

---

# High Frequency Trading and Predatory Market Making

**Bibliography of Evidence-Based Research**



**December 2013**

---

## Contents

---

Preface	ii
Research overview	1
Evidence-based research	5
Press editorials	20
The Wall Street Journal's "Dark Market" series	22
Op-eds and commentary	23
Books and documentaries	29
Government	31
High frequency trading defined	35

---

## Preface

This is a bibliography of resources on the capital markets, particularly on some of the negative effects of high frequency trading (HFT). It contains a wide variety of evidence-based academic, government, and industry research.

Research noted here also discusses how the most common business model employed by today's high frequency traders - unregulated and predatory market making, often called "scalping" - can be abusive and disruptive. Several of these studies even predate automation.

Along with evidence-based research, separate sections of this bibliography include press editorials, op-eds, other commentary, and a variety of statements from government bodies and government officials from around the world about high frequency trading.

The bibliography begins with a brief overview and discussion of the evidence-based research. A detailed research bibliography containing over 80 studies begins on page five. Please also note a list of various industry, academic, and government definitions of high frequency trading that starts on page 35.

- R. T. Leuchtkafer, December 2013

### High Frequency Trading and Volatility

In a 2010 study of the 2010 Flash Crash, the **U.S. Securities and Exchange Commission** and the **Commodity Futures Trading Commission** found that high frequency traders substantially increased volatility during the event and directly contributed to the crash. **Kirilenko et. al.** (2010) studied the 2010 Flash Crash and found the same, concluding that "High Frequency Traders may compete for liquidity and amplify price volatility." **Menkveld and Yueshen** (2013) confirmed the U.S. government's and Kirilenko's results about the Flash Crash. **Madhavan** (2012) examined almost two decades of U.S. equities data and wrote that "the current high levels of fragmentation help explain why a Flash Crash did not occur before and offers a counterpoint to the view that the Flash Crash stemmed from an unlikely confluence of events." The **Australian Securities and Investments Commission**, the stock market regulator in Australia, found in a 2012 study that during volatile markets high frequency traders reduce their liquidity supply and increase their liquidity demands. After studying a decade's worth of U.S. data, **Hasbrouck** (2013) found that high frequency traders increased a measure of intraday volatility by a factor of four.

The **Bank for International Settlements** looked at foreign exchange markets and concluded in a 2011 study that high frequency traders exacerbate volatility in stressed markets. **Ben-David et. al** (2012) studied 14 years of U.S. equity data and concluded that "HFT can be highly destabilizing as it propagates shocks across markets at very high speed." **Bichetti et. al.** examined 15 years of U.S. equities and futures data and determined that HFT strategies cause assets to "deviate from their fundamentals." **Boehmer et. al.** analyzed nine years of stock market data from 37 countries and in a 2012 paper concluded that algorithmic trading, including high frequency trading, caused higher volatility. **Zhang** (2010) studied 25 years of U.S. stock market data and determined "high-frequency trading is positively correlated with stock price volatility." **Huh** (2013) found that high frequency traders withdraw during volatile markets, which exacerbates volatility. **Kang and Shin** (2012) looked at the Korean futures markets and concluded that "massive use of limit orders including revision and cancellation by high frequency traders may potentially have negative effects on the market."

The **U.K. Government Office for Science** published a large 2012 study of capital markets around the world and concluded that "HFT/AT may cause instabilities in financial markets in specific circumstances." **Golub et. al.** looked at six years of U.S. stock market data to study mini flash crashes and determined that "Given the speed and the magnitude of the crashes, it appears likely that Mini Flash Crashes are caused by HFT activity." **Easley et. al.** (2011) found that high frequency traders can exacerbate price volatility when they dump inventory and withdraw from volatile markets, and that flash crashes will recur because of U.S. market structure. **Chung et. al.** (2012) studied U.S. stock market data from two decades and wrote that higher volatility in asset prices in recent years is due in part to "the increased role of high-frequency traders." **Breckenfelder** (2013) studied Swedish equities and found that intraday volatility increased substantially when high frequency firms came to Sweden. **Bain and Mudassir** (2013) found that though high frequency traders might narrow spreads, they increase intraday volatility, and noted "an approximate doubling of short-term volatility resulting in higher implicit execution costs for investors."

**Benos and Sagade** (2012) found that aggressive high frequency trading increased volatility in U.K. stock markets. **Nanex** (2010-2013) has analyzed U.S. trading data from 2006 onward and found thousands of events where individual stocks experienced unexplained violent price swings. **Weller** (2012) looked at U.S. futures data and wrote that "the introduction of fast, low capital intermediaries [high frequency

traders] can render markets less able to bear large liquidity demand shocks." The **Joint CFTC-SEC Advisory Committee on Emerging Regulatory Issues** (2011), which included two Nobel laureates, examined U.S. market structure and data from the Flash Crash and wrote "In the present environment, where high frequency and algorithmic trading predominate and where exchange competition has essentially eliminated rule-based market maker obligations, liquidity problems are an inherent difficulty that must be addressed. Indeed, even in the absence of extraordinary market events, limit order books can quickly empty and prices can crash simply due to the speed and numbers of orders flowing into the market and due to the ability to instantly cancel orders."

### **High Frequency Trading and Manipulation**

**Eginton et. al.** (2012) found systematic evidence of "quote stuffing," a term coined by the market data and research firm **Nanex** to describe the many events it found where exchange technology infrastructure was slowed by floods of order and order cancel activity. They wrote that "We find that quote stuffing is pervasive with several hundred events occurring each trading day and that quote stuffing impacts over 74% of US listed equities during our sample period," and found that "stocks experience decreased liquidity, higher trading costs, and increased short term volatility." **Tse et. al.** (2012) "present a detailed study of a variety of negative HFT strategies including examples of Quote Stuffing, Layering/Order Book Fade, and Momentum Ignition to demonstrate what bad HFT 'looks like', how often it happens, and how we detect it." **Ye et. al.** (2012) analyzed U.S. stock market data from 2010 and found "that stocks randomly grouped into the same [technology] channel have an abnormal correlation in message flow, which is consistent with the quote stuffing hypothesis."

### **High Frequency Trading and Market Quality**

**Kim and Murphy** (2013) examined more than a decade of U.S. stock market data and found that after controlling for changes in market dynamics in that time period, market spreads were much worse than have been reported. **Kirilenko and Lo** (2013) surveyed the research literature and concluded that "In contrast to a number of public claims, high frequency traders do not as a rule engage in the provision of liquidity like traditional market makers." **Lee** (2013) analyzed Korean futures data and found that "high frequency trading is detrimental to the price discovery process." **Machain and Dufour** (2013) investigated U.K. stock market data and found empirical evidence for "a minimum period of time a limit order should be kept on the order book to avoid speculative practices." **McInish and Upton** (2012) explored U.S. equity data and wrote that "the ability of fast liquidity suppliers to use their speed advantage to the detriment of slow liquidity demanders...unambiguously lowers market quality." **Van Kervel** (2012) studied U.K. data and found "that a specific type of high frequency traders, those who operate like modern day market makers, might in fact cause a strong overestimation of liquidity aggregated across trading venues." After analyzing U.S. stock market data, **Ye et. al.** (2012) concluded that "fleeting orders, or orders with a life less than 50 milliseconds, have trivial contributions to liquidity and no contributions to price efficiency." (Separately, in October 2013 the U.S. Securities and Exchange Commission reported that as much as 25% of all orders on U.S. stock markets have a life of 50 milliseconds or less.)

The **Australian Securities and Investments Commission** (2013) reported that it found "some examples of potentially predatory activity" and that it aggressively intervened with high frequency trading firms to change their trading practices. Its efforts caused a "behavioural change by traders which has had a marked effect on market quality," including a 40% reduction in volatility in one part of the trading day.

**Boehmer et al.** (2012) studied trading data from around the world and discovered that "algorithmic traders can have impact beyond the immediate trading environment and potentially affect the more fundamental functions of capital markets, such as the allocation of capital to firms." **Boni et al.** (2012) found that excluding high frequency traders from a market center resulted in lower volatility, less front running, and higher execution quality for institutional traders. **Boulton et al.** (2012) analyzed U.S. stock market data from 2010 and discovered that "seemingly fleeting events, such as the flash crash, can have dramatic and lingering effects on shareholder wealth and market quality." **Clark-Joseph** (2013) explored U.S. futures data and found that "Aggressive trading is a tremendously important component of HFTs' activity. In aggregate, approximately 48.5% of HFTs' volume is aggressive, and this figure rises to 54.2% among the 12 largest HFTs." **Nasdaq** (2012) looked at its market participants and concluded that because of some participant business practices investors had "a lower likelihood of successfully accessing liquidity on away markets (i.e., the 'fill rate') and an increased likelihood of ultimately receiving an execution at an inferior price."

For a \$12 million penalty, Knight Capital, one of the largest high-frequency market makers in the world, settled charges in October 2013 with the **U.S. Securities and Exchange Commission** that Knight "did not have adequate safeguards in place to limit the risks posed by its access to the markets, and failed as a result to prevent the entry of millions of erroneous orders." For a combined \$375,000 penalty, the U.S. subsidiary of the Dutch firm IMC, one of the largest high-frequency market makers in the world, settled charges in April 2013 with four U.S. stock exchanges including **Nasdaq** (2013) that it failed "to establish and maintain adequate supervisory procedures, including written supervisory procedures, and a reasonable system of follow-up and review, related to the oversight of the Firm's high frequency and algorithmic trading," as one of the settlements detailed. In July 2012, the **Hong Kong Securities and Futures Commission** fined an IMC subsidiary HK\$1.5 million for "regulatory breaches and internal control failings." For a \$450,000 penalty, Getco, one of the largest high-frequency market makers in the world, settled charges in March 2012 with **Nasdaq** that one of its subsidiaries "failed to establish and maintain a reasonable supervisory system, including but not limited to its written supervisory procedures and supervisory and operational risk control systems related to the oversight and operation of high frequency trading and algorithmic trading."

In July 2013 **FINRA** and four U.S. exchanges fined Newedge USA a total of \$9.5 million because the firm "failed to establish, maintain and enforce adequate supervisory systems and procedures, including written supervisory procedures that were reasonably designed to achieve compliance with applicable securities laws and regulations, including FINRA and exchange rules, addressing anti-money laundering and other potentially manipulative and suspicious trading activity by the Firm's DMA [electronic direct market access] and SA [sponsored access] clients, such as spoofing, marking the close, excessive repetitive order entry, and wash sale transactions, numerous instances of which may have occurred on as many as four exchanges." In November 2011 the **CME Group** fined Infinium Capital Management a total of \$850,000 because, in part, the firm allowed "a malfunctioning ATS [automated trading system] to operate in a live trading environment." In August 2013 the **China Securities Regulatory Commission** fined Everbright Securities \$85 million for "serious flaws" in its trading systems and controls that "directly affected the normal order of securities markets and caused violent stock price fluctuation" that jolted investors.

The **U.S. Federal Reserve Bank of Chicago** studied a variety of proprietary trading firms, including high frequency firms, and wrote in 2012 that "some firms do not have stringent processes for the development, testing, and deployment of code used in their trading algorithms" and that "out-of-control algorithms were more common" than it expected.

