RGM
ADVISORS, LLC

December 17, 2013

Via Electronic Submission

Ms. Melissa D. Jurgens
Secretary of the Commission
Commodity Futures Trading Commission
Three Lafayette Centre
1155 21st Street NW
Washington, DC 20581

Re: Concept Release on Risk Controls and System Safeguards for Automated Trading Environments RIN 3038-AD52; 78 FR 56542

Dear Ms. Jurgens:

Thank you for the opportunity to provide comments to the Commodity Futures Trading Commission (CFTC) in connection with its Concept Release on Risk Controls and System Safeguards for Automated Trading Environments (the "Concept Release"). I am the CEO of RGM Advisors, a trading firm based in Austin, Texas. I am also pleased to serve on the CFTC's Technology Advisory Committee, the Board of the Futures Industry Association (FIA) and the executive committee of the FIA's Principal Traders Group (FIA PTG).

The FIA last week submitted an extensive response to the Concept Release and I write in support of the detailed submission. My firm has consistently supported a regulatory environment that promotes fair competition, encourages innovation, enhances transparency, manages systemic risk, lowers costs for investors and hedgers, and gives regulators the tools they need to detect and deter abuses. It is important to point out that moves toward open, electronic markets further these valuable objectives. Moreover, in recent years, as markets around the world have become increasingly electronic and competitive, market quality has improved dramatically, saving investors and hedgers billions of dollars. This has been reflected in dozens of empirical studies using diverse methodologies and metrics. [1]

Responsible risk management requires a multi-layered structure of independent safeguards. The futures industry has, on its own initiative, developed and put in place many risk controls and system safeguards; the FIA and its member firms have been at the forefront in developing best practices for their use. Nonetheless, some are concerned that the combination of electronic markets and computer trading has increased the risk of certain kinds of market disruptions. This should be an area for ongoing collaboration between the financial industry, government and the investing public.

[1] The vast majority of evidence is clear that automation, competition and "high frequency trading" improve market quality. While some critics have claimed otherwise, we urge the Commission to make its own assessment of the relevant literature. We hope the attached literature review is helpful in that regard.

Moreover, regulators should use appropriate technology in support of their oversight and surveillance functions. In many ways, electronic markets with their detailed, electronic audit trails should make this responsibility easier. Some observers have suggested that a regulatory definition of "High Frequency Trading" is needed. We agree with the FIA view that such a definition would be arbitrary and counterproductive; regulators should focus on risk controls for and surveillance of *all* market participants, rather than just an arbitrary subset.

Thank you again for the opportunity to comment on the Concept Release.

Sincerely,

/s/ Richard B. Gorelick
Richard B. Gorelick
Chief Executive Officer
RGM Advisors, LLC

High Frequency Trading Literature Review
September 2013

This brief literature review presents a summary of recent empirical studies related to automated or "high frequency trading" (HFT) and its impact on various markets. Each study takes a unique approach, yet all paint a consistent picture of markets being improved by competition and automation.

Author(s) / Title	Dataset	Findings
Angel, Harris, Spatt "Equity trading in the 21st century", February 2010 June 2013 (Update)	U.S. equities, 1993 – 2009	Trading costs have declined, bid-ask spreads have narrowed and available liquidity has increased
Castura, Litzenberger, Gorelick (RGM Advisors) "Market Efficiency and Microstructure Evolution in US Equity Markets: A High Frequency Perspective", October 2010, and March 2012 (Update)	U.S. equities, 2006-2011	Bid-ask spreads have narrowed, available liquidity has increased and price efficiency has improved
Avramovic (Credit Suisse) "Sizing Up US Equity Microstructure", April 2010 "Who Let the Bots Out? Market Quality in a High Frequency World", March 2012	U.S. equities, 2003-2010 U.S. equities, 2004-2011	Bid-ask spreads have narrowed, available liquidity has increased, and short-term volatility (normalized by longer term volatility) has declined; the incidence of "mini" crashes has not increased
Hasbrouck, Saar "Low-Latency Trading", July 2012	U.S. equities, full NASDAQ order book June 2007 and October 2008	Low latency automated trading was associated with lower quoted and effective spreads, lower volatility and greater liquidity
Cumming, Zhan, Aitken "High Frequency Trading and End-Of-Day Manipulation", January 2013	22 international equities markets, identifying the availability of colocation as a proxy for HFT activity	Increasing HFT activity was found to be the most robust and significant predictor of a reduction in end-of-day market manipulation

