 33% by value and 33% by number of trades.

---

\(^{22}\) TMX Datalinx provided information regarding the constituents of the S&P TSXV 30 Index for the Study Period.
M. Where are HOT User IDs Trading?

The following section discusses trading activity by HOT User IDs by the listing and traded marketplace of a security.

By Listed Marketplace

Table 7: Trading by HOT User IDs by Listed Marketplace

<table>
<thead>
<tr>
<th>Listed Market</th>
<th>TSX</th>
<th>TSXV</th>
<th>CNSX²³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>94.395%</td>
<td>5.591%</td>
<td>0.014%</td>
</tr>
<tr>
<td>Value</td>
<td>99.653%</td>
<td>0.346%</td>
<td>0.001%</td>
</tr>
<tr>
<td>Number of Trades</td>
<td>98.257%</td>
<td>1.742%</td>
<td>0.001%</td>
</tr>
</tbody>
</table>

By volume, value and number of trades, HOT User IDs are trading predominantly TSX-listed securities.

Figure 31: Percentage of Trading by HOT User IDs by Listed Market

Figure 31 shows that HOT User IDs traded at least the study average in securities listed on the TSX, and less than the study average on TSXV- and CNSX-listed securities. As a proportion of

²³ Please note that for the Study Period, the information for CNSX was provided to IIROC separately from the Regulatory Feed and analyzed independently to be included in these figures. CNSX now provides trading data to IIROC through the Regulatory Feed.²⁴ The trading venues include eight ATS' and three Exchanges, including CNSX.
trading in each market’s listed securities, HOT User IDs traded most in TSX-listed securities, less in TSXV-listed securities and least in CNSX-listed securities.

**By Traded Marketplace**

By volume (illustrated below), value or number of trades, the majority of trading by HOT User IDs is conducted on three trading venues\(^{24}\).

*Figure 32: Volume of HOT Trading by Traded Marketplace*

---

\(^{24}\) The trading venues include eight ATS’ and three Exchanges, including CNSX.
Figure 33 shows that HOT User IDs traded more than their study average on five trading venues, slightly less than the study average on two trading venues, and well below the study average on the remaining four trading venues.

In summary, two trading venues showed both absolutely and proportionally more trading by HOT User IDs.

N. When are HOT User IDs Trading?

The following facts and figures explore the trading activity by HOT User IDs by month, day and intra-day periods.

By Month

Table 8: Percentage of Volume, Value & Trades by HOT User IDs by Month

<table>
<thead>
<tr>
<th>Month</th>
<th>% of Share Volume</th>
<th>% of Dollar Value</th>
<th>% of Number of Trades</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>24%</td>
<td>34%</td>
<td>43%</td>
</tr>
<tr>
<td>September</td>
<td>22%</td>
<td>32%</td>
<td>43%</td>
</tr>
<tr>
<td>October</td>
<td>20%</td>
<td>29%</td>
<td>39%</td>
</tr>
</tbody>
</table>

It should be noted that total (HOT and OTHER) share volume, total dollar value, and total trades decreased over the three months of the study period.
By Day
Both overall and HOT User ID activity (as an absolute and as a percentage) decreased over the study period, when measured by volume (illustrated below), value or number of trades. The percentage of trading by HOT User IDs is fairly consistent, with some variation and overall trending, but still bounded within a 10% to 15% range. A discussion of the other measures can be found in Appendix B.

Figure 34: Volume by Day

Figure 34 shows the fluctuations in the daily trading volume. The percentage of daily volume by HOT User IDs also fluctuates, ranging from 16.76% to 28.08%, and exhibits the general downward trend observed in the monthly charts. The standard deviation of the percentage volume traded by HOT User IDs is 2.52%.

Intra-Day – Common Trading Session
For the purposes of intra-day analysis, the trading day was divided into three sections:

- the Common Trading Session (“CTS”), defined as the period during which all marketplaces are open (between 9:30 am and 4:00 pm). The market-on-close session on the TSX (“TSX MOC”) is included (although it is technically after 4:00 pm) as it trades significant volumes and is of interest to many participants.
- pre-CTS (prior to 9:30 am)
- post-CTS (following 4:00 pm) excluding the TSX MOC session
Greater than 97% of all trading, whether measured by share volume, dollar value or trades, for both the HOT and OTHER groups, took place in the Common Trading Session. A full description of these observations can be found in Appendix B.

