

David Lauer
Market Structure and HFT Consultant
Better Markets, Inc.
Testimony on “Computerized Trading: What Should the Rules of the Road Be?”
The Committee on Banking, Housing, and Urban Affairs
Subcommittee on Securities, Insurance and Investment
September 20, 2012

Good morning Chairman Reed, Ranking Member Crapo and members of the subcommittee.
Thank you for the invitation to Better Markets to testify today.

Better Markets is a nonprofit, nonpartisan organization that promotes the public interest in the domestic and global capital and commodity markets. It advocates for transparency, oversight and accountability with the goal of a stronger, safer financial system that is less prone to crisis and failure, thereby, eliminating or minimizing the need for more taxpayer funded bailouts. Better Markets has filed almost 100 comment letters in the U.S. rulemaking process related to implementing the financial reform law and has had dozens of meetings with regulators. Our website, www.bettermarkets.com, includes information on these and the many other activities of Better Markets.

My name is David Lauer and I am a Market Structure and High-Frequency Trading Consultant to Better Markets. I’m also consulting for IEX Group, Inc., a private company that is in the process of building an investor-owned and investor-focused US equity market center. Prior to working with Better Markets and IEX Group, I worked as a senior quantitative analyst at Allston Trading and before that at Citadel Investment Group. Prior to my career as a researcher and trader, I worked at Tervela where I helped to design hardware and specialized in studying and understanding the complexities of the rapidly evolving electronic marketplace both before and after Reg NMS was implemented. I have a Master’s degree in International Economics and Finance from Brandeis University. I grew up in Southern New Jersey.

INTRODUCTION

On May 6, 2010, the US stock market demonstrated some of the most unpredictable and disturbing behavior in its 218 year history. Over the course of just 20 minutes, the stock market plunged and snapped back up, losing and then regained nearly \$1 trillion in market value. Nobody had ever seen anything like it. The crash began in the S&P E-Mini Futures market but quickly spread to and overwhelmed the equity markets. That day I was in the center of the storm, working on the high-

frequency trading floor of one of the largest S&P 500 E-Mini Futures trading firms in the world, on the global equity trading desk.

As I watched the market crash, I witnessed something unthinkable: the market simply disappeared. For what felt like an eternity, but was more likely 30 seconds to a minute, there were no bids or offers displayed in the market for major stocks and ETF's such as SPY (the S&P 500 Index ETF).

None of us knew what to do or what would happen next. Immediately before the market disappeared, our firm, like other high-frequency trading firms, withdrew our orders from the market because we did not understand what was happening, did not trust our data feeds and had no obligation to remain active in the market. Anybody who seeks to minimize the role that high-frequency trading had in the Flash Crash either was not on a trading floor that day or has an interest in maintaining the current unregulated status quo.

When more than half of the liquidity in the stock market is able to be pulled from it in a matter of seconds, dramatically worsening an unstable situation, something is dreadfully wrong.

US equity markets are in dire straits. We are truly in a crisis. Over the past three decades a technological revolution has swept over Wall Street. In many ways, this has dramatically improved the efficiency of capital markets relative to past decades: reducing spreads and volatility, and helping them to more effectively perform their core functions of price discovery and capital formation. Regardless of the arguments about this extremely volatile issue, we must judge the evolution of capital markets around these characteristics of spread width, price volatility, price discovery and capital formation as well as other characteristics such as the price impact of large institutional orders and catastrophic event frequency.

The past decade of this revolution has been marked by two primary trends: extreme marketplace fragmentation and rapid growth of high-frequency traders as the primary suppliers of liquidity. As of today, there are 13 lit exchanges and more than 50 dark pools / internalization venues. Exchanges account for between 65% and 75% of the market, and the Dark Pools, with 18 tracked by Rosenblatt, account for 12%-15%. The balance is attributed to internalization, including OTC block trades and wholesalers. This is a far departure from the stock market of the 20th century that was well understood by most Americans. If you were to ask the average retail trader or even sophisticated institutional investor what happens today when they send a buy or sell order to the market, few if any would be able to describe the labyrinthine path that order takes to be filled.

Complexity has become the hallmark of the new electronic landscape, whether it is in the form of a multitude of venues and participants or the advanced algorithms that many of them are using to analyze incoming market data. While complex systems can often provide elegant solutions to intractable real-world problems, they can also spin out of control in unexpected ways. Often the interaction of these non-linear systems is difficult or impossible to predict. In the US equity market, we have seen first-hand glimpses of what can happen as overly complex systems interact in non-linear ways. The incidents are becoming more common, and include:

- The Flash Crash in May, 2010 was set off by a single large trade estimated at \$4.1 billion in the S&P 500 E-Mini Futures Market. The cascade led to 20 minutes of extreme volatility, wiping out nearly \$1 trillion of market cap before quickly and inexplicably recovering. The total economic cost of this event is unmeasured, but certainly huge. We were lucky it didn't happen near the market close -- had the U.S. market closed before it recovered, the result could have been total economic disaster because money would have hemorrhaged out of the stock market overnight.
- In August, 2011 the stock market swung up and down by over 4.4% on four consecutive days, alternating up and down days. It was wild, unprecedented volatility -- only the third time in history that had happened, with the second time having been three years prior, during the crash of 2008. While the European crisis was becoming a more important issue at the time, this volatility was not warranted by major economic changes or historic macroeconomic events. This was computer-driven volatility.
- "Mini flash crashes" occur on a near-daily basis in individual stocks. Nanex has documented almost 2,000 instances of individual irregularities in stocks since August 2011¹. Single-stock circuit breakers have failed to stem the tide of these incidents.
- IPO's in Facebook and BATS (itself an Exchange) have gone horribly wrong due to technological "glitches," continuing to sour the already languid market for IPO's and costing untold numbers of jobs as companies cannot raise the capital they need to expand and hire.
- Few realize how lucky we were on Tuesday, July 30. An order to sell nearly \$4.1 billion in the S&P 500 E-Mini Futures Market, the same size as what precipitated the Flash Crash, was executed three seconds before the market closed. There simply was not enough time for the waterfall of May 6, 2010 to repeat itself. What happens the next time when that same order is sent in a couple of minutes sooner? While some may point to this as evidence that the market

¹ <http://www.nanex.net/aqck/aqckIndex.html>

worked, there have not been any changes in market structure since the Flash Crash other than circuit breakers, which are not active in the final 25 minutes of trading.