Weisberger, Rosa (2 Sigma) "Automated equity trading: The evolution of market structure and its effect on volatility and liquidity", June 2013	U.S. equities and CBOE VIX data	No evidence that volatility has increased due to recent market structure changes
Bollen, Whaley "Futures Market Volatility: What has Changed?", August 2013	15 futures contracts on 4 leading futures exchanges	Volatility attributable to structural factors did not change in most of these contracts over long time periods, suggesting HFT and automated trading have not impacted volatility
Jones "What do we know about high frequency trading?", March 2013	Various U.S. equities data sets	Reviews empirical evidence and finds HFT acts to "improve market liquidity, reduce trading costs, and make stock prices more efficient"
Hendershott, Riordan "Algorithmic Trading and Information", August 2009	Automated vs. other trades. Deutsche Börse equities, January 2008	Automated trades made prices more efficient and did not contribute to higher volatility
Chaboud, Hjalmarsson, Vega and Chiquoine "Rise of the Machines:	Automated vs. other trades. EBS forex market, 2006-2007	Automated trades increased liquidity and may have lowered volatility
Debelle (Markets Committee, Bank for International Settlements) "High-frequency trading in the foreign exchange market", September 2011	Various FX venues, notably Reuters and EBS, and various dates, notably May 6, 2010 and March 17, 2011	HFT is beneficial during normal market periods, with similar behavior to traditional market participants during high volatility periods
Brogaard, Hendershott, Riordan "High Frequency Trading and Price Discovery", July 2012	HFT vs. other trades. U.S. equities on NASDAQ, various periods in 2008 – 2010	HFT was positively correlated with permanent price changes and negatively correlated with transitory price changes, suggesting that HFT improves price discovery

Hirschey, Nicholas "Do High-Frequency Traders Anticipate Buying and Selling Pressure?", December 2011	HFT vs. other trades. U.S. equities on NASDAQ, various periods in 2008 – 2010	HFT was positively correlated with non-HFT, corroborating Brogaard, Hendershott and Riordan results
O'Hara, Yao, Ye What's Not There: The Odd-Lot Bias in TAQ Data, July 2011	HFT vs. other trades. U.S. equities on NASDAQ, various periods in 2008 – 2010	Odd-lots and trades of 100 shares drove the majority of price discovery; HFT was more likely to trade with odd-lots
Gerig "High-Frequency Trading Synchronizes Prices in Financial Markets", November 2012	HFT vs. other trades. U.S. equities on NASDAQ, February 2010, plus Thompson Reuters data from 2000, 2005, and 2010	"HFT facilitates information transfer between investors, which increases the accuracy of prices and redistributes profits from informed individuals to average investors by reducing transaction costs"
Jarnecic, Snape "An analysis of trades by high frequency participants on the London Stock Exchange", June 2010	HFT vs. other trades LSE equities, April – June, 2009	HFT improved liquidity and was unlikely to have increased volatility
Su, Aldinger, Labuszewski (CME Group) "Algorithmic trading and market dynamics", July 2010	Automated vs. other trades. CME futures, May 2008 – May 2010	Automated trading was associated with improved liquidity and reduced volatility
Kirilenko, Kyle, Samadi and Tuzun "The Flash Crash: The Impact of High Frequency Trading on an Electronic Market", May 2011	CME E-mini S&P-500 equities index futures contract, May 3 - May 6, 2010	HFT traders did not change their behavior during the flash crash; HFT were net buyers during the crash, net sellers during the recovery; HFT may have induced more trading during the crash

Backes (Eurex AG) "High-frequency trading in volatile markets - an examination", October 2011	Eurex FDAX: DAX equities index futures contract August 25, 2011	During "FDAX flash crash", HFT acted "in a way that protects the market by placing a rapid succession of small, non-directional buy and sell orders, thus preventing abrupt price movements", improving market quality during a period of high stress
Menkveld "High Frequency Trading and the New-Market Makers", February 2012	Dutch equities traded on Chi-X and Euronext, 2007	A single high frequency trader played an important role in the development of a competitive market center, resulting in better liquidity and lower trading costs
Lepone "The Impact of High Frequency Trading (HFT): International Evidence", September 2011	HFT vs. other trades. Singapore Exchange (SGX), Australia Securities Exchange (ASX), NASDAQ and London Stock Exchange	HFT has become a major provider of liquidity, particularly during periods of market uncertainty
Frino, Lepone and Mistry "The New Breed of Market Participants: Algorithmic Trading on the ASX", March 2012	Australia Securities Exchange (ASX), October 2006 - October 2009	Algorithmic trading grew from 35% to 55% of dollar volume and was a net liquidity supplier. Algorithmic trading rates increased when spreads were wide, volatility low, volumes low and depth low
Frino and Lepone "The impact of high frequency trading on market integrity: an empirical examination", May 2012	LSE and Euronext trade data, Jan 2006 - Dec 2011	HFT was found, statistically, to drive end of day prices away from dislocations. Additionally, HFT was found to not have a statistically significant relationship with 'Ticking", a proxy of short-term price manipulation

