

The Growth of High-Frequency Trading: Implications for Financial Stability

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INTRODUCTION

High-frequency trading (HFT), which relies on computers to execute trades at high speeds, accounts for approximately one-quarter of all trading in the Canadian equity market, and more than half in the U.S. market.¹ A relatively recent but fast-growing phenomenon, HFT has evolved with the changing structure of financial markets, yet its overall effect on financial markets and stability is not fully understood. For example, while the growth of HFT has been associated with market-wide benefits, it also magnifies certain risks, which may cascade into financial systems and lead to financial instability.

Several policy initiatives are under way in Canada and other jurisdictions to better understand the effects of HFT on markets and to mitigate potential risks. For example, the Canadian Securities Administrators (CSA 2011) “have determined that a regulatory framework is necessary to ensure that marketplace participants and marketplaces are managing the risks associated with widespread electronic trading including high frequency trading.”

This article explores the HFT landscape, discusses the associated benefits and risks, and examines some of the regulatory responses in Canada. Some background information on HFT is provided in **Box 1**, and a glossary of selected technical terms used in this report is supplied in **Table 1**.

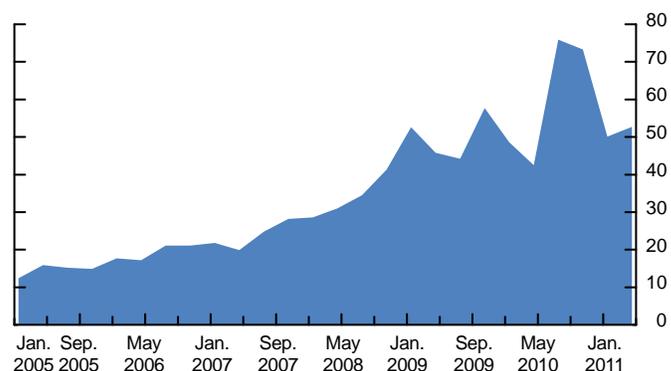
¹ These estimates for Canada are from the Investment Technology Group (ITG 2010) and do not include proprietary desks at brokerage firms or proprietary trading by clients who do not qualify as electronic liquidity providers. For the United States, Sussman, Tabb and Ilati (2009) estimate that HFT accounts for 56 per cent of the trading volume in equities.

BENEFITS AND RISKS OF HFT

The “Flash Crash” of 6 May 2010 amplified the debate over the relative merits of HFT, which has preoccupied market participants and regulators for years.² Since the advent of HFT, order-to-trade ratios and the volume of daily messages have increased dramatically: the Toronto Stock Exchange (TSX) order-to-trade ratio more than quadrupled between January 2005 and April 2011 (**Chart 1**). This increase is evidence of the growing presence of HFT, which is characterized by a high volume of trade messages relative to the number of trades actually completed. These trade messages may not always represent genuine intent to trade, but are instead designed to obfuscate the price signal in markets in order to generate profitable

Chart 1: The number of submitted orders has grown faster than the number of completed trades on the TSX

TSX order-to-trade ratio



Source: TMX

Last observation: April 2011

² On that day, the major U.S. equity indexes dropped by over 5 per cent within several minutes, before quickly rebounding. See SEC and CFTC (2010) and IIROC (2010b) for more details. The TSX Composite Index declined 3.8 per cent from the previous day's close.

High-Frequency Trading: Definition, Strategies and Development

Definition

High-frequency trading (HFT) is the high-speed execution of automated trading strategies, in which large numbers of trades are conducted in short time spans in order to profit from pricing or other market inefficiencies.

Strategies

HFT encompasses a range of strategies. For example, generating revenues by collecting rebates from exchanges that provide liquidity to the markets; taking advantage of differences in the speed of price quotations; and profiting from price differences and other short-term market anomalies. Because the profit margin on individual trades is relatively small, HFT relies on high-speed trading networks to rapidly turn over a large number of small positions. Positions are typically held for short periods (ranging from microseconds to several seconds), and there are no overnight risk positions.