## High Frequency Trading and Investor Costs

The **Industry Super Network** is an association of Australian mutual funds. In a 2013 study, it estimated that high frequency traders cost long-term Australian investors an average A\$1.6 billion a year. **Norges Bank Investment Management** (2013), one of the largest funds in the world with \$800 billion under management, surveyed the research literature and concluded that "issues of concern to large, long-term investors more deserving of attention include — Anticipation of large orders by some HFTs leading to potential adverse market impact — Transient liquidity due to high propensity for HFTs to rapidly cancel quotes real-time — Un-level playing field amongst market makers from low latency ultra HFT strategies." **Pragma Securities** (2012) examined U.S. stock trading in 2011 and 2012 and concluded that "high frequency traders' ('HFTs') profits come at the expense of investors." **Baron et. al.** (2012) studied U.S. futures data and stated that "HFTs are profitable, especially Aggressive (liquidity-taking) HFTs" and "generate their profits from all other market participants, and do so mainly in the short and medium run (seconds to minutes)."

**Nanex** (2013) detailed episodes where high frequency traders had market-moving information worth millions ahead of other investors despite widespread beliefs they did not. **McInish and Upton** (2012) looked at U.S. stock market data and "show empirically that latency differences allow fast liquidity suppliers to pick off slow liquidity demanders at prices inferior to the NBBO." **Hirschey** (2013) examined U.S. stock market data and wrote that his analysis provides "evidence supporting the existence of an anticipatory trading channel through which HFTs may increase non-HFT trading costs." **Gao and Mizrach** (2013) found that high frequency traders are more profitable when they trade against long-term investors than when they trade with other high frequency firms. The **Quantitative Services Group** (2010) examined U.S. equity data and reported that "Changes in the microstructure of equity markets and the emergence of HFT competitors have changed the nature and magnitude of transaction costs. Sophisticated pattern recognition algorithms now present a real return burden to active equity managers."

**Tong** (2013) studied U.S. stock data and found "strong evidence that HFT increases the trading costs of institutional investors." **Brogaard et. al.** studied U.K. equities data from 2007 to 2011 and found that while institutional trading costs had declined in the period, high frequency trading had nothing to do with it. **Budish et. al.** (2013) looked at U.S. futures and equities data from 2005 to 2011 and "show that the [HFT speed] arms race is socially wasteful – a prisoner's dilemma built directly into the market design – and that its cost is ultimately borne by fundamental investors via wider spreads and thinner markets." **Ding et. al.** (2013) compared the relative speeds of national utility data feeds (typically used by long-term investors) and exchange proprietary data feeds (typically used by high frequency traders) and found a substantial advantage for the proprietary data feeds, "While price dislocations have small effects on infrequently trading investors, investors that are continuously in the market [such as mutual funds] can be substantially disadvantaged."

## Evidence-based research

Author(s), Title, Year	Evidence	Relevant findings
Anand, Tanggaard, Weaver, " <a href="#">Paying for Market Quality</a> " (2009)	Swedish equities, 2002-2004	Designated market makers with affirmative obligations improve market quality, increase market valuation.
Australia Industry Super Network, " <a href="#">Some Costs of High Frequency Trading in Low Latency Markets</a> " (2013)	Australian equities, 2012	"ISN estimates that HFT activities cost non-HFT market participants, including Australian long-term investors such as super funds [mutual funds], up to \$1.9 billion per year, with a best estimate of over \$1.6 billion per year."
Australian Securities and Investments Commission, " <a href="#">Report 331: Dark liquidity and high-frequency trading</a> " (2013)	Australian equities, 2012	"High-frequency traders reduce their passive liquidity provision (price-making) during relatively volatile periods, but remain active as liquidity takers."; "Our analysis of high-frequency liquidity has detected some examples of potentially predatory activity...The traders, in these instances, have, in some cases responded positively to our intervention by modifying their algorithms, ceasing all trading in the market and in other cases they have been referred to Enforcement for investigation. In any case, we have seen behavioural change by traders which has had a marked effect on market quality."
Bain, Mudassar, " <a href="#">Evolution of Canadian Equity Markets</a> " (2013)	Canadian equities, 1996-2013	"Our study shows that the apparent benefits of higher volume and narrower spreads have come at the expense of increased relative intraday trading volatility. We believe this volatility constitutes a substantial hidden cost for natural investors and raises serious questions about the true costs and benefits of narrowed spreads."
Bank for International Settlements, " <a href="#">High frequency trading in the foreign exchange market</a> " (2011)	Foreign exchange, 2010 and 2011	"HFT has had a marked impact on the functioning of the FX market in ways that could be seen as beneficial in normal times, but also in ways that may be harmful to market functioning, particularly in times of market stress."
Baron, Brogaard, Kirilenko, " <a href="#">The Trading Profits of High Frequency Traders</a> " (2012)	U.S. futures, 2010-2012	"First, HFTs are profitable, especially Aggressive (liquidity-taking) HFTs, and generate high Sharpe ratios. Second, HFTs generate their profits from all other market participants, and do so mainly in the short and medium run (seconds to minutes). Third, firm concentration in the HFT industry is not decreasing over time, nor is its profitability. We conjecture this is tied to our fourth finding that HFTs profits are persistent, new entrants have a higher propensity to underperform and exit, and the fastest firms (in absolute and in



relative terms) make up the upper tail of performance.”; “While all work done to date considers HFT to be a single type of trading activity, we show the wide heterogeneity of trading strategies, profits, and speed within the E-mini market.”

Ben-David, Franzoni, Moussawi, <a href="#">"ETFs, Arbitrage, and Shock Propagation"</a> (2012)	U.S. equities 1998-2011	"[O]ur results also provide support for the claim that high-frequency trading has the potential to rapidly propagate liquidity shocks across markets."; "As much of ETF arbitrage is carried out at high frequencies, the evidence in the paper seems to suggest that HFT adds to the non-fundamental volatility of asset prices, at the very least. In more extreme situations, such as the Flash Crash, HFT can be highly destabilizing as it propagates shocks across markets at very high speed."
Benos, Sagade, <a href="#">"High-frequency trading behaviour and its impact on market quality: evidence from the UK equity market"</a> (2012)	U.K. equities, 2011 or 2012	"It thus appears that the more HFTs trade aggressively the more they contribute to both price discovery and excess volatility."
Bichetti, Maystre, <a href="#">"The synchronized and long-lasting structural change on commodity markets: evidence from high frequency data"</a> (2012)	U.S. futures and equities, 1997-2011	"This paper documented striking similarities in the evolution of the rolling correlations between the returns on several commodity futures and the ones on the US stock market, computed at high frequencies...we think that HFT strategies, in particular the trend-following ones, are playing a key role...commodity markets are more and more prone to events in global financial markets and likely to deviate from their fundamentals."
Boehmer, Fong, Wu, <a href="#">"International Evidence on Algorithmic Trading"</a> (2012)	Equities in 37 countries (excluding U.S.), 2001-2009	"Overall, our results show that algorithmic trading often improves liquidity, but this effect is smaller when market making is difficult and for low-priced or high-volatility stocks. It reverses for small cap stocks, where AT is associated with a decrease in liquidity. AT usually improves efficiency. The main costs associated with AT appear to be elevated levels of volatility. This effect prevails even for large market cap, high price, or low volatility stocks, but it is more pronounced in smaller, low price, or high volatility stocks."
Boehmer, Fong, Wu, <a href="#">"Algorithmic Trading and Changes in Firms' Equity Capital"</a> (2012)	Equities in 37 countries (excluding U.S.), 2001-2009	"Our findings suggest that the activity of algorithmic traders can have impact beyond the immediate trading environment and potentially affect the more fundamental functions of capital markets, such as the allocation of capital to firms."; "We find that greater AT intensity is, on average, associated with declines in equity capital in the next year. This result is only partly driven by a decline in

new securities issues; rather, greater AT intensity is associated with an increase in repurchase activity. These results control for market capitalization, book-to-market, volatility, liquidity, and information asymmetry at the firm level, and for secular trends at the market level..."

Boni, Brown, Leach, <a href="#">"Dark Pool Exclusivity Matters"</a> (2012)	U.S. equities, 2011	Excluding HFT from a market center results in lower volatility, less front-running, and higher execution quality for institutional traders.
Boulton, Braga-Alves, Kulchania, <a href="#">"The Flash Crash: Effects on Shareholder Wealth and Market Quality"</a> (2012)	U.S. equities, 2010	"We show that the flash crash was not just a 20 minute glitch as it has been described in [the] popular press. Overall, the flash crash is a significant event that affected shareholder wealth, trading costs, and volatility of stocks."; "Our results suggest that seemingly fleeting events, such as the flash crash, can have dramatic and lingering effects on shareholder wealth and market quality."
Breckenfelder, <a href="#">"Competition between High-Frequency Market Makers, and Market Quality"</a> (2013)	Swedish equities, 2009	Examines the introduction of HFT to the Swedish market; finds evidence of HFT herding, where HFT firms take the same side of the market and increase volatility; slower traders exit the market, decreasing participant diversity; "Our findings suggest unequivocally mixed results regarding market quality. First, intraday volatility increases severely by an average of over 25%, five-minute volatility 15% and maximum intraday volatility 15%."
Brogaard, Hendershott, Hunt, Latza, Pedace, Ysusi, <a href="#">"High-frequency trading and the execution costs of institutional investors"</a> (2012)	U.K. equities, 2007-2011	HFT firms maintain they lower costs for traditional investors. This study notes that while investor costs have gone down in recent years, HFT firms don't account for those lower costs.  "We show that in the UK, like in the US, there has broadly been a decrease in institutional execution costs over the last decade...[but] we fail to observe a relationship between HFT and institutional execution costs."
Budish, Cramton, Shim, <a href="#">"The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response"</a> (2013)	U.S. futures and equities, 2005-2011	"[W]e show that the [HFT speed] arms race is socially wasteful – a prisoner's dilemma built directly into the market design – and that its cost is ultimately borne by fundamental investors via wider spreads and thinner markets."  See also <a href="#">"The Big Question: Are high frequency traders ruining the market?"</a>
CFA Institute, <a href="#">"Dark Pools, Internalization, and Equity Market Quality"</a> (2012)	U.S. equities, 2009-2011	"The results from this study suggest that if a majority of trading in a given stock takes place in undisplayed venues, spreads will likely

increase and market quality will deteriorate. If the majority of order flow is filled away from pre-trade transparent markets, investors could withdraw quotes because of the reduced likelihood of those orders being filled. As investors become disincentivized from displaying orders, bid-offer spreads are likely to widen. Therefore, competition should be maintained to encourage aggressive quoting in displayed order books and a predominance of dark trading should be avoided."