Hagströmer and Nordén "The diversity of high frequency traders", September 2012	NASDAQ OMX Stockholm Equities market August 2011, February 2012	HFT market making, stat-arb and momentum strategies all mitigate intraday price volatility
Baron, Brogaard, and Kirilenko "The Trading Profits of High Frequency Traders", November 2012	Audit trail of CME ES contract, August 2010 to August 2012	HFTs were profitable, using a 1 minute measure of profitability, and earned profits trading with all classes of counterparties, up to 1 bp. Profitability was consistent over the period
Benos and Sagade, (Bank of England) "High-frequency trading behavior and its impact on market quality: evidence from the UK equity market", December 2012	Full audit-trail data for four UK stocks in a randomly chosen week in between 2011-2012	HFTs exhibited substantial variability in strategies. "Passive" appeared like traditional market making, while "aggressive" tended to trade in direction of recent price moves. Both were more active when prices were volatile and spreads, narrow. HFT had a higher information-to-noise ratio than non-HFT
Malinova, Park, Riordan "Do Retail Traders Suffer from High Frequency Traders?", May 2013	Canadian Equities data	"HFTs appear to not impose negative externalities on the least sophisticated market participants and … may be beneficial to slower and less sophisticated traders"
Hendershott, Jones, Menkveld "Does Algorithmic Trading Improve Liquidity?", February 2012	Automated quoting facility, NYSE equities, 2003	Automated trading narrowed bid-ask spreads, lowered trading costs, and improved price efficiency
Riordan, Storkenmaier "Latency, Liquidity and Price Discovery", November 2011	Xetra high-speed trading system, Deutsche Börse, 2007	Higher system speeds led to increased liquidity and improved price discovery

Hendershott, Moulton "Automation, Speed and Stock Market Quality: The NYSE's Hybrid", February 2010	NYSE TAQ database plus others, June 1, 2006 - May 31, 2007	Introduction of automation via the NYSE hybrid system improved price discovery
Brogaard, Hendershott, Hunt, Latza, Pedace and Ysusi (UK FSA) "High-Frequency Trading and the Execution Costs of Institutional Investors", January 2013	Technology upgrade events on the LSE, between 2008 - 2010	Higher system speeds correlated with increased HFT in two of four events investigated. No statistically significant relationship found between these technology upgrades and institutional transaction costs
Gomber, Arndt, Lutat, Uhle "High-Frequency Trading", March 2011	Various	Survey that highlighted beneficial aspects of HFT, while noting that perceived problems are largely a result of U.S. market structure
The Government Office for Science (United Kingdom) "Foresight: The Future of Computer Trading in Financial Markets", Final project report., October 2012	Various	Wide-ranging survey that involved over 50 studies and papers from over 150 academics from over 20 countries
Litzenberger, Castura, Gorelick (RGM Advisors) "The Impacts of Automation and High Frequency Trading on Market Quality", November 2012	Various equities data sets	Review paper that detailed the role that HFT played in improving market quality

Pinnington "The HOT Study: Phases I and II of IIROC's Study of High Frequency Trading Activity on Canadian Equity Marketplaces" (IIROC), December 2012	Canadian equities trading between August 1, 2011 – October 31, 2011	Focusing on HFTs with high order-to-trade (HOT) ratios, the author quantified several characteristics of this form of trading, including profiles of stocks traded, volume share, intraday trading trends, and venue market share
Berman "Transformational Technologies, Market Structure, and the SEC", June 2013	Various U.S. equities data sets	A speech that outlined tools and policies to investigate and understand market dynamics; observed that sudden moves were generally not caused by algos-gone-wild, but rather by "old-fashioned human mistakes"
Bell "High Frequency Trading: Do Regulators Need to Control this Tool of Informationally Efficient Markets?", July 2013	Various U.S. equities data sets	Suggested that HFT is already regulated in the markets, that HFT acts to improve market efficiency, and that there remain opportunities to improve market stability

This following studies measured improvements in overall market quality:

Angel, Harris and Spatt (February 2010) examined many measures of market quality and how they have changed over time and in response to regulatory and structural changes in the U.S. equity markets.[1] Drawing from a diverse set of data sources, they show that there has been significant improvement in virtually all aspects of market quality. They stated that "execution speeds have fallen, which greatly facilitates monitoring execution quality by retail investors. Retail commissions have fallen substantially and continue to fall. Bid-ask spreads have fallen substantially and remain low, although they spiked upward during the financial crisis as volatility increased. Market depth has marched steadily upward. Studies of institutional transactions costs continue to find U.S. costs among the lowest in the world."

[1] Angel, J., Harris, L. and Spatt, C., "Equity trading in the 21st century", http://papers.ssrn.com/so13/papers.cfm?abstract_id=1584026

Castura, Litzenberger and Gorelick of RGM Advisors, LLC **(October 2010, Updated March 2012)** studied recent data from the U.S. equity markets.[2] The authors examined trends in a number of U.S. equity market quality metrics over the period from January 2006 through June 2010 and how these metrics differed by market capitalization and by listing venue. They presented data that confirmed that over this period quoted bid-ask spreads declined, quoted market depth increased and short-term measures of market efficiency significantly improved. The updated Research Note examined the same metrics through the end of 2011, a period that included significant macro-volatility surrounding the European debt crisis and U.S. credit downgrade. The data demonstrated that trends toward improving market quality continued in later periods, despite the macro-economic shocks.

