How Do Exchanges Control the Risks of High Speed Trading?

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For the past several years, various regulatory agencies and industry groups have focused attention on pre and post trade risk controls for high frequency trading, particularly, for firms that access the markets directly. Trading firms that access the markets directly do not use their broker-dealer/futures commission merchant's (FCM) trading system. Rather, they send orders directly to the exchange matching engine via their own proprietary trading platform or via a vendor-provided trading platform the broker-dealer/FCM approves. Such arrangements are referred to as sponsored access in the equities and options markets and as direct market access in futures markets.[1] Trading firms that access markets directly may have pre trade risk controls on their trading platform and/or may rely on pre trade risk controls at the exchange level.

Broadly speaking, regulatory and industry attention on high frequency trading has produced recommendations and best practices related to how pre and post trade risk controls at one or more levels of the trade life cycle – from trade execution to trade settlement - may be improved. Staff from the Federal Reserve Bank of Chicago's Financial Markets Group used these recommendations[2] as a baseline to elicit information on the controls that are currently in place at each level of the trade life cycle to manage the risks of high speed trading. We define high speed trading as high frequency, automated, and algorithmic trading, since firms engaging in these styles of trading can potentially send thousands of orders to an exchange within a second(s). It is also important to note that it is difficult to quantify the precise number of orders that would designate a firm as being engaged in high speed trading. As an obvious example, an algorithmic trader could execute 100 trades over the course of a day, which would not be considered high speed trading.

Over thirty interviews were conducted with primarily U.S. domiciled technology vendors,[3] proprietary trading firms, broker dealers and futures commission merchants, exchanges, and clearing houses. Non-U.S. entities interviewed include one exchange, one clearing house and one foreign broker-dealer. This article summarizes what was learned during conversations with management at five exchanges that offer equities, futures, and/or options products. The interviews focused on risk controls and other topics of interest or concern to exchange staff. Future articles will summarize interviews with proprietary trading firms, brokers, FCMs and clearing houses.

Prevalence of High Speed Traders

When exchange staff was asked what percentage of their market participants were high speed traders, most mentioned that there is no clear definition of high frequency or high speed trading. Based on their internal calculations and individual definitions, staff may categorize trading firms that access the markets directly as high frequency. Staff at two exchanges said high speed trading firms represent from 25 to at least 50 percent of the trading volume on their respective exchanges.

Liquidity

A number of exchange staff acknowledged that high speed trading firms provide liquidity to the markets. While deep and liquid markets are important to every exchange, options exchanges particularly value the role of dedicated market makers because maintaining liquidity in the options market, which has tens of thousands of permutations of various product classes with multiple strike prices and contract months, is more difficult than maintaining the liquidity in the underlying stock.

One staff member from an options exchange drew a sharp distinction between high speed trading firms that are dedicated market makers, are regulated, and have obligations to quote two sides of the market over a specific number of days and in particular asset and/or product classes, and high speed trading firms

that are not designated market makers. For example, some high speed trading firms have become registered brokers, are regulated, but do not have obligations to maintain market liquidity. Still other high speed trading firms are not registered brokers or designated market makers, and have no obligations to provide dedicated liquidity. This exchange staff member also said some high speed trading firms that do not have obligations to provide liquidity to the markets and have invested heavily in faster and better technology are taking profitable trading opportunities away from designated market makers.

FMG staff noted that unlike equity and options markets, designated market makers are rare in U.S. futures markets. As such, trading firms generally have no obligations to quote two sides of the market over a specific number of days in particular asset and/or product classes. Moreover, trading firms that are not registered futures commission merchants (FCMs) and are not clearing members are unregulated.

Pre Trade Risk Controls

Well designed trading platforms include pre trade risk limits that if enabled may do one or more of the following: alert a firm when an order(s) is approaching a pre set limit, stop order entry entirely once a limit is breached, or require traders to take opposite positions when a limit is hit. Sometimes, algorithms deployed by high speed trading firms that access the markets directly may go awry due to corrupt data, programming errors, hardware failures, network issues, or any number of other unforeseen circumstances. Depending on the pre-trade risk checks[4] performed by the trading platform, out-of-control algorithms and/or erroneous orders may be detected and stopped before they would otherwise be transmitted to the exchange matching engine.