Development

HFT is widespread in global markets, including markets for equities, foreign exchange (FX), fixed-income, commodities, derivatives and emerging-market assets.¹ It is also present in the Canadian equity and FX markets. Several factors have led to the development of HFT

across different markets in recent years, including the following:

- *Technological innovation* permits trading strategies to be executed rapidly and has supported the growth of HFT in every market in which it exists.
- The *proliferation of new trading venues* creates arbitrage opportunities for high-frequency traders. In Canada, for example, there are six equity alternative trading systems (ATSs) and three equity exchanges.² As a result, trading of the same securities can take place across multiple venues, creating opportunities for arbitrage.
- *Regulatory change* has introduced trading rules such as decimalization, which altered the minimum tick size (price increment) and created new price discrepancies between trading venues, and the Regulation National Market System, which requires trades to be automatically executed at the best available price, regardless of location.
- *Reduced barriers to entry* have increased access for many new market participants, including HFT players. For example, after dealers in the FX market began offering prime brokerage services, hedge funds and other members of the professional trading community gained access to the interbank price feeds through prime brokers.

¹ Sussman, Tabb and Iati (2009) estimate that 83 per cent of U.S. HFT proprietary firms trade in stocks; 67 per cent trade in futures, 58 per cent in options, 36 per cent in U.S. Treasury securities and 26 per cent in FX.

² There are three equity exchanges and six ATSs in Canada. They are, respectively: TSX, TSX Venture, Canadian National Stock Exchange; and Alpha ATS, Bloomberg Tradebook Canada, Chi-X Canada, Liquidnet Canada Inc., MATCH Now and Omega ATS.

opportunities for the HFT firm. Consequently, an investigation into the risks and benefits associated with HFT is warranted.

While HFT has been associated with certain benefits, such as tighter bid-offer spreads, lower volatility, and increased market resilience and efficiency, it is also accompanied by risks. For example, in its review of the Flash Crash, the Investment Industry Regulatory Organization of Canada (IIROC) found that, following the sudden decline in U.S. equity indexes, the speedy withdrawal from the Canadian market of many participants, including high-frequency traders and electronic liquidity providers, contributed to the decline in liquidity, but did not trigger the crash. In addition, the rapid growth of HFT has the potential to displace traditional market-makers, which could in turn reduce liquidity in times of market stress. Other risks include the potential for HFT to overload market infrastructure and lead to new forms of credit risk.

The benefits

HFT appears to be having a profound impact on market liquidity, and its rise has coincided with an increase in trading volumes, tighter bid-offer spreads and lower market volatility, at least during periods when markets are not experiencing stress. As a result, HFT could contribute to increased market efficiency.

Liquidity—tighter spreads and higher volumes

Although the entry of new market players, such as high-frequency traders, has not been the only factor, a surge in trading volume and a compression of bid-offer spreads has been observed in all markets where HFT is present (Hendershott, Jones and Menkveld 2011). In the FX market, for example, interbank spreads are estimated to have tightened by at least half, depending on the currency pair, and customer spreads have tightened even more

Table 1: Glossary

Term	Definition
Algorithmic trading	The use of computer programs for entering orders based on trade characteristics such as time, price or quantity
Alternative trading system (ATS)	A trading venue that is approved by regulators but is not an exchange
At-market order	An order placed for quick execution at the best available price
Daily messages	The number of quotes, orders, cancellations and trades sent to an exchange
Exchange rebates	Exchanges offer rebates to liquidity providers to compensate them for taking on risk.
Market-maker	A firm or individual who is obligated, either by a contract with the exchange or by their relationship with clients, to submit quotes and maintain a liquid market. In the equity market, for example, traditional market-makers are contractually obligated to make liquid markets, while in the FX market, dealers usually supply liquidity to clients as part of a comprehensive long-term business relationship and face potential reputational risks if they do not do so.
Minimum quote life	Some trading platforms require bids and offers to be posted for a minimum amount of time in order to allow other market participants the opportunity to transact at these prices. For example, in the FX market, the Electronic Broking Services (EBS) interbank trading platform requires that bids and offers in the major currency pairs be posted for a minimum of 250 milliseconds.
Order-to-trade ratio	Ratio of orders to completed trades
Prime broker	A dealer who allows a client to access the wholesale market using the name and credit rating of the prime broker
Regulation National Market System	U.S. regulation requiring trades to be automatically executed at the best available price, regardless of location
Stop-loss order	An order to either buy or sell a security when it reaches a particular price

dramatically. In the U.S. equity market, spreads on high-volume NYSE stocks narrowed between 7.5 per cent and 46.4 per cent between 2005 and 2009 (Weisenthal 2009).