Avramovic of Credit Suisse **(April 2010, March 2012)** showed that in recent years, bid-ask spreads declined, depth at the inside quote increased and intra-day volatility normalized by longer-term volatility declined substantially.[3] The author concluded on this last point that "[t]his seems to be confirmation that the new market participants are successfully finding and removing mispricings, as well as dampening volatility that might otherwise be created by large institutional orders filled during the day." Credit Suisse, in March 2012, released a follow-up report on the impact of HFT on market quality and found that bid-ask spreads declined and depth at the inside quote increased. They also looked at historical long-term and short-term (intraday) volatility and found that long-term volatility has remained within historical norms while short-term volatility has declined over recent years. They concluded that, with regard to high frequency traders, "markets are not worse for their presence".

Hasbrouck and Saar (July 2012) explored the nature and impact of low-latency (algorithmic) trading on the NASDAQ exchange during June 2007, a 'nominal' market period, and October 2008, a volatile, uncertain period.[4] They identified periods of high market activity due to algorithms and related these to longer-term market quality metrics such as spread, effective spread and depth of liquidity. They observed in both periods "that higher low-latency activity implies lower posted and effective spreads, greater depth, and lower short-term volatility".

Cumming, Zhan and Aitken (January 2013) looked at the incidence of end-of-day market manipulation, and how HFT activity influenced such behavior.[5] Manipulative behavior was modeled by observing extreme end-of-day price movements relative to historical norms.

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[2] Castura, J., Litzenberger, R., Gorelick, R., and Dwivedi, Y., 2010: "Market Efficiency and Microstructure Evolution in US Equity Markets: A High Frequency Perspective", http://www.rgmadvisors.com/docs/MarketEfficiencyStudyOct2010.pdf

Castura, J., Litzenberger, R., Gorelick, R. 2012: "Market Efficiency and Microstructure Evolution in US Equity Markets: A High Frequency Perspective: Update March 2012", http://www.rgmadvisors.com/docs/MarketQualityStudyMarch2012.pdf

[3] Credit Suisse, 2010: "Sizing Up US Equity Microstructure", https://tradeview.csfb.com/edge/Public/Bulletin/Servefile.aspx?FileID=14377&m=1337434953

Credit Suisse, 2012: "Who Let the Bots Out? Market Quality in a High Frequency World", https://edge.credit-suisse.com/edge/Public/Bulletin/Servefile.aspx?FileID=21352&m=2100222725

[4] Hasbrouck, J. and Saar, G, "Low-Latency Trading", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1695460

[5] Cumming, Zhan and Aitken, "High Frequency Trading and End-Of-Day Manipulation", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2145565

HFT activity was estimated based on the availability of colocation services by the exchange and an estimate of when HFT actually began using such services at meaningful volumes. Using a model that incorporated legal, structural and other market quality metrics, the authors found that increased HFT activity was the strongest and most robust estimator of a reduction in the rate of end-of-day manipulation. Their model showed that HFT activity corresponded to a reduction in manipulative behavior by about 70%.

Weisberger and Rosa of Two Sigma Securities **(June 2013)** investigated changes in market volatility in U.S. equities markets.[6] They found that market structure changes do not appear to have impacted volatility, as volatility has not changed measurably in recent years. They also note several perceived shortcomings in current equity market structure.

Bollen and Whaley (August 2013) looked at the volatility of 15 major futures contracts using data spanning over 10 years.[7] They conducted two experiments; first they compared implied volatility (the VIX) to realized volatility of the ES contract, and found that realized volatility was smaller than the VIX implied volatility, suggesting that microstructure effects were not significant, and that automated trading was not influencing realized volatility. The second experiment used a variance-ratio like test, which demonstrated that, while microstructure noise is present, it has not increased measurably over the past 10 years.

Jones (March 2013) reviewed several theoretical and empirical studies on HFT and its impact on market quality.[8] Jones found that, "based on the vast majority of the empirical work to date, HFT and automated, competing markets improve market liquidity, reduce trading costs, and make stock prices more efficient. Better liquidity lowers the cost of equity capital for firms, which is an important positive for the real economy." Furthermore, he noted that historically, that when "there has been a market structure change that results in more HFT, liquidity and overall market quality have improved."

The following studies examined market data sets that distinguished between automated trades and other trades:

Hendershott and Riordan (August 2009) reported on the impact of automated trading on the Deutsche Börse's Xetra market, an equity market where automated trading activity could be distinguished.[9] The paper found that automated trading accounted for about half of the total volume in the top 30 volume stocks, and that automated trading was better than non-automated trading at driving prices toward efficiency. The authors also showed that automated trading "contributes more to the discovery of the efficient price than human trading." Furthermore, they found there was "no evidence of [automated trading] behavior that would contribute to volatility beyond making prices more efficient."