Chae, Wang, " <a href="#">Determinants of Trading Profits: The Liquidity Provision Decision</a> " (2009)	Taiwanese equities, 1997-2002	Absent mandatory obligations, market maker privileges don't induce market makers to provide liquidity; privileged but unconstrained market makers make profits when demanding liquidity in their own informed trades; unconstrained market makers are informed traders rather than liquidity providers in most scenarios.
Chakrabarty, Jain, Shkilko, Sokolov, " <a href="#">Quote intensity and market quality: Effects of the SEC naked access ban</a> " (2013)	U.S. equities, 2011-2012	"We find that indeed the naked access ban led to an increase in the trade-to-quote ratio, which in turn led to an improvement in market quality. This result is important in light of the ongoing debate on the effect of intensive quote and order submissions on modern markets. This study is, to the best of our knowledge, the first to examine the effects of a regulatory speed bump in the U.S. equity markets. As such our results bring new evidence to the ongoing debate on restrictions to high-speed trading."
China Securities Regulatory Commission, " <a href="#">Investigation and Penalties Regarding the Abnormal Trading of Everbright Securities</a> " (2013)	Trading firm Chinese equities data and trading firm procedures, 2013.	"At 11:05 August 16, 2013, due to error of its ETF strategy transactions system, Everbright Securities mistakenly placed a massive RMB 23.4 billion worth of purchase orders for 180 ETF, of which RMB 7.27 billion were concluded, causing CSI300 Index, Shanghai Composite Index and other major indices and many heavyweight stocks to experience short-lived yet violent fluctuations."
Chung, Chuwonganant, " <a href="#">Uncertainty, Fear, and Liquidity</a> " (2012)	U.S. equities, 1997, 2001, 2007-2009	"Based on this result, we conjecture that higher volatility in asset prices and larger fluctuations in liquidity in recent years may be due, at least in part, to the reduced role of [traditional, regulated] market makers and the increased role of high-frequency traders who do not have the affirmative obligation of the traditional market makers. These findings should prove useful to market regulators who are interested in devising a more robust market structure."
Clark-Joseph, " <a href="#">Exploratory Trading</a> " (2013)	U.S. futures, 2010	"The exploratory trading model also illuminates the manner in which these HFTs benefit from low latency capabilities and from their submission of large numbers of aggressive orders. Exploratory trading is a form of costly information acquisition, albeit an unfamiliar

one. HFTs who engage in exploratory trading are doing something more than merely reacting to public information sooner other market participants."

Note that access to this paper has been restricted. See ["The Influence of the For Profit Exchanges"](#).

CME Group, <a href="#">"Member Update, December 2011 Volume 12"</a> (2011).	Trading firm U.S. futures data and trading firm procedures, 2009-2010	"The Panel concluded that by failing to diligently supervise its systems, employees or agents in the conduct of their business relating to the Exchange, Infinium violated CME Rule 432.W. The Panel further concluded that in allowing a malfunctioning ATS to operate in a live trading environment, Infinium committed an act detrimental to the welfare of the Exchange, in violation of CME Rule 432.Q."
Dichev, Huang, Zhou, <a href="#">"The Dark Side of Trading"</a> (2011)	U.S. equities, 1926-2009	"Our main finding is that, controlling for other factors, there is a reliable and economically substantial positive relation between volume of trading and stock volatility. The conclusion is that stock trading produces its own volatility above and beyond that based on fundamentals..."; "The combined impression from these results is that stock trading injects an economically substantial layer of volatility above and beyond that based on fundamentals, especially at high levels of trading."
Ding, Hanna, Hendershott, <a href="#">"How Slow is the NBBO? A Comparison with Direct Exchange Feeds"</a> (2013)	U.S. equities, 2012	"While price dislocations have small effects on infrequently trading investors, investors that are continuously in the market can be substantially disadvantaged."
Easley, Lopez del Prado, O'Hara, <a href="#">"The Microstructure of the Flash Crash"</a> (2011)	U.S. futures, 2010	Unregulated or unconstrained HFT market makers can exacerbate price volatility when they dump inventory and withdraw, flash crashes will recur because of structural issues.
Egginton, Van Ness, Van Ness, <a href="#">"Quote Stuffing"</a> (2012)	U.S. equities, 2010	"We find that quote stuffing is pervasive with several hundred events occurring each trading day and that quote stuffing impacts over 74% of US listed equities during our sample period. Our results show that, in periods of intense quoting activity, stocks experience decreased liquidity, higher trading costs, and increased short-term volatility. Our results suggest that the HFT strategy of quote stuffing may exhibit some features that are criticized in the media."
Egginton, Van Ness, Van Ness, <a href="#">"Dealers and Changing Obligations: The Case of Stub Quoting"</a> (2012)	U.S. equities, 2007 and 2010	"Taken together, our results suggest that restrictions on stub quoting, which increase dealers' obligations to quote near the NBBO, may benefit financial markets in that it encourages dealers to provide liquidity."
Ferguson, Mann,	U.S. futures, 1992	Unregulated or unconstrained market makers

["Execution Costs and Their Intraday Variation in Futures Markets"](#) (2001)

in the futures market have much more rapid inventory cycles than (regulated) equity market makers, are active rather than passive traders, and "actively trade for their own accounts, profiting from their privileged access..."

---

FINRA, ["Financial Industry Regulatory Authority Letter of Acceptance, Waiver and Consent No.20090186944"](#) (2013)

Trading firm U.S. data and trading firm procedures, 2008-2011

"During the period of January 2008 through December 2011 (the 'relevant period'), the Firm failed to establish, maintain and enforce adequate supervisory systems and procedures, including written supervisory procedures that were reasonably designed to achieve compliance with applicable securities laws and regulations, including FINRA and exchange rules, addressing anti-money laundering and other potentially manipulative and suspicious trading activity by the Firm's DMA and SA clients, such as spoofing, marking the close, excessive repetitive order entry, and wash sale transactions, numerous instances of which may have occurred on as many as four exchanges."

---

Frino, Forrest, Duffy, ["Life in the pits: competitive market making and inventory control-further Australian evidence"](#) (1999)

Australian futures, 1997

Unregulated or unconstrained market makers are not passive liquidity providers, they behave aggressively like informed traders.

---

Frino, Jarneic, ["An empirical analysis of the supply of liquidity by locals in futures markets: Evidence from the Sydney Futures Exchange"](#) (2000)

Australian futures, 1997

Unregulated or unconstrained market makers demand liquidity to profit from information advantages of privileged access, less likely to supply liquidity in volatile markets, almost as likely to demand as to supply liquidity.

---

Frino, Jarneic, Feletto, ["Local Trader Profitability in Futures Markets: Liquidity and Position Taking Profits"](#) (2009)

Australian futures, 1997

Unregulated or unconstrained market makers are active and informed traders.

---

Gao, Mizrach, ["High Frequency Trading in the Equity Markets During U.S. Treasury POMO"](#) (2013)

U.S. equities, 2008-2009

"While HFT firms are generally deemed to be passive liquidity providers, we find that they act as trade initiators in nearly 47% of trades in normal times. High frequency traders appear to have superior information. Whether they are at the active or passive side, the trades are more profitable when the counterpart is a non-HFT firm rather than a HFT firm. The 'Flash Crash' helps to clarify why reporting the average effect of HFT firms on the market may provide a misleading portrait of their contribution to market quality. Analyzing their impact when the market is under stress or reacting to news needs to be isolated from their contribution during less turbulent periods."

Golub, Keane, " <a href="#">Mini Flash Crashes</a> " (2011)	U.S. equities, 2006-2010	"As soon as the [HFT] market maker's risk management limits are breached...the market maker has to stop providing liquidity and start to aggressively take liquidity, by selling back the shares bought moments earlier. This way they push the price further down and thus exaggerate the downward movement."
Golub, Keane, Poon, " <a href="#">High Frequency Trading and Mini Flash Crashes</a> " (2012)	U.S. equities, 2006-2011	"We find strong evidence that Mini Flash Crashes have an adverse impact on market liquidity and are associated with Fleeting Liquidity."; "Given the speed and the magnitude of the crashes, it appears likely that Mini Flash Crashes are caused by HFT activity."
Hasbrouck, " <a href="#">High frequency quoting: Short-term volatility in bids and offers</a> " (2013)	U.S. equities, 2001-2011	"High-frequency changes, reversals, and oscillations induce volatility in a market's bid and offer quotes. This volatility degrades the informational content of the quotes, exacerbates execution price risk for marketable orders, and impairs the reliability of the quotes as reference marks for the pricing of dark trades. This paper examines variance on time scales as short as fifty milliseconds for the National Best Bid and Offer (NBBO) in the US equity market. On average, in a 2011 sample, NBBO variance at the fifty millisecond time scale is approximately four times larger than can be attributed to long-term fundamental price variance."
Government Office for Science, " <a href="#">Foresight: The Future of Computer Trading in Financial Markets. Final Project Report. Executive Summary</a> " (2012)	Varied data; literature reviews	"A key message: despite commonly held negative perceptions, 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."
Hautsch, Huang, " <a href="#">On the Dark Side of the Market: Identifying and Analyzing Hidden Order Placements</a> " (2012)	U.S. equities, 2010	"A frequent criticism of the proprietary data feeds exchanges sell to HFT firms is that the feeds reveal information investors reasonably believe is confidential; "Using data from the NASDAQ TotalView message stream allows us to retrieve information on hidden depth from one of the largest equity markets in the world."
Hirschey, " <a href="#">Do High-Frequency Traders Anticipate Buying and Selling Pressure?</a> " (2013)	U.S. equities, 2009	"I find evidence consistent with HFTs being able to anticipate order flow from other investors."; "These findings provide evidence supporting the existence of an anticipatory trading channel through which HFTs may increase non-HFT trading costs."
Hong Kong Securities and Futures Commission, " <a href="#">SFC</a> "	Trading firm Hong Kong data and trading firm controls, 2007-2010	"IMC's failures spanned a period of over three years during a time of substantial market

[reprimands and fines IMC Asia Pacific Limited \[HK\]\\$1.5 Million](#)" (2012)

volatility when short selling controls were high on the regulatory agenda. IMC's negligent controls were well below the standards expected in Hong Kong. Market participants should be aware that short selling is tightly regulated in Hong Kong and any breaches of the rules will be strictly enforced,' the SFC's Executive Director of Enforcement, Mr Mark Steward said."

---

Huh, ["Machines vs. Machines: High Frequency Trading and Hard Information"](#) (2013)

U.S. equities, 2008

"A major concern about HFTs replacing traditional market makers is that since HFTs do not have market making obligations, they might leave the market when market makers are needed the most. Although my sample period does not cover certain extreme events such as the 2010 Flash Crash (the market turmoil in 2008 is arguably quite extreme as well, albeit in a different way), I do document that the market-making HFTs provide less liquidity replenishment when markets are volatile."

---

Johnson, Zhao, Hunsader, Meng, Ravindar, Carran, Tivnan, ["Financial black swans driven by ultrafast machine ecology"](#) (2012)

U.S. equities, 2006-2011

The authors study "18,520 ultrafast black swan events that we have uncovered in stock-price movements between 2006 and 2011" and find "an abrupt system-wide transition from a mixed human-machine phase to a new all-machine phase characterized by frequent black swan events with ultrafast durations."

---

Joint CFTC-SEC Advisory Committee on Emerging Regulatory Issues, ["Recommendations Regarding Regulatory Responses to the Market Events of May 6, 2010"](#) (2011)

U.S. futures and equities, 2010

"In the present environment, where high frequency and algorithmic trading predominate and where exchange competition has essentially eliminated rule-based market maker obligations, liquidity problems are an inherent difficulty that must be addressed. Indeed, even in the absence of extraordinary market events, limit order books can quickly empty and prices can crash simply due to the speed and numbers of orders flowing into the market and due to the ability to instantly cancel orders."

---

Kang, Shin, ["The Role of High Frequency Traders in Electronic Limit Order Markets"](#) (2012)

Korea futures, 2007

"We find that when high frequency traders make use of fleeting orders actively, the level of informativeness in the limit order book declines. This evidence suggests, albeit indirectly, that massive use of limit orders including revision and cancellation by high frequency traders may potentially have negative effects on the market."

---

Kim, Murphy, ["The Impact of High-Frequency Trading on Stock Market Liquidity Measures"](#) (2013)

U.S. equities, 1997-2009

Traditional market microstructure models have significantly underestimated market spreads in recent years. This is because of how trade sizes have decreased with the recent dominance of high frequency trading. When the authors correct for this they find that spreads have not decreased as much as HFT

proponents believe.