- On Wednesday, July 31, Knight Capital Group -- one of the largest market making firms, an official Designated Market Maker on the NYSE, had a “software glitch” according to their CEO. The result? A loss for them estimated at \$440 million, untold economic losses for retail investors with stop-loss orders in one of the almost 140 stocks that were affected and further erosion in investor confidence.

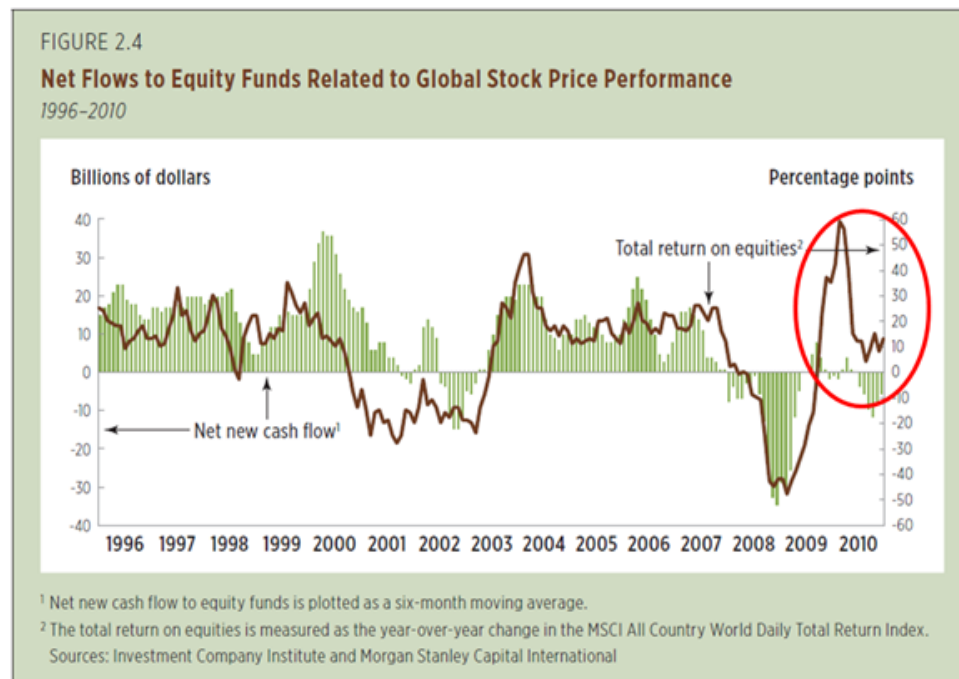
There is no doubt that electronic trading has tremendous value to offer, at times enhancing the smooth functioning of the stock market and increasing competition, thus driving down the spread that the average investor has to pay to buy or sell a stock. HFT has been so successful that it has taken over the stock market, now accounting for between 50% - 70% of equity market volume on any given day. Fortunes have been made, with estimated annual profits exceeding \$21 billion² at its peak, and estimates varying but still in the billions of dollars today.

What we must be concerned with is whether the pendulum has swung too far, and whether the nearly unregulated activities of anywhere from 50%-70% of stock market volume should be permitted to continue down this path. For the proponents of HFT to make the case that the market is functioning well, or that only incremental reforms are needed rather than wholesale changes, they must make the case unequivocally that the market satisfies the aforementioned characteristics of tightening spreads, decreasing volatility and is a more efficient and low-cost mechanism for price discovery and capital formation today than at any time in the past, and that proposed reforms are not even worth trying.

Despite the large quantity of HFT-funded research touting the benefits of HFT (lower spreads, increased liquidity, lower volatility), there are also many research studies that prove the opposite. However, a higher-level debate on the impact of HFT on today's market should also consider the fact that catastrophic event frequency has increased, IPO's have dramatically dropped and retail investors have been fleeing the stock market in droves. The flight of the retail investor during a period of incredible stock market returns is a sure sign that this exodus is a result of mistrust rather than economic conditions. Investor confidence is non-existent, with only 15% of the public expressing trust in the stock market in the latest Chicago Booth/Kellogg School Financial Trust Index – 8% lower than those

² Rob Iati, The Real Story of Trading Software Espionage, <http://advancedtrading.com/algorithms/showArticle.jhtml?articleID=218401501>, July 10, 2009

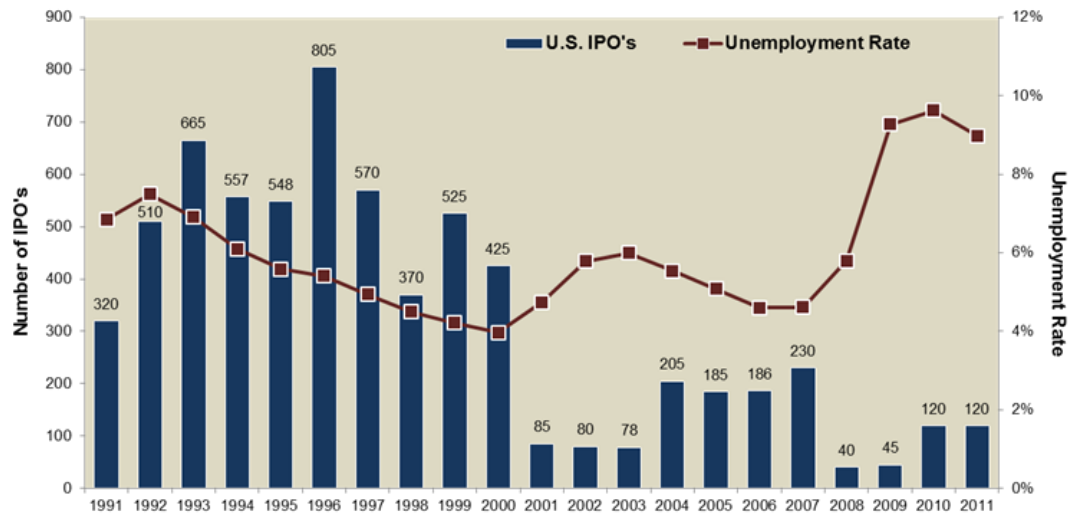
that trust the banks! The figure that follows is one of the most disturbing illustrations of the flight of the retail investor:



Source: ICI

Historically, the correlation between market performance and net flows is undeniable. Despite the rally over the past 3 years, fund inflows have not followed. Since the Flash Crash in May 2010, over \$283bn has flown out of the U.S. Equity markets. Over that time period, the S&P 500 has risen by over 21%.