**By Half Hour Increments**

When measured by volume (illustrated below), value or number of trades within the Common Trading Session, a saddle-shaped pattern of trading activity is seen, with more activity at the beginning and end of the day, with a relative lull in activity mid-day. The percentage of trading by all measures by HOT User IDs is fairly constant throughout the Common Trading Session, with slight peaks seen, including one in the last half hour of trading. HOT User IDs do not form a large percentage of the TSX MOC trading session on TSX. A discussion of the other measures can be found in Appendix B.

*Figure 35: Average Daily Volume by Half Hour Increment in Common Trading Session*

Figure 35 reveals the characteristics described above. The percentage average volume traded by HOT User IDs peaks between 10:00 and 10:30, and between 3:30 and 4:00; there is relatively little participation in the TSX MOC session.

**Open and Close of the Common Trading Session**

When the first and last half hour of trading is reviewed in 5-minute increments, breaking out the Opening Trades and TSX MOC into their own categories, we note:

- HOT User IDs do not form a large percentage of the opening trades, when measured by volume, value or trades.
- HOT User IDs do not form a large percentage of the TSX MOC session, when measured by volume, value or trades.
The volume, value and trades by all market participants in the last 5 minutes of the common trading session is markedly higher than in the preceding 5-minute time periods of the closing half hour.

The percentage of volume and value traded by HOT User IDs in the last 5 minutes of the Common Trading Session is slightly higher than in the preceding 5 minute time periods of the closing half hour.

Share volume is illustrated below and a discussion of the other measures can be found in Appendix B.

Figure 36: Average Daily Volume by 5-Minute Increment at Open and Close of CTS

Percentage Active and Passive

The following section explores the percentage of passive and active trading by HOT UserIDs in time increments over the common trading session. Because HOT User IDs on average trade a smaller portion in the opening and in the MOC session, this trading activity has not been included. Trading was divided into the following time categories:

- One minute increments between 9:30 and 9:35 (opening trades excluded)
- Five minute increments between 9:35 and 10:00
- Half hour increments between 10:00 and 3:30
- Five minute increments between 3:30 and 3:55
- One minute increments between 3:55 and 4:00

For the purposes of this summary we focus on share volume traded; other measures can be found at Appendix B.
Figure 37 shows that by volume, HOT User IDs trade more actively at the beginning and end of the common trading session. Specifically, HOT User IDs are most active and least passive in the first half hour and last minute of trading.

**Order-to-trade Ratio**

The number of new and amended orders forms a saddle shape similar to that identified for the volume, value and trades by half hour. The order-to-trade ratio has the opposite shape, with a lower order-to-trade ratio early in the day and late in the day, cresting in the middle of the day. Analysis was conducted, and it would appear that there is a weak inverse relationship between the total trades in a half hour increment and the HOT order-to-trade ratio. A full description of these observations can be found in Appendix B.
VI. Phase III – Next Steps: Impact of High Frequency Trading

IIROC has published a Request for Assistance concurrently with this Report. The Request seeks assistance from interested parties that have equity market structure expertise to use specific measures and metrics to address a number of questions regarding the impact of certain behaviours on market integrity and market quality. For details of the Request please see IIROC Notice 12-0374.
V. Appendix A – Literature Review Concerning HFT

As part of the HFT Study, IIROC undertook a review of literature, including studies, articles, and academic publications concerning HFT, algorithmic trading and other issues related to our study. The chart below contains a list of the literature reviewed which is most relevant to our study, and includes a high-level summary of the findings of each publication. We would encourage readers who are interested to read the full text of the literature:

Table 1 – Summary of Academic Papers Reviewed

<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Date</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>A dysfunctional role of high frequency trading in electronic markets</td>
<td>Jarrow, Protter</td>
<td>2011</td>
<td>A theoretical model shows that HFT earn profits by exploiting the trading patterns of ordinary traders. It also finds that HFT creates mispricing in the market.</td>
</tr>
<tr>
<td>Algorithmic Trading and Changes in Firms’ Equity Capital</td>
<td>Boehmer, Fong, Wu</td>
<td>2012</td>
<td>Increased liquidity from algorithmic trading led to less equity issuance and more share repurchases.</td>
</tr>
<tr>
<td>Are Market Makers Uniformed and Passive? Signing Trades in the Absence of Quotes</td>
<td>Menkveld, Van Der Wel, Sarkar</td>
<td>2009</td>
<td>Floor traders of US 30-year Treasury futures were not uninformed liquidity suppliers. Market makers initiated trades and took positions in order to make profits and thus were informed traders using customer order flow data to earn profits.</td>
</tr>
<tr>
<td>Do High-Frequency Traders Anticipate Buying and Selling pressure?</td>
<td>Hirschey</td>
<td>2011</td>
<td>HFT buying and selling predicted future buying and selling by non-HFTs on both a volume and return basis. Some HFTs were better at this than others. The results imply that non-HFTs experienced higher trading costs due to HFT behavior.</td>
</tr>
<tr>
<td>Does algorithmic trading improve liquidity?</td>
<td>Hendershott, Jones, Menkveld</td>
<td>2011</td>
<td>Algorithmic trading (defined as automated trading and measured by message traffic) increased liquidity by reducing spreads and reducing adverse selection.</td>
</tr>
<tr>
<td>Equilibrium High Frequency Trading</td>
<td>Biais, Foucault, Moinas</td>
<td>2011</td>
<td>Using equations and theory, the authors find that HFT increases adverse selection and provides inequitable advantages for large institutions over small ones.</td>
</tr>
<tr>
<td>Financial black swans</td>
<td>Carran</td>
<td>2012</td>
<td>Analysis of fast, extreme events suggest</td>
</tr>
<tr>
<td>Title</td>
<td>Authors</td>
<td>Date</td>
<td>Summary of Findings</td>
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</tr>
<tr>
<td>driven by ultrafast machine ecology</td>
<td>Hunsander, Johnson, Meng, Ravindar, Tivnan, Zhao</td>
<td></td>
<td>that markets are moving towards a machine-only model which reacts more quickly than humans.</td>
</tr>
<tr>
<td>Findings Regarding the Market Events of May 6, 2010</td>
<td>CFTC, SEC</td>
<td>2010</td>
<td>The flash crash was caused by a large futures sell order sent on a backdrop of high volatility and low liquidity on a day where macroeconomic concerns were high. The large sell order led to an extreme market drop and recovery due to the automated and interconnected nature of today’s markets.</td>
</tr>
<tr>
<td>HFT and the Hidden Cost of Deep Liquidity</td>
<td>Pragma Securities</td>
<td>2012</td>
<td>Data visualization techniques showed that HFT prefer low price, low volatility stocks and in these names HFT increases trading costs to investors.</td>
</tr>
<tr>
<td>High frequency trading and price discovery</td>
<td>Brogaard, Henddershott, Riordan</td>
<td>2012</td>
<td>HFT both took and provided liquidity. When they took liquidity they were acting on some type of informational advantage due to short-term price prediction and they earned profits. When they supplied liquidity they experienced adverse selection in short term price movements but were profitable when rebates were taken into account. HFT supplied liquidity on volatile as well as regular days.</td>
</tr>
<tr>
<td>High Frequency Trading and the New-Market Makers</td>
<td>Menkveld</td>
<td>2011</td>
<td>HFT quotes experienced adverse selection. HFTs skewed their quotes to get out of their positions. HFTs generated significant transitory price pressure (more than half the average bid-ask spread). Exchange fees (rebates) were a material factor in HFT profitability.</td>
</tr>
<tr>
<td>High-frequency trading in the foreign exchange market</td>
<td>Bank For International Settlements</td>
<td>2011</td>
<td>This article gives an overview of HFT in the FX market based on conversations with market participants.</td>
</tr>
<tr>
<td>High-Frequency</td>
<td>Zhang</td>
<td>2010</td>
<td>HFT increased volatility and inhibited</td>
</tr>
<tr>
<td>Title</td>
<td>Authors</td>