If they are not, exchanges act as a last line of defense and can stop orders by:

- Setting pre trade limits at the exchange level for all market participants and/or
- Providing functionality to clearing members[5] and/or market makers that allows them to determine limits for their orders (including proprietary and customer orders) as well as set limits on orders of clients that access the markets directly.

These pre trade risk checks are performed before orders reach the exchange matching engine and are one of the many ways exchanges protect the integrity of the markets. Following are the types of risk checks that the exchanges interviewed perform.

- All have order size limits that set a maximum size order that can be placed in the market. Depending on the exchange, order size limits may be set by product class, product, customer/clearing member, outrights, spreads, etc.
- All have some types of limits that restrict the number of messages that can be sent to the matching engine within a specified period of time. Some exchanges allow trading firms to purchase additional message capacity.
- Four exchanges have a price banding mechanism that only accepts orders within a specific price range and the fifth has a feature that acts as a price band. A few exchanges do not reject orders that are outside the price band if they are from market makers.
- Three exchanges have stop logic functionality that can prevent orders from creating a domino effect in the market.
- One exchange supports intraday position limits, which set maximum positions a firm can take at any time within the day, but these limits are optional and not mandatory.

- One exchange has credit limits, which restricts the dollar value a firm can trade.

Equities and options exchanges may find it difficult to set intraday position and credit limits because products in these markets are fungible and can be bought and sold on numerous trading venues. Because equities and options exchanges do not typically have information on trading firms' exposures at other equities and options exchanges, they cannot determine whether a position on one is offset at another. This is evidenced by some comments from staffs at equities and options exchanges:

- If a trading firm sold $1 trillion on my exchange, how do I know they didn't buy $1 trillion on another?
- Credit limits are not set because exchange staff cannot determine how exposed trading firms are in other markets.

Each level of the trade cycle – trading firm, clearing member, exchange – has responsibilities for setting and administering pre trade risk controls. However, tensions regarding the responsibility for and reasonableness of these limits arise at all levels. Interviews with technology providers revealed that some clearing members may not establish pre trade risk limits for their customers that access the markets directly in the race to get more business.[6] Staff at one exchange said there is a universe of proprietary trading firms that access the markets directly and do not have pre trade risk controls on their trading platforms. Instead, they rely solely on the pre trade risk controls at the exchange. But as noted above, the types of pre trade risk checks offered at the exchange level vary. Staff at an exchange that offers market makers functionality to set pre trade limits said most market makers set these limits at levels where pre trade risk protection is nil. Staff at a third equity options exchange said credit risk was the clearing house's concern.

Kill Button

Exchanges may offer trading firms and/or clearing members other tools to manage risks. When clearing members and/or trading firms are uncertain about their orders and positions, they may telephone exchange staff and request that certain or all orders be cancelled from the order book. Provided proper authorization is given by the clearing/trading firm, exchange staff manually executes these requests. To expedite this manual process, FMG staff inquired if exchanges also provide their clients with a kill button that can be used in such exigent circumstances.

One exchange requires clearing members to build kill button capabilities for their clients. Three exchanges offer some type of kill button, but:

- Some exchanges only offer the kill button to market makers and/or clearing members. Other exchanges offer the kill button to all market participants, including trading firms that access the markets directly.
- Two of the three exchanges offer clearing members and/or trading firms functionality that enable them to manually enter parameters that when breached will automatically activate a kill button.
    - At one of these two, the exchange is in the process of developing an API that will programmatically enable clearing members to automatically cancel or modify any order.

Cancel on Disconnect

Because trading firms sometimes lose connectivity between their servers and the exchange servers, exchanges were asked if they provide trading firms cancel on disconnect functionality that cancels orders in the order book when this connection is lost. All five exchanges offer cancel on disconnect functionality. But, how this functionality works and who it is offered to varies by exchange. Some exchanges delete all orders while others provide clients with the option to select what order types should be cancelled.[7] Two exchanges allow trading firms to choose what will happen when cancel on disconnect is activated – orders can be cancelled or left working in the market. Another exchange only provides automatic cancel on disconnect for market maker orders and requires trading firms to call the exchange to delete their orders.