This trend, along with unpredictable and increasing volatility, has also driven companies away from the stock market. From 1990–2000, the average number of firms going public each year was 530. Since 2001, that number has plummeted to 125. When companies are able to easily go public and access large amounts of capital, they are able to grow, expand and hire. When fragility, volatility and mistrust are the defining characteristics of the market, companies do not see an IPO as a viable means to raise capital, or in their long-term best interests. That has been the reality in the market for over a decade, becoming most acute since 2008. This is the connection from the market to the economy and the country as a whole, and it demonstrates how changes in market structure are affecting non-market participants. The void in the IPO market has correlated strongly with the U.S. unemployment rate over the past decade.



Source: Grant Thornton

It's important to note that these numbers are before 2012, and the debacles of the BATS and Facebook IPO's. Those technology "glitches" may well end up costing us countless jobs that cannot be realized because companies are increasingly reluctant to use the public marketplace to raise funding.

It does not make sense to address a problem before establishing that one exists. While it is clear that the symptoms of the problem – increasingly frequent market disruptions, retail investor flight and a stagnant IPO market – are dramatically demonstrated, it is instructive to examine the current state of US equity markets. I will seek to demonstrate that market quality has not been improved by high-frequency trading, and in fact that the market is more fragile than ever, to the degree that individual firms, and even individual servers, can have a disproportionate impact on the entire US equity market and by extension the global market. I will also demonstrate that the new, fragmented market is detrimental to long-term investors. Finally I will propose remedies to address these problems.

Market Quality and High-Frequency Trading

To suggest that regulatory changes are necessary to address problems in current market structure, it must be demonstrated that current market structure is not serving the needs of long-term retail and institutional investors, and that the current regulatory regime is insufficient to address problems in the market. To begin with, it must be demonstrated that there has been a material, adverse change in market structure that must be addressed.

In an interesting paper published in 2010,³ Reginald Smith asked the question “Is high-frequency trading inducing changes in market microstructure and dynamics?” He went on to demonstrate that while historically, the Hurst exponent⁴ of the stock market has been measured at 0.5, consistent with Brownian motion and our general understanding of how the market functions on small timescales, since 2005 and Reg NMS that value has been increasing. While this is certainly an esoteric statistical discussion, his conclusion is striking:

“we can clearly demonstrate that HFT is having an increasingly large impact on the microstructure of equity trading dynamics. ... this increase becomes most marked, especially in the NYSE stocks, following the implementation of Reg NMS by the SEC which led to the boom in HFT. ... volatility in trading patterns is no longer due to just adverse events but is becoming an increasingly intrinsic part of trading activity. Like internet traffic Leland et. al. (1994), if HFT trades are self-similar with $H > 0.5$, more participants in the market generate more volatility, not more predictable behavior.”

This is one of several shocking conclusions that we will examine in this testimony. It also speaks to the detrimental impact that the complexity of HFT algorithms, and their non-linear interactions, has on market microstructure. These algorithms are complex enough that it takes seasoned practitioner to understand them just in isolation, and nobody understands what happens as they interact with each other. The so-called “Great Quant Meltdown of 2007”⁵ from August 7-10, 2007, was an ominous harbinger of what was to come. Many people aren’t even aware that there was significant turmoil in financial markets in early August, 2007 because of unexpected behavior of long-short quantitative equity funds. Many of these funds were holding the same undervalued/overvalued securities, and suffered great losses when they did not revert and entered a positive feedback loop of liquidation. A full discussion of this is outside the scope of this testimony, but it was an indication that, while they were not HFT strategies, seemingly simple long/short quantitative strategies were not well understood by

³ Smith, Reginald, Is high-frequency trading inducing changes in market microstructure and dynamics? (Jun 29, 2010). Available at: http://arxiv.org/PS_cache/arxiv/pdf/1006/1006.5490v1.pdf

⁴ The Hurst exponent (H) is a measure of self-similarity, the autocorrelation of a time series. Computed using intraday data, it measures the tendency of a time series to form clusters or remain random. Random price oscillation is the cornerstone of our understanding of the stock market, and how the price discovery process occurs.

⁵ More information on this can be found here: <http://select.nytimes.com/2007/08/18/business/18nocera.html>

those who wrote them, and they certainly didn't understand the ramifications of their interactions with each other in the marketplace.

Many HFT strategies have been poached from other firms, or arrived at independently by quantitative analysts using identical techniques. This is one of the main reasons we have seen such a massive investment in technology. The sophistication of your trading strategy is no longer a defining characteristic of its success, rather the number of microseconds that it takes your software to react to a piece of market data has become one of the most important factors of success in the HFT industry.