The availability of additional liquidity in equity markets is partly a result of many trading platforms offering fee rebates to HFT players for supplying liquidity.³ This increased liquidity in turn attracts trading from other clients to these markets. In effect, HFT is now supplying a large proportion of liquidity in many of the most actively traded financial markets.

Lower volatility

There is evidence that the increased presence of HFT has helped to reduce some measures of price volatility. For example, Chaboud et al. (2009) find that algorithmic trading lowers realized volatility in FX markets. Similarly, Brogaard (2010) shows that HFT may have reduced volatility on the Nasdaq. The wide variety of HFT strategies has created at least some trading flows that are uncorrelated with other market activity, increasing the diversification of overall trading flow in the market. A growing share of HFT follows strategies that are based on mean reversion and have counter-flow tendencies. Some trading platforms also report a rising proportion of inter-HFT trading, indicating that not all high-frequency traders have the same strategy. Taken together, this evidence suggests that volatility is not so much a function of the *speed* of trading but of the *type* of trading strategies being practised.

³ Traders who submit orders to buy or sell securities at a specific price “make” liquidity, while traders who execute existing orders “take” liquidity.

Market resilience

During the Flash Crash, equity prices rebounded more rapidly from the sharp sell-off than they did in previous crash episodes: anecdotal evidence points to the return of high-frequency traders as a contributing factor. Similar rapid rebounds in prices have since been observed in other markets, including the FX market (e.g., the sell-off in dollars-yen on 16 March 2011) and the commodities market (e.g., the “mini crash” in cocoa futures on 1 March 2011). This pattern of rapid recovery in prices following sharp declines contrasts with other periods of market stress when HFT was not present; for example, prices did not rebound as quickly intraday following the sell-off in 1987.

Anecdotal evidence suggests as well that, during the extended market dislocation of the 2007–08 credit crisis, HFT players remained relatively active and helped to support liquidity in spot markets. While many markets were dislocated because of credit constraints, the impact on HFT strategies based on spot markets and short-term positioning was not as great.

Price efficiency

Arbitrage allows HFT to reallocate liquidity efficiently across multiple venues, helping to reduce the potential pricing inefficiencies of a fragmented market structure. Pricing is therefore more transparent and consistent across a wide range of exchanges, with uniformly tight bid-offer spreads (King and Rime 2010). Arbitrage also helps to keep pricing consistent between cash instruments and related derivatives (futures, options, indexes and exchange-traded funds), which contributes to price efficiency.

The risks

HFT technologies differ: some are beneficial, others, less so. Some of the less-favourable practices include the tendency of some HFT participants to overload exchanges with trade-messaging activity; use their technological advantage to position themselves in front of incoming order flow, making it more difficult for participants to transact at posted prices; or withdraw activity during periods of pricing turbulence. Concerns about HFT are related to the displacement of traditional market-makers, liquidity in stressed markets, credit risk and infrastructure overload.

Displacement of traditional market-makers

Given that bid-offer spreads have narrowed, some traditional market-makers have allocated fewer resources to market-making or have withdrawn from the business entirely. As a result, HFT is now supplying the majority of liquidity in some markets.

HFT differs from traditional market-making, however, in that HFT firms have no obligation—to their clients or exchanges—to supply liquidity to the market. In fact, any liquidity provided by HFT firms is merely a by-product of their trading. As a result, depending on their strategies, HFT participants may be more likely to withdraw liquidity during periods of market volatility, which can lead to extreme price movements.⁴ Yet, empirical evidence suggests that market-makers often take (in addition to providing) liquidity: they make information-based trades and earn profits from non-liquidity-providing practices (Chae and Wang 2003; van der Wel, Menkveld and Sarkar 2009). Therefore, the fact that HFT firms sometimes take liquidity does not prevent them from making markets and, in this respect, demonstrates that high-frequency traders may not be that different from other market-makers.