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[6] Weisberger, D. and Rosa, P., 2013 "Automated equity trading: The evolution of market structure and its effect on volatility and liquidity", <LINK NEEDED>

[7] Bollen, N., and Whaley, R., 2013 "Futures Market Volatility: What has Changed?", http://www.futuresindustry.org/downloads/Volatility_Study_8-27-2013.pdf

[8] Jones, C., 2013: "What do we know about high frequency trading?", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2236201

[9] Hendershott, T. and Riordan, R., 2009: "Algorithmic Trading and Information", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1472050

Similarly, in the foreign exchange market, **Chaboud, Hjalmarsson, Vega and Chiquoine (October 2009)** used a dataset that separately identified computer generated trades from human generated trades and showed that an increase in automated trading may be associated with less market volatility, and that automated traders tended to increase liquidity provision after exogenous market events such as macroeconomic data announcements.[10]

Debelle, of The Bank for International Settlements (September 2011) released a related study on the impact that growing HFT participation had on the foreign exchange market. [11] The authors based their findings on observations made from several banks and other foreign exchange markets, in addition to using historical data from Reuters and EBS, two of the largest FX trading platforms. They cited a general consensus that HFT benefits the markets under normal conditions, and therefore focused on two significant FX shocks: May 6, 2010 and March 17, 2011. In both cases, they found evidence suggesting that HFT did not withdraw from trading during the shocks, and that they may have been quicker to resume normal trading as the shocks stabilized than traditional market participants.

Brogaard, Hendershott and Riordan (July 2012) investigated the impact of HFT on U.S. equity trading on the NASDAQ and BATS exchanges.[12] Using a data set provided by the exchanges that labeled activity as either 'HFT' or 'everything else', the authors examined the impacted that HFT participants have on the market. Their analysis used a well-known regression framework to isolate various factors in the market and how HFT impacts each of these. Overall they found that HFT trades were positively correlated with permanent price changes and negatively correlated with temporary pricing errors, thereby improving price discovery. By distinguishing trades initiated by HFT, the authors found that marketable high frequency trades actively drove prices towards fair value.

Hirschey (December 2011) used the same HFT-labeled NASDAQ dataset of Brogaard, Hendershott and Riordan (2011) to investigate how HFT used marketable orders.[13] He found that HFT traded with marketable orders in the direction of previous, contemporaneous and future non-HFT orders. This corroborated the Hendershott and Riordan results, showing that HFT traded in the direction of permanent price impact.

O'Hara, Yao and Ye (July 2011) used the same HFT-labeled dataset of Brogaard, Hendershott and Riordan (2011) to investigate the use of odd-lots in trading.[14] They found that odd-lots contributed to 30% of the price discovery process, and that such trading represented a significant fraction of all trades, particularly for higher priced stocks. They showed that HFT was more likely to trade with odd-lots. Finally, they raised the concern

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[10] Chaboud, Alain, Hjalmarsson, Erik, Vega, Clara and Chiquoine, Ben, "Rise of the Machines: Algorithmic Trading in the Foreign Exchange Market" (October 2009). Federal Reserve Board International Finance Discussion Paper No. 980, http://ssrn.com/abstract=1501135 µ

[11] Bank for International Settlements, "High-frequency trading in the foreign exchange market" (September, 2011), http://www.bis.org/publ/mktc05.pdf

[12] Brogaard, J. Hendershott, T., and Riordan, R. "High frequency trading and Price Discovery", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1928510

[13] Hirschey, N. "Do High-Frequency Traders Anticipate Buying and Selling Pressure?", https://www2.bc.edu/~taillard/Seminar_spring_2012_files/Hirschey.pdf

[14] O'Hara, M. Yao, C. and Ye, M. "What's not there: The odd-lot bias in TAQ data", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1892972

that the consolidated pricing feed does not account for odd-lots, and as such may not be as useful as intended.

A similar study done by **Jarnecic and Snape (June 2010)** used data from the London Stock Exchange (LSE).[15] Like the NASDAQ data set, this set labeled all activity by participant type; HFT, investment bank, retail, etc., providing a finer granularity of participation rates and behaviors. The authors used a similar regression framework as Brogaard, Hendershott and Riordan in order to isolate the impact of HFT on various market metrics. They found that HFT participants tended to provide liquidity when spreads were wide, demand liquidity when spreads were narrow, that they were more likely to "smooth out liquidity over time and [were] unlikely to exacerbate stock price volatility".

Gerig (November 2012), developed a model of HFT in which HFT actively traded to synchronize stock prices.[16] The NASDAQ HFT-labeled data set, coupled with Thomson Reuters data was used to validate the model, which showed that price synchronization serves to more rapidly transfer information through the market, resulting in more efficient prices. Gerig speculated that such trading behavior could also propagate mis-pricings through markets.