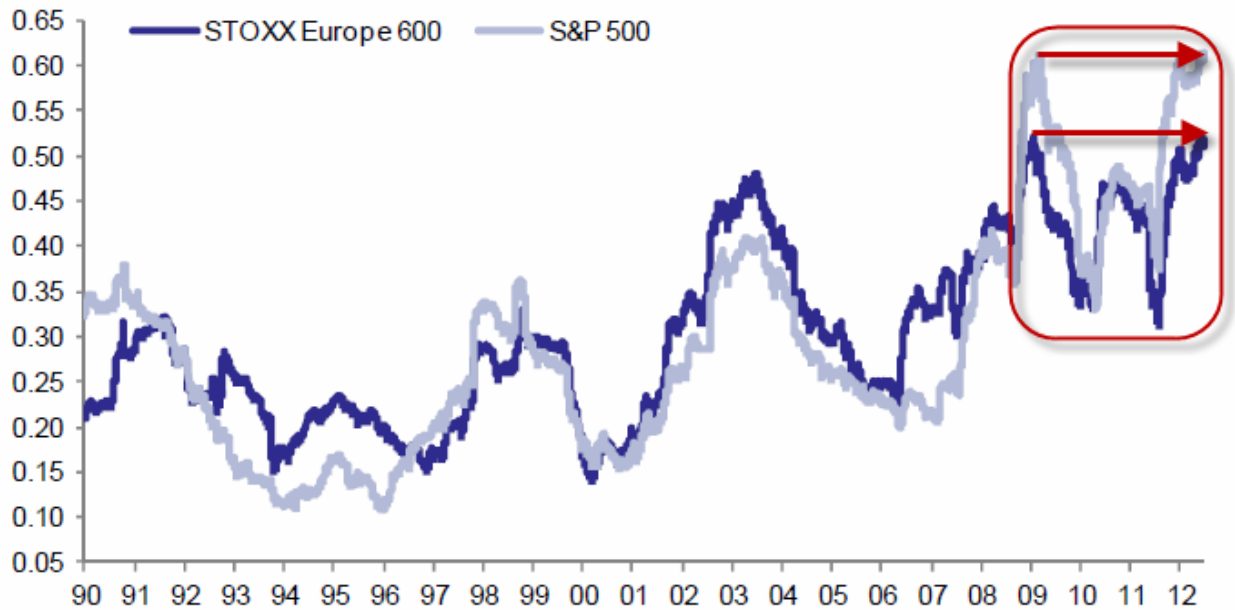
The implications of this are grave. As we see on a nearly regular basis, algorithms reacting to one another, or to manipulative behavior by nefarious actors, can exhibit non-deterministic behavior. The "mini flash crashes" that Nanex documents on a regular basis are excellent examples of this non-deterministic behavior as algorithms enter positive feedback loops either with themselves or in relation to other algorithms. Many high-frequency trading strategies rely on correlation of securities with other assets and use price movements in different securities to inform the fair-value price of another security, through high-, medium- and even low-correlation relationships. On a widescale basis, this can have unintended and non-deterministic consequences, including positive feedback loops in which liquidity is rapidly withdrawn from the market.

Giovanni Cespa and Thierry Foucault wrote a paper in March, 2012, calling this type of phenomenon an "Illiquidity Contagion."⁶ They noted that the same type of positive feedback loop I have discussed here can cause a sudden drop in market liquidity, and shift the market to a new equilibria characterized by high illiquidity and low price informativeness. That a crash in the futures market could "infect" the equity market is another symptom of the increasing interconnectedness of global security markets – equity index futures, commodities, stocks/ETF's and currencies are all now being actively traded by high-frequency traders. Using the aforementioned historical correlations has the unfortunate side effect of becoming self-reinforcing because many HFT models observe the same historical relationships and often trade assets in this manner. At the limit, when a positive feedback loop is loosed onto the markets-at-large, you can have a correlation=1 event – in other words, the Flash Crash.

The increase in correlations is a well-documented characteristic of the new electronic marketplace. Correlations between stocks are as high as they have ever been, including during the crisis in 2008, as shown in this chart from Goldman Sachs:

⁶ Cespa, Giovanni and Foucault, Thierry, Illiquidity Contagion and Liquidity Crashes (May 8, 2012). Available at SSRN: <http://ssrn.com/abstract=1804351>

Exhibit 4: STOXX Europe 600 and S&P 500 average pair-wise correlations
(12-month rolling, daily returns)



Source: Datastream, Goldman Sachs Global ECS Research.

According to JP Morgan, this “new normal” of persistently high correlations is driven by the macroeconomic environment, the increased use of ETFs and index futures, and high-frequency trading.⁷ With the stock market moving in lock-step, this means that the traditional benefits of diversification that retail investors have relied on for decades are no longer there to protect them from dramatic moves in stock market indices. It also means that the market becomes a poor indicator of company value and performance, undermining one of its core functions. In addition, the increases in volatility and correlation drive options prices higher, which increase the hedging costs to businesses that pass those costs on to their customers. Furthermore, any increase in stock market volatility has a “negative wealth effect.” Retail investors are notoriously poor at timing market moves, and have a tendency to buy when the market is high and sell when it’s low. Increasing volatility exacerbates this behavior and costs retail investors money.

It is clear that the structure of the market has changed dramatically since the advent of high-frequency trading, but that is not necessarily a bad thing. One could argue that the previous market structure was inefficient; the specialist model extracted unreasonably high rents for the service they provided, and that the benefit of tighter spreads in this new electronic marketplace outweighs the costs

⁷ J.P. Morgan, Why We Have a Correlation Bubble,
<http://www.cboe.com/Institutional/JPMDerivativesThemesCorrelation.pdf>, October 5, 2010.

of a more highly correlated market. If indeed tighter spreads and lower volatility characterize this new, more efficient marketplace, there is a case to be made that the value far outweighs the cost. We are therefore confronted with these questions:

1. Are spreads tighter, and tightening? Is volatility lower, and continuing to drop? Is the price discovery process efficient? Is the price impact of large trades acceptable? Are companies comfortable accessing capital by going public? Are regulators comfortable in their understanding of market mechanics, and able to effectively write new rules and enforce existing ones?
2. Is this the best we can do, or is there a market structure under which total transaction costs to investors are even lower? Is there a market structure that is more stable, and one that will instill confidence for institutional and retail investors?