Liquidity in stressed markets

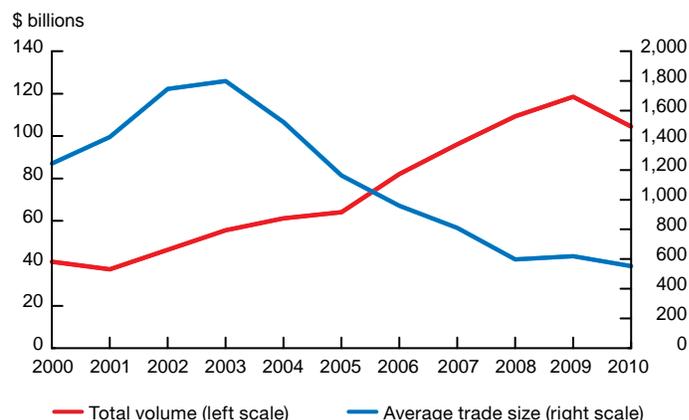
Although there may be more liquidity for “at-market” orders, anecdotal evidence suggests that, at other price points beyond the best bid and offer, there could be less liquidity to support the market in the event of large price movements. This “liquidity mirage” can quickly vanish following a market shock as HFT accounts pull their orders until the market stabilizes. This reaction can exacerbate price movements, since market participants leave stop-loss orders that automatically trigger selling once certain price points are hit. Consequently, there is a risk that these

⁴ However, only some HFT players remained active during the slide in prices that occurred during the Flash Crash of 6 May 2010. Once the plunge started, two of the twelve HFT firms mentioned in a Securities Exchange Commission (SEC) report stopped trading for the rest of the day, four curtailed trading activity for periods ranging between 1 and 21 minutes, and six scaled back trading activity but otherwise stood their ground. One of these (Getco LLC) was active throughout the worst of the selling pressure.

resting sell orders will reinforce each other in a cascade of selling.

Furthermore, while there has been a surge in volume and a narrowing of the bid-offer spreads, the average trade size has also decreased (**Chart 2**). Whereas the average trade size in 2000 was over 1,200 shares, by 2010 it had declined by more than half, to fewer than 600 shares. This decline suggests that while small orders can be easily executed in the current market, large orders are less likely to be executed quickly at posted prices, particularly in stressed conditions.

Chart 2: Total trading volume has increased on the TSX in recent years, but the average size of trades has declined



Note: Trade size is measured by the number of stocks per trade (right axis).
Source: TMX FactBook 2010 Last observation: December 2010

Moreover, given the interconnectedness of financial markets—between the cash market and derivatives, across different asset classes and across different regions—a failure in one market could propagate quickly throughout the global financial system. During the Flash Crash, for example, the chain reaction of selling started in the futures market but was quickly transmitted to the underlying equity market and other asset classes. This volatility also affected the Canadian dollar, since HFT strategies arbitrated cross-listed shares between the United States and Canada.

Credit risk

Credit risk is also a potential issue for HFT-dominated markets. The average daily trading volume of most HFT firms is typically a large multiple of their capital base, even though HFT participants take only limited outright intraday risk. Therefore, a failure in the HFT firm’s trading algorithm could conceivably lead to the rapid accumulation of large, unanticipated risk positions. In the FX market, most HFT accounts access the market through prime brokers, who are expected to monitor their clients’ risk positions and collateral postings in real time. However, it is possible that the transactional speed advantage HFT firms have over

their prime brokers may allow risk to accumulate more quickly than either the dealer or the exchange can control. This could lead to unsettled trades, the quick erosion of the HFT firm's capital position and a default risk for HFT prime brokers.

While this type of risk accumulation may not cause undue concern under "normal" market conditions, during periods of market turbulence, a typical spike in trading volumes can lead to processing delays at exchanges.

System failure and infrastructure overload

Systemic risk could arise if the market infrastructure fails to handle the large volume of transactions. Both pre-trade infrastructure, such as trading systems, and post-trade infrastructure, such as clearing and settlement systems, are exposed to high-volume, high-speed HFT strategies. Should these infrastructures become overwhelmed, this could present a market-wide threat that could pose systemic risk. The increased strain on market infrastructure could lead to latency in both pricing and trade settlements. This, in turn, could obstruct the clearing and settlement systems, which might cause errors, potentially halt transactions and interfere with the proper functioning of market infrastructure.⁵ While HFT did not trigger the Flash Crash, for example, the sheer volume of trades caused some exchanges to fall behind in processing trades and posting prices. The IT capabilities of the markets' infrastructure are being continually challenged by the increase in HFT.

MITIGATING THE RISKS

A variety of measures have been proposed or enacted by exchanges and trading platforms—to varying degrees between markets—to maintain trading integrity in the marketplace.

To limit manipulative behaviour, some trading platforms, primarily in FX markets, have imposed penalties for failing to meet minimum fill ratios. Another measure to reduce excessive trade messaging limits the number of messages that can be sent in a given time period. In addition, some trading platforms try to reduce the speed advantage of HFT messaging by imposing minimum quote lives for posted bids and offers. In equity markets, exchanges provide incentives for HFT players to post genuine liquidity by rewarding them with exchange fee rebates for supplying liquidity.