<td>Date</td>
<td>Summary of Findings</td>
</tr>
<tr>
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</tr>
<tr>
<td>Trading, Stock Volatility, and Price Discovery</td>
<td></td>
<td></td>
<td>price discovery.</td>
</tr>
<tr>
<td>International Evidence on Algorithmic Trading</td>
<td>Boehmer, Fong,</td>
<td>2012</td>
<td>Algorithmic trading (defined in terms of message traffic) improved informational efficiency overall and improved liquidity for large firms but reduced it for small firms. Algorithmic trading increased volatility for all categories of stocks.</td>
</tr>
<tr>
<td>Liquidity: What you see is what you get?</td>
<td>Van Kervel</td>
<td>2012</td>
<td>Consolidated liquidity was overstated due to duplicate limit orders on various venues that were cancelled once one order was executed. Traders who did not use a Smart Order Router had higher trading costs.</td>
</tr>
<tr>
<td>Local Trader Profitability in futures Markets: Liquidity and Position Taking Profits</td>
<td>Frino, Jarnecic, Feletto</td>
<td>2010</td>
<td>Local traders on the Sydney Futures Exchange in 1997 (when futures trading was floor-based) made money on inventory positions as well as by passive market making. Local traders were aggressive in taking liquidity to acquire their positions. The ability to earn profits from active trading was related to their presence on the floor as screen traders did not have similar results. Other correlations confirm that locals made money from an informational advantage gained on the floor.</td>
</tr>
<tr>
<td>Low-latency Trading</td>
<td>Hasbrouck, Saar</td>
<td>2011</td>
<td>Low latency trading improved market quality in terms of short-term volatility, spreads and market depth.</td>
</tr>
<tr>
<td>Middlemen in Limit Order Markets</td>
<td>Jovanovic, Menkveld</td>
<td>2011</td>
<td>HFT increased trade frequency but reduced adverse selection by increasing the speed at which quotes incorporated news.</td>
</tr>
<tr>
<td>Mini Flash Crashes</td>
<td>Golub, Keane</td>
<td>2011</td>
<td>Verified and adjusted some of Nanex’s work on the prevalence of mini flash crashes.</td>
</tr>
<tr>
<td>Title</td>
<td>Authors</td>
<td>Date</td>
<td>Summary of Findings</td>
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<tr>
<td>On the Dark Side of the Market: Identifying and Analyzing Hidden Order Placements</td>
<td>Hautsch, Huang</td>
<td>2012</td>
<td>Dark liquidity can be predicted from market conditions such as bid-ask spread.</td>
</tr>
<tr>
<td>Paying for Market Quality</td>
<td>Anand, Tanggaard, Weaver</td>
<td>2005</td>
<td>When issuers on the Stockholm Stock Exchange hired a liquidity provider their stocks experienced reduced spreads and increased depth. This led to an increase in trading activity and a reduction in volatility which in turn supported the stock price of the issuers.</td>
</tr>
<tr>
<td>Price Dynamics in the Regular and E-Mini Futures Markets</td>
<td>Kurov, Lasser</td>
<td>2004</td>
<td>SPX and NDX e-mini futures were very important in terms of price discovery in their respective indices. Exchange locals had an information advantage over off-exchange (electronic) traders, and e-mini traders received information about large floor trades in the regular-sized contracts in some manner before they hit the tape.</td>
</tr>
<tr>
<td>Quote Stuffing</td>
<td>Egginton, Van Ness, Van Ness</td>
<td>2011</td>
<td>Quote stuffing is pervasive. It decreases liquidity, increases trading costs, and increases short-term volatility.</td>
</tr>
<tr>
<td>Recommendations Regarding Regulatory Responses to the Market Events of May 6, 2010</td>
<td>CFTC, SEC Joint Advisory Committee</td>
<td>2011</td>
<td>Policy recommendations based on the events of May 6, 2010 and subsequent CFTC/SEC studies.</td>
</tr>
<tr>
<td>Sources of Market Making Profits; Man does not live by spread alone</td>
<td>Manaster, Mann</td>
<td>1999</td>
<td>Futures trading data from 1991 show that when market makers had an informational advantage, as they often did, customers had higher execution costs. Market makers had a trade-off between execution costs and profits from price moves.</td>
</tr>
<tr>
<td>Strategic Liquidity Supply in a Market with Fast and Slow</td>
<td>McInish, Upson</td>
<td>2012</td>
<td>Fast traders had better execution quality and experienced more improvement in execution quality when latency was...</td>
</tr>
<tr>
<td>Title</td>
<td>Authors</td>