The traditional mantra of the high-frequency trading industry is that HFT has helped to decrease trading costs by providing tighter spreads and lower volatility. One of the oft-cited studies in support of this claim was authored by employees of RGM Advisors, LLC, a prominent HFT firm. Another study was done by an employee of Credit Suisse, a major proponent of HFT. However, an increasing number of independent academic papers have demonstrated the opposite:

- Watson, Van Ness and Van Ness (2012) using Dash-5 data find that the average bid-ask spread from 2001-2005 was \$0.022 (2.2 cents), while the average bid-ask spread from 2006-2010 was \$0.027 (2.7 cents), a dramatic increase of 22.7%. In addition they document increasing volatility as measured by the standard deviation of the price of stocks, from 0.13 for 2001-2005 to 0.161 for 2006-2010, an increase of 23.85%.
- Zhang (2010) found that “high-frequency trading is positively correlated with stock price volatility after controlling for firm fundamental volatility and other exogenous determinants of volatility. The positive correlation is stronger among the top 3,000 stocks in market capitalization and among stocks with high institutional holdings. The positive correlation is also stronger during periods of high market uncertainty.”⁸ Zhang finds that estimated HFT trading volume is 78%, explaining that “78% is clearly excessive if HFT is meant to provide liquidity. If HFT were to provide all of the market’s liquidity, the volume of HFT would still be at most 50%.”⁹

⁸ Zhang, Frank, High-Frequency Trading, Stock Volatility, and Price Discovery (December 2010). Available at SSRN: <http://ssrn.com/abstract=1691679>

⁹ Ibid.

- Cartea and Penalva (2011)¹⁰ examine the impact of HFT on financial markets using a model with three types of traders: liquidity traders, market makers, and high frequency traders. The finding of their model is that high frequency traders increase the price impact of liquidity trades, increasing (decreasing) the price at which liquidity traders buy (sell). These costs increase with the size of the trade suggesting that large liquidity traders (i.e. large institutional traders making sizable changes to their portfolio) will be most affected by HFT. The authors also propose that HFT increases price volatility and doubles volume.
- Kirilenko, Kyle, Samadi, and Tuzun (2010)¹¹ examine the behavior of high frequency traders in E-mini S&P 500 futures contracts during the events surrounding the flash crash. HFT patterns surrounding the flash crash are inconsistent with traditional market making. They conclude that while high frequency traders may not have caused the flash crash, their response to the high selling pressure exacerbated volatility. (This is certainly consistent with my experience on the trading floor that day.)
- Mao Ye, Chen Yao and Jiading Gai (2012)¹² point out two effects of high frequency trading: “First, it may enable investors to seize trading opportunities. Second, it may increase adverse selection problem for slow traders and generate negative externality. Our results indicate that the second effect dominates in the sub-millisecond environment. Also, an increase in the cancellation ratio or message flow also creates another negative externality. Stock exchanges need to continuously upgrade trading systems to accommodate more message flow. These costs, finally, are covered by fees from traders. However, the current fee structure only charges trades, not cancellations. Therefore, cancellation actually creates an externality for traders with true intentions to trade, who subsidize the traders with lots of cancellations.”

From the industry, Morgan Stanley concluded in a recent report that institutional orders are having a much larger impact on asset prices now than in the period before 2007. They found that the maximum percentage of average daily volume that a Volume-Weighted Average Price trade (a very common institutional trading strategy) can handle without adverse price impact has declined from 10-15% to around 4-5% now.¹³ They believe the primary reason for this is that the percent of volume

¹⁰ Cartea, Álvaro and Penalva, José, Where is the Value in High Frequency Trading? (December 21, 2011). Available at SSRN: <http://ssrn.com/abstract=1712765>

¹¹ Kirilenko, Andrei A., Kyle, Albert S., Samadi, Mehrdad and Tuzun, Tugkan, The Flash Crash: The Impact of High Frequency Trading on an Electronic Market (May 26, 2011). Available at SSRN: <http://ssrn.com/abstract=1686004>

¹² Ye, Mao, Yao, Chen and Gai, Jiading, The Externality of High Frequency Trading (August 31, 2012). Available at SSRN: <http://ssrn.com/abstract=206683>

¹³ Crow, Charles and Emrich, Simon, ‘Real’ Trading Volume, Morgan Stanley Quantitative and Derivative Strategies Group, April 11, 2012.

attributable to natural buyers and sellers has declined by 40% when comparing the volume during 2001-2006 to that since 2008.

These studies show a clear, detrimental impact to spreads, price impact and volatility. Because there are other studies pointed to by the industry that enable them to claim the opposite, it is instructive to not only examine the academic literature and studies, but to look at the ultimate result. It is clear that long-term investors do not trust the market. The Morgan Stanley paper cited above concludes that the volume of trading attributable to institutional traders dropped from 47% in the period 2001-2006 to 29% since 2008, a decline of 40%.¹⁴ It is clear that long-term investors are fleeing equity markets at unprecedented rates. It should also be clear that there are severe inefficiencies in the current market structure, and that indeed these inefficiencies are **structural** – they are not going away without structural changes. The HFT industry continues to make billions of dollars each year by exploiting these structural inefficiencies. While there have recently been marginal declining returns to scale, it has not stopped the performance and technology race, which the HFT industry realizes is the only way that they can differentiate themselves from one another.

Structural Inefficiencies Have Created a Fragile Marketplace

The new electronic marketplace has several structural inefficiencies. These are what have permitted HFT to become a destructive force in the market, rather than a passive liquidity providing mechanism. This should not be construed to say that all HFT is bad, but there are 2 important points to make – the structural inefficiencies present in the market have created a massive misallocation of resources into technology that provides no social benefit, and structural deficiencies in market structure have allowed for nefarious or accidental actions to disrupt the market.

The overriding aspect in the current market that we should fear most is the inordinate impact that a single market participant, or even a single server, can have on the market-at-large. This is a grave concern from any perspective. Whether we are dealing with nefarious, predatory behavior such as quote stuffing and pinging, or simply accidental mistakes such as the Knight Capital fiasco appears to be, one thing should be clear: The market has become more fragile than we should expect or accept given the tremendous advances in technology over the past decades.

¹⁴ Ibid.