Exchange staff was also asked if high speed trading firms are required to subscribe to cancel on disconnect. Four exchanges leave this decision up to the individual trading firm, but staff at one of these exchanges said that almost every high speed trading firm subscribes to cancel on disconnect. The fifth exchange requires market makers to subscribe to cancel on disconnect.

Error Trades/Out-of-Control Algorithm

Each exchange interviewed has dedicated teams that monitor abnormal trading behaviors such as firms accumulating significantly larger positions and volumes compared to historical data. Some exchanges also use automated tools to detect unusual trading patterns that, when detected, might result in exchange staff calling the clearing member and/or trading firm responsible.

Exchanges may choose to bust or adjust trades that create a significant price impact and/or that are caused by out-of-control algorithms or unusual orders. Sometimes, exchanges honor these trades. The action(s) that is taken in such circumstances varies by exchange. For example, some exchanges are reluctant to bust trades and choose to adjust the price of the executed trade instead. Other exchanges may bust rather than adjust trades, which could potentially result in breaking one side of a firm's hedged position. Still other exchanges may only bust trades outside the price band. In addition, the time frames trading firms have to report an error trade to an exchange also differs by exchange and by product (e.g. 8-30 minutes).

Exchanges staff was asked about the frequency with which out-of-control algorithms and erroneous trades occur. During these conversations, it was revealed that there is no standard definition of out-of-control algorithms and there is no clear pattern as to what causes them. Staff at one exchange said out-of-control algorithms happen extremely infrequently and it never had to shut down a trading firm's server. The second exchange stated it had not had an out-of-control algorithm since 2008, when a trading firm had an algorithm that traded with itself 10,000 times. Following this occurrence, exchange staff contacted the SEC and had the trades pulled from the consolidated tape. However, this exchange does see 1-2 erroneous trades a day. The third exchange said out-of-control algorithms occur a few times a year and can only be detected if it creates a significant price impact. Algorithms that slowly add up positions over time cannot easily be identified, but exchange staff has heard stories of such occurrences. The fourth exchange indicated out-of-control algorithms and/or clearly erroneous trades occur daily in illiquid options. How long it takes to detect them depends on the pattern, the impact on the market, and how quickly humans can identify the problem. The fifth exchange was unable to quantify the frequency of clearly erroneous trades or out-of-control algorithms.

Clearing Member Audits

Because clearing members assume the financial risk of all their customers' trades, FMG staff surmised that exchanges would be intensely interested in the controls clearing members have in place to manage the risks associated with high speed trading and would review these controls during periodic audits. Two exchanges outsource the audit process to FINRA. A third exchange only looks for irregularities when a new clearing member account is opened. Staff at a fourth exchange said if a trading firm has sponsored access, they check whether the risk administrator at the clearing member is able to view and control risk limits on their customers' trading platforms. This exchange does not approve situations where the clearing member does not have exclusive access to customers' pre trade risk controls.

Manipulative Market Practices

Inquiries regarding how exchanges monitor whether spoofing or layering and other types of order manipulation are occurring revealed that exchanges rely on manual or automated tools or both to detect such practices.[8] Exchanges have the capability to monitor whether manipulative market practices are occurring at their individual exchange. However, the fragmented structure of equities and options markets, where products are fungible and firms are able to buy and sell the same instrument at multiple trading venues, prevents these exchanges from detecting whether a trading firm is engaging in manipulative practices across multiple exchanges. Equities and options exchanges provide the Intermarket Surveillance Group (ISG)[9] with information for cross market surveillance, but do so on a lagged basis three days after the trade (T+3).

In the futures markets, where some products are traded almost exclusively at a single trading venue, exchange staff is able to view the majority of trades in these products. However, futures markets face the same challenges in detecting manipulative practices firms may be engaging in across exchanges. Futures exchanges can obtain information on cross market activity from the ISG for this purpose, subject to the limitations described above.