Su, Aldinger and Labuszewski of the CME Group **(July 2010)** released a report on automated trading activity on the CME futures exchange.[17] They labeled all participants as either "ATS" (automated trading system) or "non-ATS." They compared trade volume and messaging rates for each participant against market measures such as liquidity and volatility. ATS's impact on these measures varies by futures contract, but as a whole, they concluded that ATS-based "volume and message traffic tend to be associated with enhanced liquidity and reduced volatility".

Kirilenko, Kyle, Samadi and Tuzun (May 2011) investigated the role that HFT played in the flash crash on May 6, 2010.[18] With access to all trades and accounts for the CME's S&P 500 e-mini futures contract, they classified participants by activity patterns, including a group of participants that they characterized as "HFT". They found that these participants accounted for a large portion of trading and that they did not change their trading behavior before or during the flash crash. HFT participants were net buyers during the crash and net sellers during the recovery. The authors suggested that HFT during a brief period of the crash may have caused other participants to think there was more liquidity than truly available.

Backes (October 2011), representing the Eurex futures group, performed a similar investigation into the crash of the FDAX futures contract on August 25, 2011, which shared many characteristics of the "flash crash" in the U.S.[19] Analysis of the behavior of HFT

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[15] Jarnecic, E. and Snape, M., "An analysis of trades by high frequency participants on the London Stock Exchange", http://mfs.rutgers.edu/MFC/MFC17/MS/MC10~447_Snape_Jarnecic.pdf

[16] Gerig, "High-Frequency Trading Synchronizes Prices in Financial Markets", http://www.austingerig.com/research/high-frequency-trading

[17] The CME Group, "Algorithmic trading and market dynamics", http://www.cmegroup.com/education/files/Algo_and_HFT_Trading_0610.pdf

[18] Kirilenko et al., "The Flash Crash: The Impact of High Frequency Trading on an Electronic Market", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1686004&rec=1&srcabs=2013789

[19] Backes, "High-frequency trading in volatile markets - an examination", http://www.eurexchange.com/download/documents/publications/factsheet_highfrequency.pdf

during this time found that HFT played an important role in maintaining and providing liquidity during the sharp drop in the FDAX contract. The author stated that HFT acted "in a way that protects the market by placing a rapid succession of small, non-directional buy and sell orders, thus preventing abrupt price movements".

Menkveld (April 2011) studied the development of the Chi-X European stock MTF in 2007 and the simultaneous entry of a large high frequency trading participant on Chi-X.[20] He found that this new participant was largely responsible for the increase in market share of Chi-X and ultimately led to reduced bid-ask spreads for the stocks that it traded.

Lepone (September 2011) summarized the results of research conducted by the Australian organization Capital Markets Cooperative Research Centre (CMCRC).[21] These papers examined the impact of HFT on market quality for markets in Singapore, Australia, the U.S. and the U.K. Their data allowed them to identify trading participants and classify them into HFT and non-HFT groups. Following a methodology similar to Brogaard, Hendershott and Riordan, each of these papers measured the impact of HFT on market quality metrics. The findings showed a consistent pattern of improved market quality coinciding with growing HFT participation. They also demonstrated that HFT was active during all volatility conditions and "become the primary providers of liquidity" in periods of high uncertainty.

Frino, Lepone and Mistry (March 2012) used full book data from the ASX to examine how algorithmic trading had grown between 2006 and 2009.[22] They found that algorithmic trading grew steadily to over 55% of total dollar value traded and that algorithmic traders were net liquidity suppliers. This study also examined the relationship between algorithmic trading rates and market quality and found that relative algorithmic trading increases when spreads are wide, volumes are low, volatility is low, and depths are small.

Frino and Lepone (May 2012) looked at HFT on the LSE and Euronext Paris to study whether HFT participated in manipulative behavior.[23] Using message traffic as a proxy for HFT, and using two different proxy measures for market manipulation, "Dislocation Price Alerts" and "Ticking", the authors found no link between HFT activity and market manipulation. Specifically, the authors found a negative relationship between HFT activity and Dislocation Price Alerts (implying that HFT actively reduces these events) and no statistical relationship between HFT activity and Ticking.

Hagströmer and Nordén (September 2012) examined HFT strategies on NASDAQ OMX Stockholm during a high volatility period (August 2011) and a low volatility period

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[20] Menkveld, A., 2011: "High Frequency Trading and the New-Market Makers", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1722924

[21] Lepone, A., 2011: "The Impact of High Frequency Trading (HFT): International Evidence", http://www.cmcrc.com

[22] Frino, A., Lepone, A. and Mistry M., "The New Breed of Market Participants: Algorithmic Trading on the ASX", working paper

[23] Frino, A., Lepone, A., "The impact of high frequency trading on market integrity: an empirical examination", http://www.bis.gov.uk/assets/foresight/docs/computer-trading/12-1057-dr24-impact-high-frequency-trading-on-market-integrity.pdf

(February 2012).[24] They had access to trader IDs for each message, and were therefore able to classify HFT into different strategies, with a focus on HFT market making and HFT stat-arb and momentum strategies that they labeled as "opportunistic". They found that market making accounted for the majority of quoting and trading activity. Both market making and opportunistic trading by HFT acted to mitigate intraday pricing volatility. Finally, they suggested that financial transactions taxes like those proposed in Europe would disproportionately impact HFT market making, resulting in greater market volatility.