These structural inefficiencies have been created by the unintended consequences of regulations:

- The approval of the maker/taker model and Pay-For-Order-Flow deals.
- The disappearance of affirmative market-making obligations.
- The fragmentation of equity markets into lit and unlit market centers, with little regulation of the unlit centers.
- The rubber-stamp approval of exotic order types without proper study or justification.
- The unbridled latency race to zero without concern over the impact on markets, and the massive investment in technology required to keep pace.

While proponents of the existing market structure will argue that they must be given a free market to allow capitalism and competition to fix any inefficiency, they ignore the fact that many of the inefficiencies have been created by regulation and must therefore be remedied by regulation. They must also be reminded of the consequences of unfettered, unregulated industries with negative externalities whose costs are not borne by the producers. In much the same way that polluting enterprises have to be regulated so that they bear the cost of negative externalities, so must HFT firms.

In a ground-breaking study done at the University of Illinois at Urbana-Champaign, Mao Ye, Chen Yao and Jiading Gai demonstrated the following¹⁵:

- While aggressive investment in new technology to reduce latency has obvious benefits for market participants making that investment, it is unclear whether there is an associated social benefit when negative externalities are properly accounted for.
- They examined two consecutive technological shocks that decreased latency from microseconds to nanoseconds. They found that those shocks “drastically increase both the trading speed and the cancellation ratio, which escalates from 26:1 to 32:1. However, there is no impact on trading volume, spread, depth, or price efficiency.”¹⁶
- They go to conclude that “high-frequency trading may cause an adverse selection problem for slow traders” and that this effect “dominates at the sub-millisecond level.”¹⁷

¹⁵ Ye, Mao, Yao, Chen and Gai, Jiading, The Externality of High Frequency Trading (August 31, 2012). Available at SSRN: <http://ssrn.com/abstract=206683>

¹⁶ Ibid.

¹⁷ Ibid.

- They also demonstrate conclusive evidence for quote stuffing, a practice in which the infrastructure of data feeds is manipulated in order to slow down traders with inferior technology and to take advantage of this. They shockingly demonstrate “clear evidence of co-movement of message flow for stocks in the same channel through factor regression. This result is consistent with quote stuffing, because message flow of a stock slows down the trading of the stock in the same channel, but does not have the same effect on stocks in a different channel.”¹⁸ This claim is reinforced by Egginton, Van Ness and Van Ness who “find that quote stuffing is pervasive with several hundred events occurring each trading day and that over 74% of U.S. listed equity securities experience at least one episode during 2010.”¹⁹ Why is this such a shocking conclusion? Stock symbol distribution across channels is alphabetic – essentially random. You would expect co-movement of message flow across industries or correlated stocks, but not based on an alphabetic distribution. This is clear evidence of market manipulation.
- Finally they demonstrate that 50ms would be a reasonable “speed limit” for minimum quote life, as they find that 30-40% of orders are canceled within 50 milliseconds and they have a trivial if any contribution to liquidity. The elimination of these orders could have a \$0.0000378 increase in quoted spread, or 0.5 share decrease in depth within 10 cents of the best bid and ask. In addition, limit order books without these orders have the same variance ratio (a measure of price discovery and efficiency) as order books with these orders.

It seems that in the latency race to zero, it is those participants who are not engaged in this race that are paying the unintended costs. Market data feed volume has risen exponentially in recent years, and increasing technology investments are being borne by retail and institutional investors in the fees that they must pay to trade. The genesis of this problem was the maker-taker business model of the for-profit exchange / ECN / ATS. This business model is designed to compensate those who provide liquidity by charging those who take it. Almost every single exchange now makes money on the spread between the rebate paid to liquidity providers (previously market makers, now HFT firms) and the fees charged to institutional and retail investors to take liquidity. This has created a tremendous conflict-of-interest for exchanges, especially now that they are publicly traded and beholden to shareholders (at least in the case of Nasdaq, NYSE, and eventually BATS). They make money through volume and churn, and have little incentive to maintain fair, orderly markets.

¹⁸ Ibid.

¹⁹ Egginton, Jared F., Van Ness, Bonnie F. and Van Ness, Robert A., Quote Stuffing (March 15, 2012). Available at SSRN: <http://ssrn.com/abstract=1958281>

Another consideration with the maker-taker model is the complete lack of viable alternatives. Exchanges have had “glitches” and blow ups, notably BATS and Nasdaq during high-profile IPO’s. Yet their market share has not suffered because, frankly, there are no viable alternatives. This is not to say that there’s no hope. Other efforts are underway to provide an alternative business model, of which I am devoting my expertise and time to one of those potential alternatives. In our current environment, a two-pronged approach is critical: regulators must address structural inefficiencies, transparency, level playing field, anti-fraud and related matters, while allowing private industry’s innovation and developments to operate in a fair and open marketplace.

The increasing fragmentation of the marketplace and the advent of pay-for-order-flow deals have led to a phenomenon called adverse selection. This means that profitable trades (from a market-making perspective) never reach the market. Retail and institutional order flow pass through a gauntlet of internalizers and high-frequency trading desks, which pick off any profitable order flow before it ever reaches the public, lit market. While these orders are filled within the NBBO, meaning that the originator of the order is no worse off on that particular order, market quality as a whole suffers. Natural buyers and sellers are virtually nonexistent under this structure, and the majority of the volume on the exchanges becomes “toxic flow” an industry term for orders that nobody wants to interact with. The end-product is consistent with the Morgan Stanley report cited above, although for different reasons than the authors of the report would point to. Other countries mandate significant price improvement to internalize order flow, but the SEC has not.