Drop Copy

Exchanges typically provide drop copies to clearing members and to high speed trading firms that access the markets directly. Depending on the exchange, drop copies may include details on filled trades and working orders by trading account. Trading firms may compare the drop copies against the trade execution records on their trading platforms to identify any discrepancies in the number of trades recorded by the exchange and the number of trades recorded on the trading platform. What is included in and the time it takes to receive drop copies differ by exchange. Some exchanges do not include working orders in drop copy while others do. Some exchanges provide drop copy in near real time (microseconds) and other only provide drop copy at the end of the trading day.

FMG staff inquired if exchanges were working toward standard communication protocol(s) for drop copy to assist trading firms' reconciliation efforts. One exchange said that standard protocol(s) for drop copies and an API capability to send a stop trading message if a significant discrepancy is identified, is the next logical step. Two options exchanges indicated that their regulator forbids them to work together with other options exchanges on joint issues without its expressed permission.

How do exchanges envision high speed trading evolving over the next few years?
When asked how they saw high speed trading evolving over the next few years, exchange staff expressed the following opinions:

- The massive transformation to high speed trading is largely complete and growth will not be as steep as before.
- More and more traditional market makers are being replaced by high speed trading firms, but liquidity provision strategies will not be as profitable for new entrants.
- High frequency trading is migrating to options markets. However, there is less of it at exchanges with maker-taker pricing models.
- As long as there is a high degree of fragmentation in the markets, there will be arbitrage traders.

Has the market reached a saturation point for marginal returns for high speed trading?
Some exchanges feel that the markets have reached a saturation point for marginal returns for high speed trading, which was a novel industry ten years ago when there were easier opportunities to make money. More recently, profits and spreads have narrowed and established players are having difficulties finding moneymaking trades. One exchange staff member said some evidence of this is the downsizing of staff at some U.S. high speed trading firms and the consolidation of several others. Another pointed to the decrease in statistical arbitrageurs in Europe. However, staff at a third exchange said there is too much uncertainty in the markets to predict whether high speed trading has reached a saturation point and that the biggest uncertainty is rule making by regulators.

One interviewee said it is difficult to predict how high speed trading might evolve in the options space, since there are hundreds and thousands of series to trade compared to two or three series in stocks. While there are potentially wider margins in options markets, the risks and costs, including the requisite capital investment of trading this asset class are higher.

Staff at another exchange emphasized that demonizing high frequency trading as stealing money from long term investors is wrong. Trading is not a zero sum game. Rather, long and short term investors both benefit.

What keeps exchange staff awake at night?
Competition was at the top of the list of concerns for three exchanges. One questioned whether this competition is leading to unfair business practices, such as exchanges trying to drive each other out of business using predatory pricing tactics while nothing is being done in the anti-trust space. Staff at a non-U.S. exchange had three concerns:

- Achieving the right balance of high and low latency trading firms was challenging,
- Requiring interoperability among CCPs in Europe is creating a race to the bottom in risk management and risk controls as CCPs compete for business. This competition is leading to degradations in systems' stability and capabilities and increasing systemic risk, and
- The increasing number trades executed in dark pools, broker crossing networks, and multilateral trading systems.

Finally, staff at another exchange was concerned about the magnitude of losses that other clearing houses could potentially bear.

What would exchanges do if they had the power and ability to change anything for the betterment of the markets?