"[I]ncreased high-frequency trading may not necessarily be associated with improved liquidity."

---

Kirilenko, Lo, " <a href="#">Moore's Law vs. Murphy's Law: Algorithmic Trading and Its Discontents</a> " (2013)	Literature review	"In contrast to a number of public claims, high frequency traders do not as a rule engage in the provision of liquidity like traditional market makers. In fact, those that do not provide liquidity are the most profitable and their profits increase with the degree of 'aggressive,' liquidity-taking activity."
Kirilenko, Samadi, Kyle, Tuzun, " <a href="#">The Flash Crash: The Impact of High Frequency Trading on an Electronic Market</a> " (2010)	U.S. futures, 2010	Unregulated or unconstrained HFT market makers exacerbated price volatility in the Flash Crash, hot potato trading, two minute market maker inventory half-life; "[H]igh Frequency Traders exhibit trading patterns inconsistent with the traditional definition of market making. Specifically, High Frequency Traders aggressively trade in the direction of price changes...when rebalancing their positions, High Frequency Traders may compete for liquidity and amplify price volatility."
Kurov, Lasser, " <a href="#">Price Dynamics in the Regular and E-Mini Futures Markets</a> " (2004)	U.S. futures, 2001	Unregulated or unconstrained market makers demand liquidity to profit from information advantages of privileged access.
Lee, " <a href="#">High Frequency Trading in the Korean Index Futures Market</a> " (2013)	Korean futures, 2009-2010	"We find that high frequency traders (HFTs) do not provide liquidity in the futures market, nor does HFT have any role in enhancing market quality. Indeed, HFT is detrimental to the price discovery process."
Linton, O'Hara, " <a href="#">The impact of computer trading on liquidity, price efficiency/discovery and transaction costs</a> " (2011)	Literature review and survey	"The nature of market making has changed, shifting from designated providers to opportunistic traders. High frequency traders now provide the bulk of liquidity, but their use of limited capital combined with ultra-fast speed creates the potential for periodic illiquidity"; in "regular market conditions," liquidity has improved and transaction costs are lower.
Locke, Sarajoti, " <a href="#">Interdealer Trading in Futures Markets</a> " (2004)	U.S. futures, 1995	Unregulated or unconstrained market makers demand liquidity to manage inventories.
Lyons, " <a href="#">A Simultaneous Trade Model of the Foreign Exchange Hot Potato</a> " (1997)	Model derived from empirical studies of 1992 U.S. foreign exchange market.	Demonstrates hot potato trading among unregulated or unconstrained market makers. "Hot potato trading" means cascading inventory imbalances from market maker to market maker in response to a large order. Hot potato trading explains most of the volume in foreign exchange markets. Hot potato trading is not innocuous - it makes prices less informative.



See also Kirilenko, Samadi, Kyle, Tuzun, "[The Flash Crash: The Impact of High Frequency Trading on an Electronic Market](#)".

---

Lyons, " <a href="#">Foreign exchange volume: Sound and fury signifying nothing?</a> " (1996)	U.S. foreign exchange, 1992	Unregulated or unconstrained market makers cascade inventory imbalances from one to another, as "...trading begets trading. The trading begotten is relatively uninformative, arising from repeated passage of inventory imbalances among dealers...this could not arise under a specialist [regulated market maker] microstructure."
		See also Kirilenko, Samadi, Kyle, Tuzun, " <a href="#">The Flash Crash: The Impact of High Frequency Trading on an Electronic Market</a> ".
Machain, Dufour, " <a href="#">The Price Impact of Limit Order Cancellations</a> " (2013)	U.K. equities	"[P]olicy makers have recently suggested the introduction of a minimum period of time a limit order should be kept on the order book to avoid speculative practices. In this paper, we provide empirical evidence supporting that."
Manaster, Mann, " <a href="#">Life in the pits: competitive market making and inventory control</a> " (1996)	U.S. futures, 1992	Unregulated or unconstrained market makers aggressively manage inventory, are "active profit-seeking," have much shorter inventory cycles than then-regulated equities market makers.
Manaster, Mann, " <a href="#">Sources of Market Making Profits: Man Does Not Live by Spread Alone</a> " (1999)	U.S. futures, 1992	Unregulated or unconstrained market makers demand liquidity to profit from information advantages of privileged access, are "predominant" informed traders.
Madhavan, " <a href="#">Exchange-Traded Funds, Market Structure and the Flash Crash</a> " (2011)	U.S. equities, 1994-2011	"We show that the impact of the Flash Crash across stocks is systematically related to prior market fragmentation."; "Using intraday trade data from January 1994-September 2011, we find that fragmentation now is at the highest level recorded."; "The link to higher frequency quotation activity and the current high levels of fragmentation help explain why a Flash Crash did not occur before and offers a counterpoint to the view that the Flash Crash stemmed from an unlikely confluence of events."
McInish, Upson " <a href="#">Strategic Liquidity Supply in a Market with Fast and Slow Traders</a> " (2012)	U.S. equities, 2008	"We model and show empirically that latency differences allow fast liquidity suppliers to pick off slow liquidity demanders at prices inferior to the NBBO. This trading strategy is highly profitable for the fast traders."; "[O]ur research focuses on the ability of fast liquidity suppliers to use their speed advantage to the detriment of slow liquidity demanders, which we believe unambiguously lowers market quality. The ability of fast traders to take advantage of slow traders is exacerbated in the U.S. by the regulatory and market environment that we describe below."

---

Menkveld, Yueshen, <a href="#">"Anatomy of the Flash Crash"</a> (2013)	U.S. futures and equities, 2010	An independent study confirming Kirilenko's findings that high-frequency traders exacerbated volatility and caused significant price declines in the Flash Crash; "There is a widespread concern that Flash Crash type events are the result of vulnerable electronic markets....One reading of the new results is that the crash cannot be attributed to a single agent but really is the product of agent interaction."
Nanex, <a href="#">"Ongoing Research - Market Events and Phenomena"</a> and <a href="#">"Research Pages"</a> (2010-2013)	U.S. options, futures, and equities, 2006-2013	Nanex has prepared some of the most compelling - and disturbing - evidence-driven analyses of U.S. capital market events and dislocations publicly available.  See also the following CNBC reports <a href="#">"News organizations respond to Fed lockup questions,"</a> <a href="#">"Unraveling Monday's Early Data Release to Traders,"</a> and <a href="#">"Thomson Reuters Gives Elite Traders Early Advantage."</a>
Nasdaq, <a href="#">"Notice of Acceptance of Letter of Acceptance, Waiver and Consent No. 20100214899-02"</a> (2013)	Trading firm U.S. data and trading firm procedures, 2009-2011.	"During the review period, IMCC failed to establish and maintain adequate supervisory procedures, and a reasonable system of follow-up and review, related to the oversight of the firm's high frequency and algorithmic trading, including procedures related to the review of wash sales, levels of message traffic and quotes, potentially erroneous trading activity, or the filing of Clearly Erroneous Execution ('CEE') petitions."
Nasdaq, <a href="#">"Notice of Acceptance of Letter of Acceptance, Waiver and Consent No. 20100242271-01"</a> (2012)	Trading firm U.S. data and trading firm procedures, 2010-2011.	"During the review period, the firm failed to establish and maintain a reasonable supervisory system, including but not limited to its written supervisory procedures and supervisory and operational risk controls systems related to the oversight and operation of high frequency trading and algorithmic trading."
Nasdaq, <a href="#">"Self-Regulatory Organizations: The NASDAQ Stock Market LLC; Notice of Filing of Proposed Rules Change to Amend Rule 4758(a)(1)(A) to Reflect a Change in Nasdaq's Routing Functionality"</a> (2012)	U.S. equities	A remarkable statement by an exchange that quotes posted on US exchanges are often fleeting and inaccessible, resulting in inferior prices for investors; "NASDAQ has observed that upon partial execution of a routable order at NASDAQ...market participants often react to the order by cancelling their orders on other markets and entering new orders at inferior prices. This occurs because the current process directs the order to NASDAQ before attempting to access available liquidity at other markets and thereby allows market participants to react to the execution (an effect known as 'market impact' or 'information leakage'). As a consequence, the available shares at the away market are no longer available, resulting in a lower likelihood of

successfully accessing liquidity on away markets (i.e., the 'fill rate') and an increased likelihood of ultimately receiving an execution at an inferior price."

See also Van Kervel, "[Liquidity: What You See is What You Get?](#)"

Norges Bank Investment Management, " <a href="#">High Frequency Trading - An Asset Manager's Perspective</a> " (2013)	Literature review	With \$750 billion under management, NBIM is the world's largest sovereign wealth fund. "In our view, issues of concern to large, long-term investors more deserving of attention include – – Anticipation of large orders by some HFTs leading to potential adverse market impact — – Transient liquidity due to high propensity for HFTs to rapidly cancel quotes real-time — – Un-level playing field amongst market makers from low latency ultra HFT strategies."
Panayides, " <a href="#">Affirmative obligations and market making with inventory</a> " (2007)	U.S. equities, 1991 and 2001	Mandatory market maker obligations reduce volatility.
Pragma Securities, " <a href="#">HFT and the Hidden Cost of Deep Liquidity</a> " (2012)	US equities, 2011 and 2012	"In this essay we present evidence that high-frequency traders' ('HFTs') profits come at the expense of investors. In competing to earn spreads and exchange rebates by posting passive orders, HFTs crowd out directional traders' passive orders, force them to cross the spread more often, and result in higher trading costs for investors."
Quantitative Services Group, " <a href="#">Liquidity Change and Price Reversals: Is High Frequency Trading Adding Insult to Injury?</a> " (2010)	U.S. equities, 2008-2009	"Changes in the microstructure of equity markets and the emergence of HFT competitors have changed the nature and magnitude of transaction costs. Sophisticated pattern recognition algorithms now present a real return burden to active equity managers."; "Order anticipation strategies have long been a feature of equity markets. What have changed are the technology-fueled enhancements for improved pattern recognition, speed of execution and breadth of coverage... The complexity of these interrelationships and their close proximity to legitimate market making activities will be a challenge for regulators to grapple with."
Schroder Investment Management Limited, " <a href="#">High frequency trading: Credible research tells the story</a> " (2011)	Literature review	"As standards in research continue to improve, simple default commentary such as HFT are 'liquidity providers,' HFT 'dampens volatility' and HFT 'decreases bid-ask spreads' have suffered something of a credibility anorexia despite their continued use by some."
Silber, " <a href="#">Marketmaker Behavior in an Auction Market: An Analysis of</a> "	U.S. futures, 1982-1983	Unregulated or unconstrained market makers profit from the information advantages of privileged access, two minute inventory cycles.