Dan Weaver, a professor out of Rutgers University has designed a research study to measure what the impact of dark pools and extreme fragmentation has been on the lit venues. He has found that trading in off-market venues such as dark pools directly impacts the spread in the lit markets, and that the cost of trading is 1.28 cents higher in NYSE lit markets because of this.²⁰ Weaver goes on to say that “as the percentage of internalization increases, average trades will have an increasing impact on prices. Finally, for all market segments, higher levels of internalization are associated with higher levels of return volatility.”²¹ And in fact, in his literature review, Weaver reviews two studies that demonstrate that “the internalizing of uninformed order flow by discriminating dealers reduces the number of

²⁰ Weaver, Daniel G., Internalization and Market Quality in a Fragmented Market Structure (May 19, 2011). Available at SSRN: <http://ssrn.com/abstract=1846470>

²¹ Ibid.

uninformed orders for the non-discriminating dealers to spread their informed losses over. The result of this is a widening of spread charged by the non-discriminating dealer.”²²

The current level of fragmentation and complexity is helpful to HFT firms. They are the masters of the complexity, some of the few actors in the market that understand the relationships and interconnectedness and realize high returns based on arbitrage. They also use these unlit venues as signaling mechanisms, and many of these venues cater to them, for a price.

Adding to the complexity in the current market structure is the proliferation of exotic order types. While the SEC deliberates extensively on any rule change and regulation, the hurdle is far lower for new order types. It is extremely rare to have the SEC refuse an exchange’s request for a new order type, regardless of whether the order type does anything to further price discovery or make markets more efficient.

Many of the newest order types appear to have been designed by the HFT firms themselves, with little to no utility outside of their automated strategies. It remains completely unclear what social utility comes of hidden midpoint pegs, sliding, hide-and-slide, post-only, PNP, PL select and the rest of the alphabet soup of order types. Even sophisticated sell-side algorithmic trading desks rarely use anything other than a limit order, an order for the opening/closing auction and maybe a midpoint or peg order. HFT firms thrive on this contrived, structural complexity. They make it their business to understand these order types and how best to exploit them.

What Can Be Done?

The current structure of the US equity markets is demonstrably unwieldy, overly complex, and extremely fragile. It is subject to manipulation, whether nefarious or accidental, on a daily basis. Spreads are no longer tightening and volatility is no longer dropping. The price impact of large, institutional orders is rising.

Technological mayhem is more frequent and likely to increase. These events are not technology “glitches” and “bugs,” as the industry and its allies like to dismissively refer to them as, because they wreak havoc on the market in multiple material ways. It is simply a matter of time before we have another catastrophe of the same magnitude or worse than the Flash Crash. The next time it happens, we may not be so fortunate with regard to the timing – it was only luck that the Flash Crash didn’t start in

²² Ibid.

the morning, inciting markets around the world to crash, or at 3:45pm EST, with the market closing after the drop, but before it could recover. If this were to happen, there would be an overnight exodus from the market with disastrous consequences for the US economy.

In addition, until confidence in markets is restored, retail investors will continue to stay away, regardless of the returns they're missing (as has been shown over the last 2 years), and companies will hesitate to go public costing untold jobs.

I'd like to start with a proposal for some concrete steps that regulators can take to address much of the instability and unfairness in capital markets:

1. Unify trading rules, regardless of venue – exchange, ATS, ECN and dark pools should all abide by the same general rules. Require substantial price improvement to internalize flow. This means more than \$0.001.
2. To receive a rebate from any venue on which securities are transacted, a market participant must be a genuine registered "market maker" subject to affirmative market making obligations. All such rebates or other compensation must be disclosed.
3. Mandate a unique identifier for every supervisory individual. This ID would have to be attached to every quote submitted to any venue, and provide a mechanism for regulators to associate quotes with the supervisory individual on the trading desk.
4. Eliminate pay-for-order-flow practices.
5. Establish strong, clear market technology standards and regularly audit firms to ensure they are being followed.
6. Revoke order type approval for order types that do not have a clearly demonstrated utility to long-term investors and market stability.

It cannot be legitimately denied that the fragmentation of the equity market has added unnecessary complexity and created structural inefficiencies. A change of mentality is required from a regulatory point-of-view: from the view that there are market centers to be regulated to the view that there is a marketplace to be regulated, independent of individual market centers. Reg NMS (National Market System) was a first step down this path, but the mentality must be embraced at every level.

Rules and regulations should apply to all actors and all venues where security transactions are taking place. All of the ideas referred to here are guided by this principle. In addition, much greater coordination and visibility must be achieved across asset classes. HFT firms trade equities, futures, FX

and treasuries without blinking. It's near impossible to regulate the industry without a cross asset-class viewpoint.

As mentioned before, the maker-taker business model leads to skewed incentives for exchanges and "good times" for liquidity providers. A simple change could have a dramatic impact on the quality of liquidity in the market and the level of volatility: any venue that offers any type of rebate for liquidity provision should be required to tie that rebate to affirmative market-making obligations. According to a review by Charitou and Panayides (2006), many markets around the world have embraced a form of this model, including the Toronto Stock Exchange, the London Stock Exchange, the Deutsche Bourse, Euronext, and the main stock markets of Sweden, Spain, Italy, Greece, Denmark, Austria, Finland, Norway, and Switzerland. All of them designate market makers with affirmative obligations to supply liquidity for at least some stocks. The London Stock Exchange requires market makers to register and to maintain quotes within a maximum spread band, and with minimum size.

Another study by Bessembinder, Hao and Lemmon (2011) concluded the following about the maximum spread model²³:

- A maximum spread rule will lead to a narrowing of bid-ask spreads, not a widening, and that will lead "to increased trading, which can improve allocative efficiency in the presence of information-based externalities."
- This type of rule "can improve social welfare" as long as the "spread is not constrained to be less than the real friction, i.e. the social cost of completing trades."
- Such a rule can also increase the speed of price discovery by encouraging more trading by both informed and uninformed traders.
- Most importantly, they show that "future flash crashes can be potentially avoided, and economic efficiency enhanced, by agreements calling for one or more designated market makers to continue to provide liquidity during periods of enhanced information asymmetries. While the DMMs would need to be compensated for their losses suffered at such times, the social gains from trade would exceed the costs."