When asked what they would do if they had the power and ability to change anything for the betterment of the markets, exchange staff expressed a variety of suggestions, including:

- Having reasonable regulators and regulations so that trading firms do not migrate to non-U.S. exchanges with looser risk controls, particularly in Asia.
- Opening up access to and transparency of all trading venues. Enforcing mandatory clearing of all asset classes, including FX and fixed income options.
- Setting tick sizes relevant to the price of the stock. Currently, one stock may trade at $520 and another at $4 but each stock has a tick size of one cent. Staff at this exchange said there is an absolute correlation between the spread, tick size, and how much trading is going on in dark pools.
- Eliminating flash orders in the options markets.
- Cutting the cost of clearing in Europe by making it a public utility analogous to DTCC.
- Requiring derivatives to be fungible across exchanges.
- Allowing high speed trading firms to stream two sided quotes without any market making obligations and other regulations have caused deterioration in the quality of the markets. In addition, high speed trading firms are stepping in front of traditional market makers' orders thereby usurping potentially profitable trading opportunities and priorities historically reserved for market makers. Market makers should be given tax benefits to incent them to remain in the market.
- Controlling orders in the options markets by requiring high speed trading firms that are not market makers to have commitments or governors on their trading systems. Staff at this exchange said that the liquidity high speed trading firms provide is not in balance with the orders they submit and that these firms only make markets in 10 percent of the series in an options class.

What are your concerns from a regulatory perspective?

When asked about their concerns were from a regulatory perspective, exchanges raised a variety of issues, including: their desire to see more products traded on exchanges, the dangers arising from regulations that are based on a misunderstanding of the markets, the possibility that regulations can cause more harm than good, the need for regulations to be applied consistently across markets, and the opinion that dark pools pose systemic risk.

Conclusion

Exchanges act as a last line of defense by conducting various pre trade risk checks before orders reach the exchange matching engine. These and other measures protect the integrity of the markets. Some pre trade risk checks are under the control of the exchange and are evenly applied to all market participants at the individual exchange. Doing so increases latency, but uniformly and equitably for all participants.

Exchanges may also offer functionality to clearing members and/or market makers so they can input limits that are applied to their proprietary and customer orders, including customers that access the markets directly. However, the types of pre trade limits applied by exchanges or by clearing members/market makers vary by exchange. In addition, some clearing members/market makers may

input few or no limits, slowing orders for some trading firms and not others. To further protect the integrity of the markets, there may be role for exchanges to conduct periodic audits of the types of pre trade risk controls clearing members utilize, the methodology for how these controls are applied, and the reasonableness of the limits set.

One way exchanges can limit firms' financial exposures is by establishing or providing functionality for clearing members to establish credit or position limits. However, two exchanges pointed out that they cannot set credit or position limits because of the fragmented structure of U.S. markets, which prevents them from identifying whether trading firms have any offsetting positions at other exchanges. Market fragmentation creates other challenges as well. Exchanges can monitor if manipulative trading practices are occurring in their own markets, but they are unable to detect if such practices are occurring across multiple markets. While exchanges submit trade level data to the ISG for this and other purposes, they send this data three days after the trade. Exchanges may also have differing policies for defining/breaking/adjusting error trades and out-of-control algorithms, which may create uncertainties for trading firms during times of market distress.

For extreme scenarios, exchanges offer cancel on disconnect and kill button functionalities, but how these functionalities are activated and what orders get deleted from the order book vary by exchange, which may create uncertainties for trading firms with regard to which orders are left working in the market. Exchanges may want to consider standardizing the definition for cancel on disconnect and clearly communicating what type of orders are deleted by their automatic kill functionalities.

A critical way trading firms monitor their positions in the market is by reconciling the trade report generated on their trading platform with the exchange drop copy. While most exchanges provide drop copy in real time, one provides it on an end of day basis. In addition, not all exchanges include working orders in their drop copies, which may limit firms' abilities to monitor overall exposures.

Exchange staff acknowledged that high speed trading firms provide liquidity to the markets and agreed that the massive transformation to HST is largely complete and markets have reached a saturation point for marginal returns. However, staff at one exchange said the liquidity high speed trading firms provide is not in balance with the number of orders they submit in the options markets. One staff member from an options exchange was concerned that some high speed trading firms are replacing traditional market makers and have no obligations to provide liquidity. Options exchanges particularly value the role of market makers because maintaining liquidity in this market is more difficult than maintaining liquidity in the underlying stock. FMG staff noted that unlike equity and options markets, designated market makers are rare in U.S. futures markets and that trading firms that are not registered futures commission merchants (FCMs) and/or clearing members are unregulated.