[Scalpers in Futures Markets](#)", (1984)

Smidt, " <a href="#">Trading Floor Practices on Futures and Securities Exchanges: Economics, Regulation, and Policy Issues</a> " (1985)	Literature review and survey	On futures exchanges, inventory imbalances among unregulated or unconstrained market makers create "potentially unstable" markets and price overreactions during "scalper inventory liquidation."
Tong, " <a href="#">A Blessing or a Curse? The Impact of High Frequency Trading on Institutional Investors</a> " (2013)	U.S. equities, 2008-2009	"I find strong evidence that HFT increases the trading costs of institutional investors."
Tse, Lin, Vincent, " <a href="#">High Frequency Trading - Measurement, Detection and Response</a> " (2012)	European equities, 2010-2012	"We present a detailed study of a variety of negative HFT strategies - including examples of Quote Stuffing, Layering/Order Book Fade, and Momentum Ignition - to demonstrate what bad HFT 'looks like', how often it happens, and how we detect it."  <a href="#">See also "From High Frequency Trading To A Broken Market: A Primer In Two Parts"</a> .
Turbeville, " <a href="#">High Frequency Trading</a> " (2013)	Literature review	"[T]he illusion of market liquidity provided by HFT volume leads to the inherent instability of market pricing mechanisms. In addition, aggressive HFT tactics mislead market participants in terms fundamental price. Finally, Dark Pools, trading venues that exist because of HFTs, impair price discovery."
United States Commodity Futures Trading Commission and Securities and Exchange Commission, " <a href="#">Findings Regarding the Market Events of May 6, 2010</a> " (2010)	U.S. futures and equities, 2010	Unregulated or unconstrained HFT market makers exacerbated price volatility in the Flash Crash, hot potato trading.  <a href="#">See also Kirilenko, Samadi, Kyle, Tuzun, "The Flash Crash: The Impact of High Frequency Trading on an Electronic Market"</a>
United States Federal Reserve Bank of Chicago, Carol Clark, " <a href="#">How to Keep Markets Safe in the Era of High-Speed Trading</a> " (2012)	Interviews and fieldwork with proprietary trading firms, including high frequency trading firms.	"Another area of concern is that some firms do not have stringent processes for the development, testing, and deployment of code used in their trading algorithms. For example, a few trading firms interviewed said they deploy new trading strategies quickly by tweaking old code and placing it into production in a matter of minutes. In fact, one firm interviewed had two incidents of out-of-control algorithms. To address the first occurrence, the firm added additional pre-trade risk checks. The second out-of-control algorithm was caused by a software bug that was introduced as a result of someone fixing the error code that caused the first situation."
United States Federal Trade Commission, "Report	U.S. futures, 1915-1922	Unregulated or unconstrained market makers both cause and exacerbate price volatility;

of the Federal Trade Commission on the Grain Trade," Volume 7 (1926)

"The scalpers who operate with reference to fractional changes within the day may have a stabilizing effect on prices so far as such changes with the day are concerned, but when the market turns they run with it, and they may accentuate an upward or downward movement that is already considerable."

---

United States Securities and Exchange Commission, "[SEC Charges Knight Capital With Violations of Market Access Rule](#)" (2013)

Trading firm U.S. equities data and trading firm procedures, 2012.

"An SEC investigation found that Knight Capital did not have adequate safeguards in place to limit the risks posed by its access to the markets, and failed as a result to prevent the entry of millions of erroneous orders."

---

Van der Wel, Menkveld, Sarkar, "[Are Market Makers Uninformed and Passive? Signing Trades in the Absence of Quotes](#)" (2009)

U.S. futures, 1994-1997

Unregulated or unconstrained market makers demand liquidity for a substantial part of the day and are active and informed speculators.

---

Van Kervel, "[Liquidity: What You See is What You Get?](#)" (2012)

U.K. equities, 2009

"We show that a specific type of high-frequency traders, those who operate like modern day market makers, might in fact cause a strong overestimation of liquidity aggregated across trading venues. The reason is that these market makers place duplicate limit orders on several venues, and after execution of one limit order they quickly cancel their outstanding limit orders on competing venues. As a result, a single trade on one venue is followed by reductions in liquidity on all other venues."

See also Nasdaq, "[Self-Regulatory Organizations; The NASDAQ Stock Market LLC; Notice of Filing of Proposed Rules Change to Amend Rule 4758\(a\)\(1\)\(A\) to Reflect a Change in Nasdaq's Routing Functionality](#)"

---

Venkataraman, Waisburd, "[The Value of the Designated Market Maker](#)" (2006)

French equities, 1995-1998

Designated market makers with affirmative obligations improve market quality, increase market valuation.

---

Wang, Chae, "[Who Makes Markets? Do Dealers Provide or Take Liquidity?](#)" (2003)

Taiwanese equities, 1997-2002

Absent mandatory obligations, market maker privileges don't induce market makers to provide liquidity; they derive profits from their own informed trades; "While dealers may be meant to perform the socially beneficial function of liquidity provision, the institutional advantages granted to them also give the ability to act as super-efficient proprietary traders if they choose to."

---

Weild, Kim, Newport "[The Trouble with Small Tick Sizes](#)" (2012)

U.S. equities, 1991-2011

"Rather than supporting long-term company growth by bringing research, sales and capital to investors, high-frequency traders seek to make a quick profit by identifying short-term

price discrepancies."

---

Weller, "Liquidity and High Frequency Trading" (2012)	U.S. futures	"[T]he introduction of fast, low-capital intermediaries can render markets less able to bear large liquidity demand shocks. The sudden prevalence of flash crashes—Nanex, a market data feed provider, estimates more than 1,800 miniature flash crashes occurred in 2010 alone—is not surprising when viewed from this perspective."  Note that access to this paper has been restricted. See <a href="#">"The Influence of the For Profit Exchanges"</a> .
Working, "Tests of a Theory Concerning Floor Trading on Commodity Exchanges" (1967)	U.S. futures, 1952	Unregulated or unconstrained market makers are also trend traders, profiting from the information advantages of privileged access; they can trade aggressively, especially when the market goes against the firm; inventory cycles of "minutes"; trend trading accelerates price changes (but the author believes may moderate extremes).
Ye, Yao, Gai, <a href="#">"The Externality of High Frequency Trading"</a> (2012)	U.S. equities, 2010	"We find that stocks randomly grouped into the same channel have an abnormal correlation in message flow, which is consistent with the quote stuffing hypothesis."; "We also find that fleeting orders, or orders with a life less than 50 milliseconds, have trivial contributions to liquidity and no contributions to price efficiency."
Zhang, <a href="#">"High-Frequency Trading, Stock Volatility, and Price Discovery"</a> (2010)	U.S. equities, 1985-2009	"[H]igh-frequency trading may potentially have some harmful effects" because "high-frequency trading is positively correlated with stock price volatility."
Zigrand, Cliff, Hendershott, <a href="#">"Financial stability and computer based trading"</a> (2011)	Literature review and survey	Self-reinforcing feedback loops in computer-based trading can lead to significant instability in financial markets; market participants become inured to excessive volatility in a cultural "normalization of deviance" until a large-scale failure occurs; research to date has not shown a persistent increase in market volatility, but HFT research is nascent.

## Press editorials

### ["Wall Street Trades at Speed of Light Need Traffic Cops: View"](#)

Bloomberg, January 3, 2012

"At this point, it's beyond doubt that high-frequency trading contributes to volatility, fueling perceptions among retail investors that insiders have the game rigged."

See also these Bloomberg editorials: ["U.S. Leads in High-Frequency Trading, Trails in Rules"](#), ["High-Frequency Trading Prospers at Expense of Everyone"](#) and ["Knight Blowup Shows How High-Speed Traders Outrace Rules"](#)

### ["Wait a second: The latest cock-up on Wall Street shows that more safeguards are needed"](#)

Economist, August 11, 2012

"This newspaper seldom finds itself on the side of restraining either technology or markets. But in this case there is a doubt whether the returns justify the risk. Society needs a stockmarket to allocate capital efficiently, rewarding the best companies with higher share prices. But high-frequency traders are not making decisions based on a company's future prospects; they are seeking to profit from tiny changes in price. They might as well be trading baseball cards. The liquidity benefits of such trading are all very well, but that liquidity can evaporate at times of stress. And although high-frequency trading may make markets less volatile in normal times, it may add to the turbulence at the worst possible moment."

### ["Asia takes on algos"](#)

Financial Times, August 14, 2012

"Two years after the 'flash crash' exposed the risks of automated trading systems running amok, this month's Knight Capital fiasco shows that the US Securities and Exchanges Commission has done too little to control the ever evolving technology traders now rely on to navigate fragmented markets."

See also these Financial Times editorials: ["Taming Trading"](#), ["Calmer markets"](#) and ["Expelling gremlins from the exchange"](#).

### ["Volatile markets: twitchy about Twitter"](#)

The Guardian, April 26, 2013

"Using algorithms, dealing-room computers conduct hundreds of thousands of automatic trades within seconds. These can sometimes steady or smooth markets, as when algorithms correct an error made by a fat-fingered human. But other times they can make things worse, by exacerbating a dramatic move in asset prices."

### ["When Speed Kills"](#)

The Japan Times, August 14, 2012

"Market officials and regulators are increasingly skeptical of the notion that faster is by definition better."

### ["Trading in the Dark"](#)

The New York Times, April 7, 2013

"Potential interactions between the off-exchange venues and the high-speed, computer-driven trading that now dominates the stock market are also cause for worry, because increasingly complex systems can malfunction in unexpected and catastrophic ways."

["High-frequency trading insanity"](#)

USA Today, September 26, 2012

"Slap a small transaction tax on rapid trades, impeding the practice and returning markets to their core purpose."

See also these USA Today editorials: ["Flash-crash analysis leaves investors reason to worry"](#) and ["Time to put the brakes on high-frequency stock trades"](#)

["The Dark of Knight"](#)

Wall Street Journal, August 2, 2012

"From the 2010 'flash crash' to trading snafus at Facebook's initial public offering in May, the basic plumbing of the equity markets has never seemed so troubled."



## The Wall Street Journal's "Dark Market" series (selected articles)

### ["Deutsche Börse's News Service for Traders Draws Scrutiny of Investigators"](#)

Brody Mullins and Scott Patterson, August 12, 2013

"[N]ow owned by the Deutsche Börse stock exchange, Need To Know News has operated with an overriding mission: sending data directly from the government through high-speed lines to financial firms that are able to trade on it instantly. Some have paid \$375,000 a year for the service."

### ["High-Frequency Traders' Safeguards Come Under Scrutiny"](#)

Scott Patterson, July 18, 2013

"The widening look at high-speed algorithms was sparked by Finra's recent investigations into high-speed-trading mishaps, Mr. Gira said. Last week, Finra and several stock-exchange regulators fined Newedge USA LLC, which is jointly owned by French banks Société Générale and Crédit Agricole CIB, \$9.5 million for lax oversight of computer-driven trading firms."

### ["High Speed Traders Exploit Loophole"](#)

Scott Patterson, May 1, 2013

"Fast-moving traders can get a head start in looking at key information because they connect directly to the exchange's computers, giving them the data just before it reaches the so-called public tape accessible to everyone else."

### ["High-Speed Traders Race to Fend Off Regulators"](#)

Jenny Strasburg and Scott Patterson, December 28, 2012

"High-frequency trading firms are fighting to fend off regulation as scrutiny of their practice of unleashing blizzards of orders coincides with repeated technical glitches in the markets. As the firms work to convince policy makers their practices are benign or even beneficial, one of their primary tools has been research seeded by the industry itself, promoted by lobbying that has increased in recent years."

### ["Probe Sparks Split on Trades"](#)

Scott Patterson, December 18, 2012

"A regulatory investigation into whether stock exchanges have given unfair advantages to high-speed traders has sparked complaints against the exchanges, fueling a broader debate about how the market operates and is regulated."

### ["Exchanges Get Closer Inspection"](#)

Scott Patterson and Jean Eaglesham, November 20, 2012

"Federal securities regulators are stepping up oversight of stock exchanges as they scramble to catch up to trading advantages that some say have developed for sophisticated clients at the expense of ordinary investors."