There is no doubt that many if not all of these ideas are controversial. However, historically ideas such as these have not been so controversial. It's not clear what mechanism can be used to compensate DMMs for losses during severe events. It should be clear that it is in the public interest to

²³ Bessembinder, Hendrik (Hank), Hao, Jia and Lemmon, Michael L., Why Designate Market Makers? Affirmative Obligations and Market Quality (June 2011). Available at SSRN: <http://ssrn.com/abstract=989061>

have DMMs provide liquidity during high-stress events, so it is worth thinking creatively about whether the public or individual exchanges can help to backstop liquidity providers during these events. There is no doubt, however, that liquidity providers are making substantial profits, but without affirmative obligations to maintain markets they are shifting much of the risk to the public. If the market is truly a public good then it is incumbent on regulators to ensure that it remains stable, fair and orderly, rather than ensuring that exchanges continue to profit from the maker-taker model.

The SEC should also maintain a database of supervisory individuals and assign a unique identifier to each of them. Any venue that accepts incoming orders can mandate the inclusion of another field that would contain the unique ID of the supervisory individual. While this information would not be propagated publicly, it would be available to exchange surveillance teams and to regulators. This would have a two-pronged effect. It would allow rapid identification of individuals responsible for aberrant order flow, and provide the ability to quickly contact them and find out what is happening. In addition, it would remove the cloak of anonymity that participants currently enjoy, and thereby act as a deterrent to predatory behavior such as quote stuffing, stop-hunts and other manipulative behavior. The technological effort to implement this is not trivial, but it is not complex either. As someone who has worked with these applications, protocols and connections for nearly a decade, I can tell you that it could be implemented in a month or less if so mandated.

The practice of selling retail order flow, what is commonly referred to as Pay-For-Order-Flow, should be ended. It exacerbates the problem of adverse selection discussed earlier, and removes natural buyers and sellers from the market. It is having a negative impact on market quality, with no benefit other than to the firms selling their order flow and to those firms able to pick out the lucrative orders before sending the toxic ones to market.

Finally, the bar for order type approval should be raised to be similar to any regulatory or rule change. The SEC demands evidence that any changes benefit the market, and should do the same with exotic order types. As Scott Patterson demonstrates in his book, Dark Pools, these order types are having a poorly understood impact on markets and long-term investors. Many order type approvals should be revoked, and the burden of proof placed on the exchange to demonstrate their social utility.

Additionally, I believe the SEC should consider some more creative, novel ideas for limited implementations or pilots to assess their efficacy and actual impact on the market. These ideas include:

- A 50ms minimum quote life / time-in-force

- Open up access to historical and current market data, and incentivize programmers to help design better tools for regulators.
- Greatly increase the SEC's technology capabilities. This means a substantial investment in technology and personnel, and creative thinking about market-wide surveillance.

The SEC should consider a 50ms minimum quote life, at least on a pilot basis, to observe what the actual impact would be. With so much evidence against the utility of "fleeting orders" it is at least worth considering. This is the type of effort that could be rolled out quickly on a preliminary basis, in order to examine what the impact actually is. Not only would removing those orders help reduce the technology burden to firms to participate in markets, but the requirement to stand by a quote, at least for 1/6th of the time it takes to blink an eye, could help to change some of the behavior of HFT strategies. Claims that this would widen spreads are unsubstantiated, and must not be accepted until proven in a pilot program. One reasonable concern is the cross-asset nature of securities, and therefore in a broader rollout, such a program should be considered within a cross-asset perspective and effort.

Finally, a dramatic change in how market data and surveillance are viewed should be considered. The Internet and Open Source efforts have taught us that open systems are nearly always preferable to closed. In that spirit, and under the premise that markets are a public good, market data feeds and tick data history should be opened up. It is critical to understand that many academic papers are skewed because they are either funded directly by the industry, or provided access to expensive and proprietary data by the industry. Opening up access to this data would have a dramatic effect.

Access to the historical data of direct market data feeds should be made available freely to the public, and a prize-based incentive created for those who can find innovative ways of designing surveillance systems and algorithms. While the exchanges will surely argue vigorously against this idea as market data is a major profit engine for them, it is in the public's interest for the regulation and enforcement to move out of the 20th century.

The SEC should also consider implementing a market-wide surveillance mechanism. In this new interconnected market, individual surveillance groups at market centers are not sufficient. The SEC must build sophisticated surveillance capabilities. They have taken a first step, although unfortunately a very inexplicable one. They have contracted with a prominent HFT firm to build a ticker plant, the first step towards processing and storing market-wide tick data. This is reminiscent of the fox guarding the hen house. This HFT firm is not in the business of building ticker plants. They are in the business of making

money trading. They would not have taken this on if they did not believe it was in the long-term best interests of their trading profit center.

In addition, there are a multitude of vendors who do this all day everyday – why one of them was not chosen for this contract is inexplicable. The SEC should consider canceling the contract with the HFT firm or just contract with a technology vendor, just as any other firm would. The SEC should also hire quantitative researchers, and compensate them as close as possible to industry rates, along with bonuses based on a percentage of the fines that they are able to uncover through data analysis. The SEC needs to attract top-line talent, and to do so they must be able to compensate competitively. This is an arms race that Wall St. is winning easily right now. While the SEC has obvious budgetary constraints, they can get creative about bonuses, potentially offering % of fines, similar to their whistleblower program.

The quantitative data analysis will be made much more robust with the unique identifiers associated with supervisory individuals mentioned earlier. The SEC should work very closely with individual surveillance teams at the exchanges, leveraging best-of-breed ideas, and helping those that are behind to catch-up. A market-wide surveillance system could eventually be expanded into a robust set of technology standards, tripwires/speed bumps, and other mechanisms for quickly detecting aberrant or nefarious behavior and immediately throttling or cutting off the offending firm's market access.

Many of the ideas referenced here are not popular within the HFT industry. Whenever an idea is proposed that they do not agree with, they respond that there is no way they can operate under such rules, they will go out of business, spreads will blow out, the market will cease to function, and generally the sky will come crashing down and life will end as we know it. I have worked with these folks for years now, and I must have a much higher opinion of their capabilities than they do. These are some of the smartest people in the world, and they will figure out how to continue to make money, and compete, albeit on a more level playing field. Some will go out of business, as is the nature of capitalism, and some will thrive. In the end our markets will be much more stable, resilient and effective price discovery and capital formation mechanisms, and confidence will be restored to the retail and institutional investors.