Baron, Brogaard, and Kirilenko (November 2012) investigated the profitability of HFT for the CME S&P 500 E-mini contract.[25] Using full transaction data with trader identifications, the authors identified a set of traders they labeled as HFT, using quantitative criteria such as turnover rate, max position, etc. The authors used this classification to determine the gross trading profits earned by these participants between August 2010 and August 2012. Using a variety of measures of profitability, the authors found that HFT was profitable, including strategies that were primarily aggressive, strategies that were primarily passive, and strategies that were a blend of the two. Using a 1-minute measure of profitability, and assuming a zero-sum trading models, the authors found that HFT earned profits when trading with other trading participants, including fundamental sellers and buyers, other market makers, opportunistic traders and small retail traders. [How much?] They also showed that profitability of HFT has remained relatively stable throughout the entire period studied.

Benos and Sagade of the Bank of England **(December 2012)**, used a unique dataset that identified traders to investigate the impact of HFT on market quality.[26] They randomly chose one week of data within the past two years, and then selected four representative stocks to investigate. They identified HFT firms based on various information sources, including media reports and company web sites. The authors sorted these HFTs by the ratio of marketable orders to resting orders placed, and partitioned the firms in to two equal groups denoted "aggressive" and "passive". Investigating the nature of trades placed by these two groups, the authors found that the "aggressive" group tended to trade in the direction of recent price changes, and that the "passive" group tended to do the opposite. Using a tick-time specification, the authors attempted to determine the degree to which HFT added to price discovery and short-term volatility. They found that HFTs contributed to both information and noise and tended to have a higher information-to-noise ratio than other traders, contributing positively in net to price discovery.

Malinova, Park, Riordan (May 2013) looked at Canadian equity data to determine how HFT activity impacts retail traders.[27] The authors used the introduction of a new fee that primarily applied to HFT as an exogenous event that they could use as a causative link.

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[24] Hagströmer and Nordén, "The diversity of high frequency traders", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2153272

[25] Baron, Brogaard, and Kirilenko "The Trading Profits of High Frequency Traders", http://www.scribd.com/doc/120289479/Baron-Brogaard-Kirilenko

[26] Benos and Sagade, "High-frequency trading behavior and its impact on market quality: evidence from the UK equity market", http://www.bankofengland.co.uk/publications/Documents/workingpapers/wp469.pdf

[27] Malinova K., Park, A., Riordan, R., "Do Retail Traders Suffer from High Frequency Traders?", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2183806

They found that HFT activity was reduced after the change. They also found that "HFTs appear to not impose negative externalities on the least sophisticated market participants and that they may be beneficial to slower and less sophisticated traders."

These event studies investigated the impact of improvements to a market center's trading technology:

Hendershott, Jones and Menkveld (February 2012) examined the impact on the NYSE of their auto-quoting facility introduced in 2003.[28] This study showed that for all stocks, and particularly large-cap stocks, automated trading increased liquidity. It also demonstrated that the increase in automated trading caused a reduction in effective spreads, thereby reducing costs to investors.

Similarly**, Riordan and Storkenmaier (November 2011)** reported on how a 2007 upgrade to the Deutsche Börse's Xetra trading system focused solely on latency reduction, positively affected market quality.[29] After latency reductions in the exchange's trading systems, liquidity increased across market capitalization and trade sizes, and adverse selection and permanent price impact were reduced.

Hendershott and Moulton (February 2010) studied the introduction of the NYSE hybrid system in 2006, which moved the NYSE to a faster and more automated matching system.[30] They found that prices became more efficient due to faster price discovery and reduced noise in prices.

Brogaard, Hendershott, Hunt, Latza, Pedace and Ysusi (January 2013) investigated the impact that HFT may have on the trading costs of institutional investors on the London Stock Exchange.[31] The authors investigated four technology upgrades at the LSE that modestly reduced the latency of their matching engine. They found a statistically significant relationship between latency and HFT activity for some market capitalizations in two of the four upgrades. Performing a two-stage regression to try to find a causal link between the increase in HFT activity and institutional transaction costs, the authors were unable to find a statistically significant relationship.