In addition, some exchanges have implemented circuit breakers, which suspend trading activity after certain price movements. This allows traders to assess the situation and rebalance their order books.

⁵ Market dislocation from system overload also occurred before the advent of HFT (i.e., 1987).

Exchanges, dealers, trading platforms and prime brokers have a vested interest in maintaining orderly market conditions, and the measures they have implemented to limit disruptive trading behaviour by HFT (and other) accounts have helped to improve market integrity. A number of markets have "best practice" codes enforced by exchanges, prime brokers and market committees. Nonetheless, given that HFT's share of overall market activity is growing and because its implications are still not fully understood, especially during periods of market stress, some degree of public oversight is still desirable.

Regulatory support may be needed to coordinate many of the policies designed to limit disruptive market behaviour. For example, price volatility during the Flash Crash may have been exacerbated by differences in the trading controls employed between platforms, leading to distortions in the flow of liquidity that day. These potential distortions may become proportionally more important as HFT links more trading venues, financial products and regional markets. Such coordination should nonetheless take account of the fact that every financial market has its own characteristics that require individualized monitoring and controls.

Regulated vs. unregulated markets

Different markets currently operate with varying levels of regulatory oversight. While the equity market imposes formal regulations on its participants and closely monitors their behaviour, self-regulated markets such as FX markets often have their own codes of conduct that are enforced throughout the various stages of the trading process.

In equity markets, Canadian authorities have taken several steps to increase market surveillance. For example, IIROC launched the Surveillance Technology Enhancement Platform (IIROC 2010a), an advanced system for monitoring trading activity in equity markets. More recently, the CSA (2011) acknowledged the increasingly important role that electronic trading plays in markets, and on 8 April 2011, proposed rules that introduce "provisions governing electronic trading by marketplace participants and their clients." Both of these measures serve as regulatory vehicles for monitoring and mitigating potential risks associated with the changing structure of equity markets.

Self-regulated markets carry a low regulatory burden but must comply with codes of conduct that are enforced throughout the trading process. For example, HFT accounts operating in FX markets face at least three levels of trading controls. First, HFT firms have their own risk-management systems. Second, HFT firms typically access markets through prime brokers, who also impose controls on risk management and trading.⁶ HFT accounts

⁶ Dealers have made great strides in improving the sophistication of their risk-management systems to better monitor HFT risk exposure and collateral positions in real time.

trade using both the name and credit of their prime brokers who, in turn, are given incentives to monitor client behaviour for unacceptable trading practices that might generate legal and reputational risks. This is not entirely different from HFT in the equity markets, where many dealers offering direct electronic access to HFTs have put risk-management and trading controls in place as well. Finally, the interbank market platforms, such as Reuters and Electronic Broking Services (EBS), limit aggregate trading exposure and shut off access to prime broker clients reaching trading limits.⁷ While these trade controls are generally beneficial in limiting risk, this is not a cause for false confidence: they do not remove the need for vigilance in monitoring and controlling risk.

The range of regulations in place across markets can be attributed in part to the differences between markets. FX markets, for example, are much larger, more global and deeper than equity markets, and comprise a diverse array of participants (e.g., retail, corporate, institutional and sovereign wealth funds). The controls imposed in every market are thus geared toward its structure and participants.

CONCLUSION

HFT is playing a significant role in markets today. It began in equities and rapidly spread to other asset classes, such as FX, linking these markets through cross-asset-class trading strategies and heightening concerns about its relative merits. Yet the overall impact of HFT on financial markets and its ability to penetrate further into financial systems remains unclear.

Although there are benefits associated with HFT, its effects are not yet fully understood, in terms of either growing market penetration or stressed markets. HFT has therefore created new challenges for public policy-makers, who will have to monitor and address the potential risks that HFT poses to financial markets and financial stability. While self-regulated markets may be more likely to address these risks independently, other markets may require a regulatory push. In either case, public input and coordination between various financial markets and jurisdictions will be necessary to avoid unintended consequences.

⁷ These controls are not mandated on some of the electronic communication networks that HFT accounts use to trade FX, but these platforms are generally only secondary sources of liquidity in FX markets, behind EBS and Reuters.

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