Regulators with deep market knowledge and regulations that do not result in unintended consequences or regulatory arbitrage are needed. Otherwise trading firms may migrate to other regions where regulation is less stringent.

While most exchanges advocated for market transparency, competition from other exchanges was at the top of the list of concerns. Staff at one exchange went so far as to question whether encouraging competition between exchanges and clearing venues in Europe was creating a race to the bottom in risk management and impacting the stability of the markets.

[1] As of July 2011, the SEC implemented Rule 15c3-5, which among other things requires broker dealers providing sponsored access to maintain a system of risk controls and supervisory procedures reasonably designed to limit the financial exposure of the broker dealer that could arise as a result of market access. In addition, the CFTC issued a notice of proposed rulemaking, "clearing member risk management," Vol. 76, *Federal Register* No. 147, p. 45724 to bolster risk management at the clearing member level on 8/1/11.

[2] See: FIA Asia (2007), "Profile of exchange and fcm risk management practices for direct access customers," December 3; OICU-IOSCO (2008), "An overview of the work of the IOSCO technical committee," July; OICU-IOSCO (2007), "Multi-jurisdictional information sharing for market oversight," April; FIA (2009), Letter from John Damgard to Greg Tanzer, IOSCO, May 26; FSA (2008), *Market Watch,* November, Issue no. 30, pp.10-13; FIA-FOA (2009), Clearing Risk Study; OICU-IOSCO (2009), "Policies on direct electronic access," February; FIA (2010), "Market access risk management recommendations," April; OICU-IOSCO (2010), "Principles for direct electronic access to markets," August; FIA (2010), "Recommendations for risk controls for trading firms," November; SEC (2010), "Risk management controls for brokers and dealers with market access," Release No. 34-63241; File No. S7-03-10**,** November; CFTC (2011), "Recommended practices for trading firms, clearing members and exchanges involved in direct market access," Pre-Trade Functionality Subcommittee of the CFTC Technology Advisory Committee, March.

[3] A summary of the interviews with technology providers can be found at http://www.chicagofed.org/webpages/publications/policy_discussion_papers/2011/pdp_1.cfm

[4] Risk controls include the processes, procedures and systems a firm needs to prudently manage all the risks resulting from its trading activities to ensure they are within the firms' risk appetite. Risk checks scrutinize orders against a particular limit(s) and are carried out as part of the broader risk control process.

[5] For a definition of clearing member, see Clark, Carol 2010, "Controlling Risk in a Lightning Speed Trading Environment, Federal Reserve Bank of Chicago *FedLetter,* March at http://www.chicagofed.org/webpages/publications/chicago_fed_letter/2010/march_272.cfm

[6] See http://www.chicagofed.org/webpages/publications/policy_discussion_papers/2011/pdp_1.cfm. This comment was made before July 2011 when SEC Rule 153c-5 referenced above.

[7] For example, GTD (good till date orders) are non-persistent order types that are only valid for the trading day. At the end of the trading day, these orders get cancelled by the exchange. GTC (good till cancel orders) are persistent order types that do not get cancelled by the exchange at the end of the trading day. GTC orders are generally cancelled by the trader/trading firm/clearing member, but some exchanges set limits on how many days a GTC order can stay in the market.

[8] The FSA defines spoofing or layering as a manipulative market practices that may give false or misleading information on the supply or demand for a security. Spoofing or layering involves a trading firm submitting multiple orders at different prices on one side of the exchange order book and then submitting an order on the other side of the order book revealing the true intention of the trade. Following the trade, the multiple orders in the order book or cancelled. See http://www.fsa.gov.uk/pubs/newsletters/mw_newsletter33.pdf .

[9]The Intermarket Surveillance Group ("ISG") was established in the early 1980s and is comprised of an international group of exchanges, market centers, and market regulators that perform front-line market surveillance in their respective jurisdictions. ISG has two main purposes: (1) the coordination and development of programs and procedures to identify possible fraudulent and manipulative activities across markets; and (2) information sharing." Information found at https://www.isgportal.org/home.html on 9/19/11.