These papers provided an overview of "high frequency trading" and related market structure issues:

Gomber et al. (March 2011) presented background information on HFT. Their paper analyzed HFT and "certain proposed regulatory measures."[32] They claimed that HFT is a technology rather than a strategy, and is a natural evolution in the market place. They highlighted the beneficial aspects that HFT can provide, and noted that perceived problems

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[28] Hendershott, T., Jones, C.M. and Menkveld, A.J.,: "Does Algorithmic Trading Improve Liquidity?", Journal of Finance, Volume LXVI, No. 1, February 2011

[29] Riordan, R. and Storkenmaier, A., 2011: "Latency, Liquidity and Price Discovery", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1247482

[30] Hendershott, T. and Moulton, P., February 2010: "Automation, Speed, and Stock Market Quality: The NYSE's Hybrid", http://www.hotelschool.cornell.edu/research/facultybios/research-papers/documents/AutomationSpeedHybrid_accepted.pdf

[31] Brogaard, Hendershott, Hunt, Latza, Pedace and Ysusi, "High-Frequency Trading and the Execution Costs of Institutional Investors", http://www.fsa.gov.uk/library/research

[32] Gomber, P., Arndt, B., Lutat, M., and Uhle, T., March 2011: "High-Frequency Trading", http://www.frankfurt-main-finance.com/en/data-facts/study/High-Frequency-Trading.pdf

with HFT are largely a result of U.S. market structure rather than anything inherent in HFT itself. They provided several recommendations for policy makers that would maintain the beneficial aspects of HFT while providing markets with additional safety.

The **Foresight Project (October)** by the U.K. government was a wide-ranging study intended to "explore how computer generated trading in financial markets might evolve in the next ten years or more", with a particular emphasis on stability, integrity, competition, efficiency and costs.[33] It commissioned over 50 papers and involved over 150 academics from 20 countries. It concluded that "the available evidence indicates that high frequency trading (HFT) and algorithmic trading (AT) may have several beneficial effects on markets. However, HFT/AT may cause instabilities in financial markets in specific circumstances. This Project has shown that carefully chosen regulatory measures can help to address concerns in the shorter term. However, further work is needed to inform policies in the longer term, particularly in view of likely uncertainties and lack of data."

Litzenberger, Castura and Gorelick (RGM Advisors; November 2012) published a review of market quality and the impact of automation and high frequency trading.[34] Looking at data from several sources, they showed that market quality has improved by most measures over the past decade, a result of increasing automation, competition and the advent of high frequency trading. They examined several dimensions of market quality and suggested that regulatory initiatives could further improve market quality without damaging the improvements seen to date.

In the first two phases of a planned three-phase study, **Pinnington (December 2012)**, an analyst with the Canadian securities regulator, IIROC, surveyed the trading behavior of traders in Canadian equities markets with high order-to-trade ratios (HOT).[35] The author investigated the nature of such trading, noting that HOT traders accounted for 11% of user IDs, 22% of volume traded, 42% of trades executed and 94% of new and modified orders. HOT traders traded primarily passively using resting orders and earned much of their revenue through rebates. Finally, HOT tended to focus on liquid stocks, particularly ETFs and ETNs, as well as stocks cross-listed in both the United States and Canada. In the final phase of the study, IIROC plans to study the impact of HFT activity on Canadian marketplaces with respect to market quality and market integrity.

Berman (US S.E.C; June 2013) presented a speech in which he outlined challenges in oversight and analysis of market structure issues and crashes in the US.[36] Looking at data drawn from U.S. equities markets, Berman provided examples of how reasoned analysis

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[33] BIS Foresight Project: http://www.bis.gov.uk/foresight/our-work/projects/current-projects/computer-trading

[34] Litzenberger, B., Castura, J., Gorelick, R., "The Impacts of Automation and High Frequency Trading on Market Quality", http://www.annualreviews.org/eprint/YzxTE65MaACB3Xmw2iYf/full/10.1146/annurev-financial-110311-101744

[35] Pinnington, "The HOT Study: Phases I and II of IIROC's Study of High Frequency Trading Activity on Canadian Equity Marketplaces", http://docs.iiroc.ca/DisplayDocument.aspx?DocumentID=C03DBB4490324C6B946E6F2BD6CF4E23&Language=en

[36] Berman, G., "Transformational Technologies, Market Structure, and the SEC" (speech before SIFMA Tech conference, June 18, 2013), http://www.sec.gov/News/Speech/Detail/Speech/1365171575716#.Uid_ObyE4Z5

can shed light on market events and lead toward understanding root causes. In several instances, he found that suspicious looking activity was in fact the result of complex interactions among trading participants and observed that sudden moves were generally not caused by algos-gone-wild, but rather by "old-fashioned human mistakes."

Bell (July 2013) looked at the role that HFT plays in today's markets.[37] She found that HFT is a tool employed to implement modern market making strategies and has resulted in improved market efficiency. However, concerns have been raised about risks to market stability and integrity as a result of these new tools. The author found that these concerns are not HFT-specific, but that HFT participants and market regulators have an opportunity to improve stability through safeguards such as circuit breakers.

[37] Bell, H., 2013. "High Frequency Trading: Do Regulators Need to Control this Tool of Informationally Efficient Markets?", http://www.cato.org/publications/policy-analysis/high-frequency-trading-do-regulators-need-control-tool-informationally