### ["For Superfast Stock Traders, A Way to Jump Ahead in Line"](#)

Scott Patterson and Jenny Strasburg, September 19, 2012

"At issue is whether exchanges sometimes allow high-speed trading firms to trade ahead of less-sophisticated investors, potentially disadvantaging them and violating regulatory rules."

For an index of the Wall Street Journal's "Dark Markets" series, see <http://topics.wsj.com/subject/D/dark-markets/6986>.

---

## Op-eds and commentary

### ["Stock-Order Rebates Should Be Stopped, Arnuk Says"](#)

Sal Arnuk and Joseph Saluzzi interviewed by Erik Schatzker and Stephanie Ruhle  
Bloomberg, September 20, 2012

"What we've done is we've taken two deep liquidity pools and taken their worst feature - the worst feature - amplified it a billion times, mechanized it, and now that is our modern market structure."

See also [http://www.themistrading.com/market\\_structure](http://www.themistrading.com/market_structure)

### ["Serving All, Not Just the Elite Few"](#)

Sal Arnuk and Joseph Saluzzi, New York Times Room for Debate, August 6, 2012

"Trading today is mostly computerized scalping done under a sanitized name – 'market making.'"

### ["Too Fast to Fail: Is High-Speed Trading the Next Wall Street Disaster?"](#)

Nick Baumann, Mother Jones, January/February, 2013

"The chief executives of publicly traded companies—who are hired and fired based on stock prices—increasingly worry that their shares could be sent into a free fall by an algorithmic feeding frenzy. The current markets have created a 'somewhat disjointed world between what a company does and what its stock does,' the CEO of one billion-dollar, NYSE-traded company told *Mother Jones*."

See also ["Yet More Evidence That High-Frequency Trading is Bad for Us"](#).

### ["Introduction to HFT Scalping Strategies"](#)

Haim Bodek and Mark Shaw, Decimus Capital Markets, LLC / Haim Bodek Consulting, November 2012

"HFT scalping's impact on the equity markets include high frequency price fluctuations, high order cancellation rates and liquidity gaps."

### ["Not so fast: The risks posed by high-frequency trading"](#)

Buttonwood, Economist, August 6, 2011

"The problem may be that, unlike marketmakers, HFT investors have no obligation to trade in difficult conditions."

### ["Rise of the Machines"](#)

Citizens for Responsibility and Ethics in Washington, May 13, 2013

"CREW studied the lobbying and campaign contribution records of 48 companies known for high frequency trading. Their campaign contributions soared by a staggering 673 percent between the 2008 and 2012 cycles, and their lobbying spending jumped 93 percent."; "HFTs have aggressively commissioned research and circulated it on Capitol Hill to buttress arguments against regulation."

### ["SEC must put a stop to casino markets"](#)

Leon Cooperman, Sal Arnuk and Joseph Saluzzi, Financial Times, September 24, 2012

"Clearly, the SEC's market structure experiment has failed. Unless something changes, confidence-shaking events will only increase in frequency."

### ["The Day The Market Almost Died \(Courtesy Of High Frequency Trading\)"](#)

Tyler Durden, ZeroHedge, May 6, 2010

"What happened today was no fat finger, it was no panic selling by one major account: it was simply the impact of everyone in the HFT community going from port to starboard on the boat, at precisely the same time."

See also [http://www.zerohedge.com/taxonomy\\_vtn/term/140](http://www.zerohedge.com/taxonomy_vtn/term/140) and [http://www.zerohedge.com/taxonomy\\_vtn/term/12411](http://www.zerohedge.com/taxonomy_vtn/term/12411)

#### "Regulator puts a spotlight on high-frequency trading "

Boyd Erman, The Globe and Mail, June 18, 2012

"From retail investors commenting on The Globe and Mail's website to Tony Fell, who once ran the country's biggest brokerage, the message is the same: The markets are seen as a casino where high-frequency traders are winning too often for it all to be just chance."

#### "A new type of market crash proliferates"

The Economist, August 31, 2013

"Even before the glitches, the SEC was taking increased interest in potential trading problems and how they might be disclosed. In March it published a proposal known as Regulation SCI (systems compliance and integrity). Exchanges and banks are resisting one of its requirements, which is to report blackouts even if they do not lead to anything as severe as trading halts. America's regulators are often accused of being heavy-handed. But forcing more transparency on the black boxes that have replaced screaming humans on Wall Street must be a good thing."

#### "High Frequency Trading HFT panel (Finance Watch Conference)"

Finance Watch (2012)

"Significant concerns have been raised about the quality of liquidity provided, as well as the risks posed in terms of stability and integrity for our financial markets by these types of trading."

See also [www.finance-watch.org](http://www.finance-watch.org).

#### "High-frequency trading and the \$440m mistake"

August 10, 2012

Tim Harford, BBC Radio 4

"Humans still watch the systems, but the computers move far too quickly for us to react to everything they do - and at Knight Capital, the computer glitch meant the company was making trades it didn't intend to make. That's how to lose almost half a billion dollars in a little over half an hour."

#### "High frequency trading needs severe regulation"

Anthony Hilton, London Evening Standard, October 23, 2012

"HFT is now so dominant it overwhelms everyone so there is no countervailing force to the direction taken by the computers."

#### "Risiken des Hochfrequenzhandels: Das systemische Risiko der Dummheit" ("Risks of High Frequency Trading: The Systemic Risk of Stupidity")

Yvonne Hofstetter, Frankfurter Allgemeine, October 15, 2013

"Ultra-fast trading algorithms are a systemic risk to our economy - all the more so when no one seems to be able to control their behavior." ([Google Translate](#))

#### "Traders may have gotten last week's Fed news 7 milliseconds early"

Neil Irwin, The Washington Post Wonkblog, September 24, 2013

"It is the reality of how much trading activity, particularly of the ultra-high-frequency variety is really a dead weight loss for society."

"Closer Look: No Rewind Button for Everbright Securities"

Fan Junli, Caixin Online, August 19, 2013

"The Everbright incident has raised alarms on the limits of risk control and supervision capacity in HFT, which refers to rapid securities trading that relies on technological tools and computer algorithms."

"Preventing the Next Flash Crash"

Edward E. Kaufman Jr and Carl M. Levin, New York Times, May 5, 2011

"America's capital markets, once the envy of the world, have been transformed in the name of competition that was said to benefit investors. Instead, this has produced an almost lawless high-speed maze where prices can spiral out of control, spooking average investors and start-up entrepreneurs alike."

"A Dark Magic: The rise of the robot traders"

Laurence Knight, BBC News, July 8, 2013

"But, what made things far worse was a 'hot potato' effect: amid the confusion, one by one the robot traders tried to cut and run, and the stock exchange's computers got swamped."

"Testimony on 'Computerized Trading: What Should the Rules of the Road Be?'"

David Lauer testimony before the U.S. Senate Committee on Banking, Housing, and Urban Affairs Subcommittee on Securities, Insurance and Investment, September 20, 2012

"US equity markets are in dire straits. We are truly in a crisis."

"Public Comment on Consultation Report"

R. T. Leuchtkafer, August 12, 2011

"A basic function of any market is to produce a quote. Today's HFT quotes are toxic, a hoax on equities markets."

See also "No more 'hot potatoes' please" and <http://www.sec.gov/comments/s7-02-10/s70210-107.htm>.

"Why Couldn't Wall Street Weather a Storm?"

Arthur Levitt, Wall Street Journal, November 7, 2012

"And thanks to software errors in high-speed trading firms and 'fat finger' errors by human traders, it's becoming clearer that many major market participants simply have not properly tested their existing trading systems or prevented fraud and error from creeping into their trading books."

"High-frequency trading - split seconds"

Lex, Financial Times, September 26, 2012

"Constraining the relentless advance of technology is rarely easy. But that is no excuse for not trying when its potential effects may be damaging."

"A Speed Limit for the Stock Market"

Roger Lowenstein, New York Times, October 1, 2012

"The 'liquidity' H.F.T. provides is long past the point of being helpful."

"Markets: In search of a fast buck"

Arash Massoudi and Michael Mackenzie, Financial Times, February 20, 2013

"The potential benefits to investors seem clear: trading will become cheaper and more transparent...But the potential downsides are markets plagued by computer errors and outages. Most worrying of all: the risk of a global flash crash across major markets linked by the speed traders."

"High Frequency Trading: Wall Street's Doomsday Machine?"

Christopher Matthews, Time Magazine, August 8, 2012

"[H]igh-speed trading systems may also pose risks to the stability of the overall financial system."

"Recommendations for Equitable Allocation of Trades in High Frequency Trading Environments"

John McPartland, Federal Reserve Bank of Chicago (2013)

"This paper (1) acknowledges and summarizes much of the relevant published research (2) discusses some of the HFT strategies that likely run counter to good public policy and (3) makes six recommendations that, if implemented, would not preclude any current HFT strategies, but would likely restore some competitive advantage to market participants that would be willing to expose their resting orders to market risk for more than fleeting milliseconds."

"Why High-Frequency Trading Doesn't Compute"

Jim McTague, Barrons, August 11, 2012

"Markets have been jarred by four major computer mishaps this year, including the recent one at Knight Capital. It's time to rein in the Street's speed demons: trading bots."

"The Rise of the HFT Machines"

Nanex, LLC

"The following animated GIF chronicles the rise of the HFT Algo Machines from January 2007 through January 2012."

See also <http://www.nanex.net/FlashCrash/OngoingResearch.html>

"Dennis Kelleher on PBS Discussing High Frequency Trading"

National Business Report interviews Dennis Kelleher, September 20, 2012

"There's been shockingly little done regarding our capital markets since the flash crash."

See also [www.bettermarkets.com](http://www.bettermarkets.com).

"Cuban, Cooperman: Curb High-Frequency Trading"

Bruno J. Navarro, CNBC, October 2, 2012

(Includes CNBC interviews of Mark Cuban and Leon Cooperman)

"There is no value to HFT, period. End of story."

"Frankenstein Takes Over the Market"

Joe Nocera, New York Times, August 4, 2012

"This week, yet another Wall Street firm most people have never heard of, relying on a computerized trading program that they can't possibly understand, shook investors' faith in the market."

"Strong and Fast Markets, but No Time to Think"

Floyd Norris, New York Times, August 3, 2012

"The same computerization and increased competition that provided the benefits also weeded out people who had the obligation to step up in times of stress, and virtually eliminated the ability of people and institutions to slow or halt markets when something goes badly wrong."

"Can High-Frequency Trading Drive the Stock Market Off a Cliff?"

Wei Pan, Alex Sandy Pentland, Ren Cheng and Lisa Emsbo-Mattingly

MIT Sloan Management Review, June 18, 2013

"[H]igh-frequency trades influenced the market price, which then affected the next trades of the high-frequency trading firms. As a result, many of these high-frequency trading firms started to sell together, in synchrony, which added up to billions of dollars worth of sell trades per second. This was an event of enormous magnitude, even for the U.S. equity market. The synchronized selling caused prices to collapse."

#### ["A Dark Magic"](#)

Robert Peston, BBC Radio 4, July 7, 2013

"And what may disturb you is that it's like a terminator movie with competing algorithms clashing with each other and on occasion causing market meltdowns."

["Trading algorithmique: mobilisation contre la 'menace' des ordinateurs boursiers"](#) ("Algorithmic Trading: mobilization against the 'threat' of trading computers")

Edouard Pflimlin, Le Monde, May 20, 2013

"The battle against the excesses of algo-trading only start." ([Google Translate](#))

#### ["Long-term investors would benefit from Tobin tax"](#)

John Plender, Financial Times, September 28, 2011

"It is a paradoxical result of increased competition from off-exchange trading platforms and from regulatory developments such as Europe's Markets In Financial Instruments Directive that long-term investors are being disadvantaged. A financial transactions tax might help redress the balance."