<td>Date</td>
<td>Summary of Findings</td>
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</tr>
<tr>
<td>Traders</td>
<td></td>
<td></td>
<td>Fast traders made money by trading against slow traders.</td>
</tr>
<tr>
<td>The Externality of High Frequency Trading</td>
<td>Gai, Yaho, Ye</td>
<td>2012</td>
<td>Quote stuffing does occur. Fleeting orders did not have significant impact on price discovery or liquidity. Increased number of cancellations and unfairly allocated technology costs may have a negative effect.</td>
</tr>
<tr>
<td>The Flash Crash: The Impact of High Frequency Trading on an Electronic Market</td>
<td>Kirilendo, Kyle, Samadi, Tuzun</td>
<td>2011</td>
<td>Data from May 6, 2010 showed that HFT did not cause the Flash Crash. HFT increased volatility on that day as HFTs were not willing to take large positions and could not absorb the large fundamental seller.</td>
</tr>
<tr>
<td>The Future of Computer Trading in Financial Markets: An International Perspective</td>
<td>UK Government Office for Science, Foresight</td>
<td>2012</td>
<td>Analysis of the available evidence has shown that Computer Based Trading has led to benefits to the operation of markets, notably relating to liquidity, transaction costs and the efficiency of market prices. Any new policies or market regulation should preserve these benefits. However, this Project has also highlighted legitimate concerns that merit the close attention of policy makers, particularly relating to the possibility of instabilities occurring in certain circumstances, and also periodic illiquidity.</td>
</tr>
<tr>
<td>The Impact of High-Frequency Trading on Stock Market Liquidity Measures</td>
<td>Kim, Murphy</td>
<td>2011</td>
<td>Existing models tended to underestimate effective spreads. By aggregating smaller trades into larger ones the authors show that this underestimation is due to the fact that in recent years large orders tend to be broken up into many smaller ones and models do not account for the price impact of the series of orders.</td>
</tr>
<tr>
<td>The Microstructure of the 'Flash Crash'</td>
<td>Easley, Lopez de Prado,</td>
<td>2011</td>
<td>VPIN (volume-synchronized probability of informed trading), a measure of order</td>
</tr>
<tr>
<td>Title</td>
<td>Authors</td>
<td>Date</td>
<td>Summary of Findings</td>
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</tr>
<tr>
<td>The HOT Study</td>
<td>O'Hara</td>
<td></td>
<td>flow toxicity, increased just before the flash crash and could be a way of monitoring market stability.</td>
</tr>
<tr>
<td>The synchronized and long-lasting structural change on</td>
<td>Bicchetti, Maystre</td>
<td>2012</td>
<td>The authors use increasing correlations between assets (stock index and commodity futures) at intraday time intervals as evidence of increased high frequency and algorithmic trading since 2008.</td>
</tr>
<tr>
<td>commodity markets: evidence from high frequency data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Value of the Designated Market Maker</td>
<td>Venkataraman, Waisburd</td>
<td>2006</td>
<td>Using data from French stocks which trade by call auction only (i.e. illiquid names) the authors find that a market making arrangement improves market quality in a stock.</td>
</tr>
<tr>
<td>The Volume Clock: Insights into the High Frequency</td>
<td>Easley, Lopez de Prado, O'Hara</td>
<td>2012</td>
<td>Opinion piece which argues that it is not just speed that sets HFT apart. HFT traders focus on infrastructure and trading strategy and thus have a fundamentally different paradigm than low-frequency traders. By appropriately prioritizing trading as part of the investment process, low-frequency traders can combat the challenges posed by HFT.</td>
</tr>
<tr>
<td>Paradigm</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Too many middlemen? Impaired learning from trades</td>
<td>Menkveld, Yueshen</td>
<td>2012</td>
<td>Theoretical model describes trades between HFT participants. The authors suggest that trades between HFTs be flagged to allow others to see the information content or lack thereof of the trades.</td>
</tr>
<tr>
<td>Who Makes Markets? Do Dealers Provide or Take Liquidity?</td>
<td>Chae, Wang</td>
<td>2003</td>
<td>Using weekly data from the Taiwan Stock Exchange, the authors find that proprietary traders (as opposed to customer brokers) trade on information and have a speed advantage.</td>
</tr>
</tbody>
</table>