#### ["The problem with high frequency trading"](#)

Felix Salmon, BBC Radio, October 6, 2012

"But if you look at what's happened over the past five years, since 2007, the benefits of high-frequency trading have pretty much plateaued. And the downsides are becoming more and more obvious."

#### ["Cramer Slams High-Speed Trading"](#)

Drew Sandholm, CNBC, September 18, 2012

(Includes excerpts from "Mad Money with Jim Cramer")

"To me, right now, the high-speed traders are this generation's equivalent of the German machine guns that mowed down British soldiers by the thousands and the people being annihilated by the traders? That's you, the average investor, just trying to using stocks to save some money as generations have before you."

#### ["Turbo-Aktienhändler: 'Dann wird geschossen'"](#) ("Turbo Stock Trader: 'Then is shot'")

Christoph Scheuermann, Spiegel Online, August 23, 2013

"On one of those crazy days was a lot of money lost, 'because an algorithm is haywire,' as Breuer says. The algorithm to bite like a rabid ferret. Only after seven minutes, they were able to bring it under control, but it was too late." ([Google Translate](#))

#### ["The Spider and the Fly"](#)

Rajiv Sethi, August 3, 2013

"If one wants to argue that the new organization of markets has been beneficial to investors, one needs to make the case that the costs of financial intermediation in the aggregate have gone down. Smaller bid-ask spreads have to be balanced against the massive increase in volume, the profits of the new market makers, and most importantly, the costs of high-frequency trading."

See also ["The Risk and Reward in High Frequency Trading"](#) and ["The New Market Makers"](#)

["A Tax to Kill High Frequency Trading"](#)

Lee Sheppard, Forbes.com, October 16, 2012

"The United States should adopt a financial transactions tax (FTT) to kill high frequency trading (HFT) by removing the juice from this pernicious practice."

["The danger of high-frequency traders: Why critics fear HFTs are undermining markets, one penny at a time"](#)

Chris Sorensen, *Maclean's*, October 16, 2013

"Of particular concern for securities regulators is whether all of this light-speed trading has increased the volatility of equity markets, contributing to reduced investor confidence. In addition to the "flash crash," there have been a growing number of painful stock market glitches in recent years that were either related to, or exacerbated by, computers run amok."

["Quick View: Twitter hack shows tech dangers"](#)

Philip Stafford, Financial Times, April 24, 2013

"As the UK government-backed Foresight report into computer-based trading highlighted, one of the dangers within all automated systems lies in what is known as a positive feedback loop, in which a small change in computer trading feeds back on itself, triggering a bigger change, which in turn feeds back on itself, and so on. The process amplifies volatility, especially in interlinked markets."

["Fair Play Measured in Slivers of a Second"](#)

James B. Stewart, New York Times, July 12, 2013

"Two seconds may not seem like much, but for high-speed traders with supercomputers, it's plenty."

["Reign of the High-Frequency Trading Robots"](#)

Wallace Turbeville, U.S. News and World Report, October 18, 2013

"HFT traders often do supply executable price quotes, which superficially increase liquidity. True liquidity, however, comes when offers can be relied upon, allowing investors to predict whether the transactions they seek can be completed within their preferred price range. Because HFT traders can morph from providers to consumers of liquidity whenever the herd abruptly shifts from buy to sell, they create uncertainty rather than predictability."

See also ["Are Academics for Hire Influencing the HFT Debate?"](#) and ["High Frequency Trading"](#).

["Hurrying Into the Next Panic?"](#)

Paul Wilmott, New York Times, July 28, 2009

"Thus the problem with the sudden popularity of high-frequency trading is that it may increasingly destabilize the market."

["When Will Retail Investors Call It Quits?"](#)

Jason Zweig, Wall Street Journal, August 2, 2012

"So much for the reassurances from regulators and stock-exchange officials that a repeat of the 'flash crash' is impossible."

## Books and documentaries

### ["Broken Markets: How High Frequency Trading and Predatory Practices on Wall Street are Destroying Investor Confidence and Your Portfolio"](#)

Sal L. Arnuk and Joseph C. Saluzzi (2012)

"The market has been hijacked. An evolved class of leveraged short-term, high-speed traders, sometimes called *high frequency traders*, who trade massive amounts of shares based on proprietary algorithms, has eclipsed other types of traders."

See also [http://www.themistrading.com/market\\_structure](http://www.themistrading.com/market_structure)

### ["The Problem of HFT"](#)

Haim Bodek (2013)

"With automation, the US equities markets had evolved into a vast complex machine, one that was purposefully well-tuned to the nuances of HFT scalping strategies. Modern HFT wasn't a paradigm shift because its innovations brought new efficiencies into the marketplace. HFT was a paradigm shift because its innovations proved that anti-competitive barriers to entry could be erected in the market structure itself to preference one class of market participant above all others."

### ["The Payoff"](#)

Jeff Connaughton (2012)

"Our stock market had changed dramatically. No one understood how these changes were affecting average investors. Today's stock market is a constantly evolving, bewilderingly complex electronic labyrinth."

### ["Krach machine: Comment les traders à haute fréquence menacent de faire sauter la bourse"](#) ("Crash machine: How high frequency traders threaten to blow up the stock exchange")

Lelièvre, Pilet (2013)

"Qui sont ces traders qui agissent pratiquement à la vitesse de la lumière?" ("Who are these traders who operate at nearly the speed of light?")

### ["Crapshoot Investing"](#)

Jim McTague (2011)

"The stock market has changed radically since 2005, yet few persons realized the greatness of the seismic shift until May 6, 2010, when the major averages collapsed over the course of 10 minutes."

### ["Dark Pools: High-Speed Traders, A.I. Bandits, and the Threat to the Global Financial System"](#)

Scott Patterson (2012)

"Insiders were slowly realizing that the push-button turbo-trading market in which algos battled algos inside massive data centers and dark pools at speeds measured in billionths of a second had a fatal flaw."

### ["Ghost Exchange"](#)

Arbitrage Pictures (2012)

Directed by Camilla Sullivan

"I think the flash crash sent a clear message that there's something wrong in our system."



["Backlight - Money and Speed: Inside The Black Box"](#)

VPRO, Dutch public broadcasting (2011)

Directed by Marije Meerman.

Produced by Mariska Schnider for the series "Backlight."

"On May the 6th 2010, at 1400 hours, 42 minutes, and 44 seconds, the U.S. stock markets go into free fall. The Dow Jones takes the fastest and most dramatic nosedive in its history, an event that will be remembered as the 'Flash Crash.'"

["Wall Street Code"](#)

VPRO, Dutch public broadcasting (2013)

Directed by Marije Meerman.

Produced by Jenny Borger, Helen Goosens, and Marie Schutgens for the series "Backlight."

"Super-quick computers and advanced mathematic formulas have largely taken over trading on the financial markets from human beings. Algorithms, which seem to have a life of their own. Algorithms secretly lie waiting for the moment that your Apple share or your pension money gets in the market."

## Government

### Central banks

#### ["How to Keep Markets Safe in the Era of High-Speed Trading"](#)

Carol Clark, Federal Reserve Bank of Chicago, October 2012

"A number of recent technology-related snafus have focused attention on high-speed trading and affected investor confidence in the markets. These incidents and the resulting losses highlight the need for risk controls at every step of the trading process."

#### ["High-frequency trading in the foreign exchange market"](#)

Guy Debelle, Reserve Bank of Australia, October 12, 2011

"While HFT generates increased activity and narrower spreads in normal times, it may have reduced the resilience of the system as a whole in stressed times by reducing the activity of traditional market participants who may have otherwise been an important stabilising presence in volatile environments."

#### ["European Commission's Public Consultation on the Review of the MiFID - Eurosystem Contribution"](#)

European Central Bank, February 2011

"In the last few years, automated trading, and in particular High-Frequency Trading (HFT), has experienced strong growth. Such a development may trigger a number of risks for orderly trading and for financial stability."

#### ["Opinion of the European Central Bank of 13 December 2012 on high frequency trading"](#)

European Central Bank, December 13, 2012

"[A]lthough AT practices [including high frequency trading] may have legitimate purposes, they might also jeopardise the liquidity and efficiency of financial markets, particularly in times of market stress, as they could disturb the normal functioning of the market and increase volatility, which would be contrary to the public interest."

#### ["Race to Zero"](#)

Andrew Haldane, Bank of England, July 8, 2011

"Far from solving the liquidity problem in situations of stress, HFT firms appear to have added to it. And far from mitigating market stress, HFT appears to have amplified it. HFT liquidity, evident in sharply lower peacetime bid-ask spreads, may be illusory. In wartime, it disappears."

#### ["High-frequency trading and market implications - an assessment from a central bank perspective"](#)

Dr. Joachin Nagel, Deutsche Bundesbank, July 4, 2012

"There are increasing signs, for example, that, especially in volatile market situations, HFT might prove to be tricky - in the sense of further destabilising the market."

#### ["Electronic trading and financial markets"](#)

Kiyohiko Nishimura, Bank of Japan, November 29, 2010

"Although the expansion of electronic trading has brought many positive effects, as noted, it also has its own negative side with respect to the proper functioning of financial markets."

## Regulators

### ["New Species: How Market Participants Have Evolved in Financial Ecosystems"](#)

Bart Chilton, Commissioner, U.S. Commodities Futures Trading Commission, February 1, 2011

"Mini-flash crashes occur all the time, too. More than once last year in futures markets and several times in stocks, runaway robotic programs disrupted markets and cost people money. One company lost a million dollars in the oil market in less than a second when an algo ran wild."

### ["OSC head leans to the negative about high-frequency trading"](#)

Boyd Erman, The Globe and Mail, August 20, 2012

Interview of Howard Wetston, Chairman, Ontario Securities Commission (Canada)

"We ask ourselves the fundamental question: Is this type of trading actually consistent with what we expect of financial services and financial markets?"

### ["New rules for high-frequency trading"](#)

Federal Financial Supervisory Authority (Germany), November 22, 2012

"High-frequency trading has increased the speed and complexity of trading. This is associated with risks: for example, large order volumes may place a heavy burden on trading systems. Algorithms may also react to market events and trigger additional algorithms as a result, which may in turn trigger even more algorithms (cascade effect), leading to an increase in volatility."

### ["Speed limit for high-frequency trading - Federal Government adopts legislation to avoid risks and prevent abuse in high-frequency trading"](#)

Federal Ministry of Finance (Germany), September 26, 2012

"Computer-based high-frequency trading using algorithms poses multiple risks of extreme and irrational price fluctuations, overloaded trading systems and new opportunities for abuse."

### ["France wants tougher HFT regulation"](#)

Jeremy Grant and Philip Stafford, Financial Times, December 19, 2011

Press conference of Thierry Francq, secretary-general of Autorité des Marchés Financiers (France)

"Mr Francq called for the creation of a 'preventive framework' of new market rules to 'minimise the risk of HFT, and that means probably a rather harsh slowdown of this technique.'"

See also ["Issues related to MiFID II"](#) .

### ["Keynote speech by Jean-Pierre Jouyet"](#)

Jean-Pierre Jouyet, Chairman of the Autorité Des Marchés Financiers (France), February 13, 2012

"More generally, high-frequency algorithmic trading can aggravate the instability of a market by provoking unfounded price oscillations or anomalies arising from the interaction of two algorithms, as we saw with the Wall Street flash crash of May 6th 2010."

See also ["Issues related to MiFID II"](#) .

### ["ASIC Chairman's address to FINSIA Conference 2012"](#)

Greg Medcraft, Chairman, Australian Securities and Investments Commission, October 10, 2012

"And while some say high-frequency trading provides liquidity, I know some very senior bankers that privately describe it as providing only 'phantom liquidity.'"

### ["Remarks Before the Investment Company Institute's General Membership Meeting"](#)

Mary L. Schapiro, Chairman, U.S. Securities and Exchange Commission, May 6, 2011

"High frequency traders turned what was a very down day for many investors into a very profitable one for themselves by taking liquidity rather than providing it."

["We need rules to limit the risks of superfast trades"](#)

Martin Wheatley, CEO, Hong Kong Securities and Futures Commission  
Financial Times, September 20, 2010

"When a single strategy becomes as dominant as HFT appears to have become - as happened in 1987 with 'portfolio insurance' and as is happening now with HFT - markets become fragile. And this fragility will lead to more shock events such as the 'flash-crash'."

## Legislators

["Tougher rules to protect investors and curb high-frequency trading"](#)

European Parliament, October 26, 2012

"MEPs also tightened up proposed rules on high-frequency trading."

["MiFID: European Parliament wants safer financial markets"](#)

EPP Group in the European Parliament, September 27, 2012

"The new EU Directive on Markets for Financial Instruments (MiFID) ought to ban destructive speculation on financial markets."

["Harkin: Tax high-speed traders to fill budget hole"](#)

U.S. Senator Tom Harkin interviewed by Ronald D. Orol of MarketWatch, November 29, 2012

"I really don't see any evidence that these high-speed traders add anything to the economy, but they do also create some aberrations in the market that have led to some disturbances."

["Ongoing Market Structure Review"](#)

U.S. Senator Edward E. Kaufman, August 5, 2010

"For example, while speed and efficiency can produce certain benefits, they have also created a micro-arms race that is being waged in our public marketplace by high frequency traders and others."

["Kaufman Delivers Final Senate Floor Speech on Market Structure Issues, High Frequency Trading"](#)

U.S. Senator Edward E. Kaufman, September 28, 2010

"Simply put, technological developments must operate within a framework that ensures integrity and fairness."

See also ["Archived Web Site \(captured November 2010\) of Ted Kaufman \(U.S. Senate, 2009-2010\)"](#).

["Request for Comments Regarding Findings and Recommendations of the Joint CFTC-SEC Advisory Committee on Emerging Regulatory Issues"](#)

U.S. Senator Carl Levin. April 8, 2011

"Regulations designed to ensure the stability and integrity of our markets must be coordinated across all of the markets, and while the recent coordination by the SEC and CFTC is a useful step, I believe much more needs to be done."

See also ["Statement of Sen. Carl Levin - Subcommittee on Securities, Insurance and Investment"](#).

["Letter to U.S. Commodity Futures Trading Commission Chairman Gary Gensler"](#)

U.S. Congressman Edward J. Markey, September 19, 2012

"The 2010 Flash Crash in equity markets severely damaged confidence and sent a signal to ordinary investors that they are at a disadvantage. If high-frequency traders are now causing similar crashes in

the commodity markets, both the investment community and the general public will lose confidence that the markets are working properly." See also [letter to Elisse B. Walter, U.S. Securities and Exchange Commission](#) and ["Markey: Rules of Road Needed for Wall Street's High Speed Trading"](#).

["Senator Jack Reed: Market Disruptions Are 'Wake Up Call' on HFT"](#)

U.S. Senator Jack Reed interviewed by Lee Pacchia, Bloomberg, September 20, 2012

"I think we need much more emphasis on what's going on. I think we have to look very carefully. We've had some wake up calls - the flash crash, the situation with the Facebook public offering - and so we've been put on notice we have to look."

["SCHUMER TO SEC: IMPOSE TOUGHER RULES ON HIGH-FREQUENCY TRADERS TO CURB STOCK PRICE VOLATILITY AND PREVENT ANOTHER FLASH CRASH"](#)

U.S. Senator Charles E. Schumer, August 11, 2010

"This disappearance of high frequency traders and their withdrawal of liquidity reveal a serious problem with our market regulation."

See also ["SCHUMER TO SEC: SLOW DOWN HIGH-FREQUENCY TRADERS WHEN MARKETS GET VOLATILE; SENATOR ALSO CALLS FOR PROBE INTO 'QUOTE STUFFING,' POSSIBLE BAN ON SUB-PENNY BIDS"](#)

## **Prosecutors**

["Cracking Down on Insider Trading 2.0"](#)

Eric T. Schneiderman, New York Attorney General, October 11, 2013

"Small groups of privileged traders have created unfair advantages for themselves by combining early glimpses of critical data with high-frequency trading – superfast computers that flip tens of thousands of shares in the blink of an eye. This new generation of market manipulators has devised schemes that allow them to suck all the value out of market-moving information before it hits the rest of the street."

## **Other**

["ESRB response to the ESMA Consultation Paper"](#)

European Systemic Risk Board, September 21, 2011

"There is also a growing concern that the expansion of HFT might undermine investor confidence and their willingness to participate in the markets."

["Position Paper"](#)

Securities and Markets Stakeholder Group, European Securities and Markets Authority (ESMA), October 26, 2011

"On one hand, studies demonstrate that HFT firms are also active during times of crises, but on the other hand, they also found that when volatility is rising, HFTs increase their demand for liquidity, while decreasing their supply of liquidity."

## High frequency trading defined

Definitions of "high frequency trading" (HFT) can vary, but every definition published to date includes one common attribute: High frequency trading includes any business model or trading strategy where positions in the market are bought and sold quickly, often hundreds or even thousands of times a day. High frequency traders rarely hold on to a position overnight and usually close a position within minutes or even within seconds.

### Industry participants

"The main innovation that separates high-frequency from low-frequency trading is a high turnover of capital in rapid computer-driven responses to changing market conditions."

-Irene Aldridge, *High-Frequency Trading: A Practical Guide to Algorithmic Strategies and Trading Systems* (2009).

"While traditional buy-side trading strategies hold positions for weeks or even months, HFT is characterized by fast turnover of capital. Instead of capturing large price changes over extended periods of time, HFT aims to book multiple small gains over short periods of time. An overwhelming 86% [of survey respondents] believe that the term 'high-frequency trading' referred strictly to holding periods of only one day or less."

-Irene Aldridge, "FINalternatives Survey: High-Frequency Trading has a Bright Future," (2009).

"High frequency trading is best understood as a subset of algorithmic trading that is characterized by high levels of messaging deployed in a very low latency infrastructure as well as high turnover with short holding periods."

CME Group letter, "Public Comment on Consultation Report: Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency," (2011).

"High-frequency trading is a method of trading that involves frequent turnover of positions, not a strategy in itself."

FIA Principal Traders Group / European Principal Traders Association, "FIA Principal Traders Group and FIA European Principal Traders Association Response to the IOSCO Consultation Report: Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency," (2011).

### Academics

"HFTs are identified as those firms with high volume, low intraday inventory, and low overnight inventory...The categorization of traders used in this paper is based on capturing the common characteristics of a high frequency trader: a market participant who trades a large number of contracts, consistently maintains a low inventory level, and ends the day at or near a zero inventory position."

Baron, Brogaard, Kirilenko, "The Trading Profits of High Frequency Traders" (2012).

"HFT is a type of investment strategy whereby stocks are rapidly bought and sold by a computer algorithm and held for a very short period, usually seconds or milliseconds."

Jonathan Brogaard, "The Activity of High Frequency Traders", (2011).

"High frequency traders submit and cancel a massive number of orders and execute a large number of trades, trade in and out of positions very quickly, and finish each trading day without a significant open position."

Cvitanic, Kirilenko, "High Frequency Traders and Asset Prices" (2010).

"Indeed, the typical high frequency market maker turns over his or her inventory 5 or more times a day, explaining how high frequency firms have come to have such a high share of trading volume. These market makers also seek to hold very small or even zero inventory positions at the end of the session. "

Easley, Lopez de Prado, O'Hara, "The Microstructure of the 'Flash Crash'", (2010).

"Like traditional intermediaries HFTs are central to the trading process, have short holding periods, and trade frequently."

Hendershott, Riordan, "High Frequency Trading and Price Discovery", (2011).

## Regulators

"[H]F traders execute trades in matters of milliseconds on electronic order books and hold new equity positions possibly down to a 'sub-second.' HFT generally involves getting in and out of positions throughout the day with a 'flat' position at the end of the day."

Committee of European Securities Regulators, "Micro-structural issues of the European equity markets" (2010) .

"Trading activities that employ sophisticated, algorithmic technologies to interpret signals from the market and, in response, implement trading strategies that generally involve the high frequency generation of orders and a low latency transmission of these orders to the market. Related trading strategies mostly consist of either quasi market making or arbitraging within very short time horizons. They usually involve the execution of trades on own account (rather than for a client) and positions usually being closed out at the end of the day."

European Securities and Markets Authority, "Final Report: Guidelines on systems and controls in an automated trading environment for trading platforms, investment firms and competent authorities" (2011) .

"We generally characterise HFT as automatically generating large numbers of orders based on price movements and market information, holding positions for a very short time, and ending the day with a zero position."

Greg Medcraft, Chairman, Australian Securities and Investments Commission (2012).

"Other characteristics often attributed to proprietary firms engaged in HFT are...(3) very short time-frames for establishing and liquidating positions..."

Mary L. Schapiro, Chairman, U.S. Securities and Exchange Commission, testimony before the Subcommittee on Securities, Insurance, and Investment of the United States Senate Committee on Banking, Housing, and Urban Affairs, May 20, 2010.

"A number of common features and trading characteristics related to HFT can be identified...It is characterized by a high daily portfolio turnover and order to trade ratio (i.e. a large number of orders are cancelled in comparison to trades executed); It usually involves flat or near flat positions at the end of the trading day...Positions are often held for as little as seconds or even fractions of a second."

Technical Committee of the International Organization of Securities Commissions, "Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency: Final Report" (2011) .

"Other characteristics often attributed to proprietary firms engaged in HFT are...(3) very short timeframes for establishing and liquidating positions..."

U.S. Securities and Exchange Commission, "Concept Release of Equity Market Structure" (2010) .

"There is no widely accepted definition of HFT, but it typically exhibits some common characteristics, such as: (1) high volume of trades on a daily basis but low level of profits per trade; (2) extreme short stock holding period (I know of one HFT firm operated out of the west coast of the US that boasts its average holding period for US equities is 11 seconds); (3) submitting numerous orders; and (4) no significant open position overnight."

Martin Wheatley, CEO of the Securities and Futures Commission in Hong Kong, and former deputy chief executive of the London Stock Exchange, (2010).

"The attribute that most clearly characterises high-frequency trading and differentiates it from other trading is the percentage of turnover bought and then sold, or sold and then bought, within each trading day. High-frequency traders tend to close out a high proportion of trading intraday, so their overnight positions are relatively small. This metric distinguishes high-frequency trading from the more widespread execution algorithms which trade in only one direction during a day."

Australian Securities and Investments Commission, "Report 331: Dark liquidity and high-frequency trading" (2013).

"HFT typically refers to the use of computerized trading to move in and out of positions rapidly, generally ending the day flat with little or no exposure to the market on an overnight basis."

United States Financial Stability Oversight Council, "Financial Stability Oversight Council: 2012 Annual Report" (2012).